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In This Issue

- Comminuted Intraarticular Distal Radius Fractures: Functional Outcome and Short-term Follow-up after Surgical Treatment with Spanning External Fixation
  AlSaifi1Mohammed, et al.
- Incidence, Clinical Profile and Prognostic Indicators for Visual Outcome in Traumatic Cataract Surgery in Yemen
  Alakhlee Hisham, et al.
- Clinical Presentation Variants of Chronic Subdural Hematoma Cases
  Me'asar Mojahed, et al.
- Epidemiological Description of Primary Brain Tumors: A Single-Center Retrospective Study of 75 Cases, Yemen
  Shamsaldin Mohamed, et al.
- The Role of Clinical Pharmacists in the Detection and Evaluation of Adverse Drug Events: A Review Article
  Al-Akhali Khaled and Alyahawi Ali.
- Application of Genome-Based Therapy in Clinical Pharmacy Practice: Prospects and Challenges.
  Al-kaf Ali G. and Alyahawi Ali.
- Lumbosacral Nerve Root Compression by Gravid Uterus as a Cause of Sciatica in Pregnancy: Diagnosis by Exclusion
  Al-Dofri Saif.

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Original Research Article

Comminuted Intraarticular Distal Radius Fractures: Functional Outcome and Short-term Follow-up after Surgical Treatment with Spanning External Fixation

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Abstract

Background: Treating a severely comminuted distal radius intraarticular fracture is challenging as it can lead to disability, unless the alignment of the fractured bones is restored as accurately as possible and maintained in an anatomical position.

Objective: This study aims to assess the efficacy of utilizing an AO spanning external fixator in the treatment of comminuted distal radius intraarticular fracture.

Methods: Between January 2020 and September 2022, 38 individuals with isolated closed comminuted intraarticular distal radius fractures (DRFs) were enrolled in this research. The patients underwent clinical and radiological evaluations using the AO classification system in the emergency department. The patients were taken to the operating theatre, where closed reduction techniques and a stable mini-AO spanning external fixator were employed to restore the radiological parameters of the distal radius. The functional status of the patients was assessed at 3, 6, and 12 months using the modified Green and O'Brien scale. The collected data were then analyzed to evaluate treatment outcomes.

Results: 32 (84%) patients were males with an average age of 32. Among the cases, 45% of the patients had AO-23C3 fractures, while 55% had AO-23C2 fractures. The procedure duration ranged from 15 to 25 minutes. The external fixator was removed after a median period of seven weeks. Additional percutaneous K-wires were used in 6 patients for enhanced stability. Three

Mohammed Saleh AlSaifi[1]*, Khaled Mohammed Swailem[2], Randa Ahmed AlSalahi[3], Anwer Abdulqader Mahyoub[2], Mohammed Nagi Zaid[4]

patients experienced pin tract infections during treatment. Radiographic measures of the distal radius showed normal values. Functional outcomes were favorable; with 55% of patients had excellent results, 29% experienced good outcomes, and 11% and 5% presented fair and bad outcomes respectively.

Conclusion: Severely comminuted DRFs can be effectively treated with minimally invasive spanning external fixation, restoring anatomical and radiological parameters and achieving favorable functional outcomes

Keywords: Distal Radius Fracture, External Fixation, Radiological Parameters, Anatomical Parameters, Surgical Treatment

Introduction

Distal radius fractures (DRFs) are among the most common orthopedic injuries, accounting for approximately 17% of all fractures in adults. Comminuted DRFs, characterized by multiple bone fragments, present unique challenges due to their inherent instability and risk of malunion, which can lead to chronic pain, reduced wrist function, and diminished quality of life [1]. While treatment options range from conservative casting to open reduction and internal fixation (ORIF), severely comminuted fractures often require advanced stabilization techniques [2]. Spanning external fixation (SEF), which bridges the wrist joint to maintain alignment while allowing soft tissue recovery, has emerged as a viable option [3].

SEF is a well-established technique for managing unstable and highly comminuted distal radius fractures [3]. It provides indirect fracture reduction by ligamentotaxis, stabilizes the fracture fragments, and maintains the wrist in a functional position during the healing phase. Compared to open reduction and internal fixation (ORIF), external fixation offers the advantage of minimal soft tissue disruption, making it particularly useful in cases with compromised soft tissue conditions or polytrauma patients. However, concerns remain regarding its efficacy in achieving anatomical reduction, long-term functional outcomes, and the risk of complications such as joint stiffness and pin tract infections [3,4].

Previous studies have reported variable results, with some suggesting that SEF provides satisfactory functional recovery, while others highlight limitations in regaining wrist motion and grip strength. Moreover, the comparative advantages of SEF over volar plating or hybrid fixation strategies remain unclear [5]. Given these uncertainties, there is a need for further investigation into the clinical efficacy, radiological outcomes, and complication rates associated with SEF in the treatment of comminuted DRFs.

This study hypothesizes that SEF provides adequate stabilization, satisfactory radiological reduction, and acceptable functional outcomes with a manageable complication profile, making it a viable treatment option for comminuted DRFs. Accordingly, the aim of the study is to evaluate the functional outcomes of SEF in

comminuted DRFs, assess the radiographic parameters postoperatively, including radial height, radial inclination, volar tilt, and articular step-off, and determine the complication rates associated with SEF, including pin tract infections, stiffness, and malunion.

Methods

This retrospective analysis was conducted at the Orthopedic and Trauma Department of Al Thawra Modern General Teaching Hospital in Sana'a, Yemen. The study included 38 patients with severe intra-articular comminuted DRFs treated between January 2020 and September 2022. Data were retrospectively retrieved from medical records, surgical reports, and admission databases using a standardized data collection form. Data were entered into a structured electronic database. Double-data entry verification was performed to minimize transcription errors and missing or ambiguous entries were cross-referenced with original source documents.

To ensure demographic and clinical homogeneity, exclusion criteria comprised:

- Concomitant neurovascular injuries or compartment syndrome,
- Ipsilateral fractures of the hand, forearm, elbow, or humerus,
- Pathological fractures or open fractures (Gustilo-Anderson type III), and
- Patients aged <20 years.

The patients were evaluated clinically and radiologically. The fractures were classified according to the AO classification system in the emergency department to ensure that only patients with fractures meeting the inclusion criteria were included in the study. Subsequently, the patients underwent a surgical procedure in the operation theater. Closed reduction was performed, and a stable mini-AO spanning external fixator was applied to the wrist joint to restore the radiological and anatomical parameters of the distal radius. The mini-AO spanning external fixator is employed in the management of intra-articular comminuted DRFs due to its ability to address the biomechanical challenges posed by severe fragmentation and joint instability. Unlike internal fixation, which risks further disrupting compromised bone or soft tissues, the spanning fixator utilizes ligamentotaxis—applying traction across the wrist joint to indirectly realign displaced articular fragments through tensioned ligaments and capsular structures. This minimally invasive approach preserves periosteal blood supply critical for healing, reduces infection risk, and avoids hardware failure in osteoporotic or highly comminuted bone.

The distal pins were inserted into the second metacarpal proximally at the transition from the head to the shaft and distally at the transition from the shaft to the metacarpal base. The pins achieved good cortical stability. The proximal pins were inserted perpendicular to the transverse section of the radius, proximal to the muscle bellies of abductor pollicis longus (APL) and extensor pollicis brevis (EPB). The pins insertion technique was applied according to AO principles.

Postoperative control X-rays were obtained immediately after the surgery and were

Mohammed Saleh AlSaifi[1]*, Khaled Mohammed Swailem[2], Randa Ahmed AlSalahi[3], Anwer Abdulqader Mahyoub[2], Mohammed Nagi Zaid[4]

repeated during the first postoperative visit after one week. Routine follow-up appointments were scheduled for the patients at 6, 9, and 12 weeks, during which a physiotherapist was consulted. The external fixation device was removed once the radiological and clinical signs of fracture healing were observed. The functional evaluation of the patients was conducted at 3, 6, and 12 months of follow-up.

The outcomes were assessed using the Modified Green and O'Brien functional score (**Table 1**).

Table 1: Modified Cooney Green and O'Brien Functional score for wrist

Variables	Findings	Score
Pain	No pain	25
	Mild Occasional	20
	Mild, regular, no significant effect on activity	15
	Moderate, activity reduced, no pain at rest	10
	Severe pain at rest	0
Range of Movements (arc)	>140°	25
	100-140°	20
	70-99°	15
	40-69°	10
	<40°	0
Hand Grip (compared to normal side)	Normal	25
	75-90°	20
	50-74°	15
	25-49°	10
	<24°	0
Activity	No limitations	25
	Normal duties, some medication	20
	Light duties due to wrist pain	15
	Unable to work	0
Results	Excellent	90-100
	Good	80-89
	Fair	65-79
	Poor	<65

It is a functional assessment tool originally designed to evaluate outcomes of wrist injuries, particularly DRFs. It combines objective measurements (e.g., range of motion, grip strength) and subjective patient-reported outcomes (e.g., pain, functional limitations) to generate a composite score. While less commonly used today, compared to alternatives, but it provides a comprehensive assessment as it integrates both objective biomechanical parameters (e.g., radial deviation, supination) and subjective patient experiences; providing a holistic view of wrist function. In addition to strongly correlates with radiographic alignment, it is useful in prioritizing anatomical outcomes.

The statistical analysis of data was performed using a recent version of SPSS program, with frequencies and percentages used for categorical variables.

Results

This study included a total of 38 cases, with the majority being males, accounting for 32 cases (84%), while the remaining 6 cases (16%) were females **(Figure 1).**

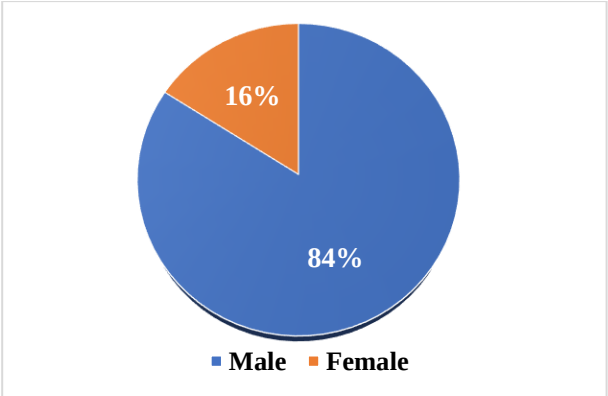

Figure 1: Gender of the presented cases

Mohammed Saleh AlSaifi[1]*, Khaled Mohammed Swailem[2], Randa Ahmed AlSalahi[3], Anwer Abdulqader Mahyoub[2], Mohammed Nagi Zaid[4]

The age distribution of the patients showed that 18 cases (47%) fell within the age range of 31-40 years, followed by 10 cases (26%) in the age range of 41-50 years, 6 cases (16%) in the age range of 20-30 years, and 4 cases (11%) over 50 years of age. The mean age of the patients was 32.16 ± 7.46 years, with a mean BMI of 24.7 ± 4.39 kg/m2. Among the cases, 22 (58%) were affected on the right side, while 16 (42%) had fractures on the left side. According to the AO classification, 21 cases (55%) were classified as AO 23C2, and 17 cases (45%) were classified as AO 23C3 (**Table 2**).

Table 2: Detailed information on the included cases

Characteristics	Findings	Frequency (N)	Percentage %
Age (years)	20-30	6	16
	31-40	18	47
	41-50	10	26
	>50	4	11
Affected Side	Left	16	42
	Right	22	58
AO Classification of fracture	AO 23C2	21	55
	AO 23C3	17	45

Falling was found to be the primary cause of fracture, accounting for 32 cases (84%), while 6 cases (16%) were attributed to road traffic accidents (**Table 3**).

Table 3: Causes of injury based on the collected data

Causes	Frequency (N)	Percentage %
Fall down	32	84
RTA	6	16
Total	38	100

Table 4: Time for EX FIX removal with percentage

Variables	Frequency (N)	Percentage %
4 weeks	1	3
6 weeks	8	21
8 weeks	19	50
>8 weeks	10	26
Meantime (weeks)	7.4 ± 10.59	

Among all the cases, postoperative complications were observed in 6 patients, representing a frequency of 15.8%. The most common complication was pin tract infection, which occurred in 3 patients (7.9%). Additionally, 2 cases (5.35%) experienced loss of reduction, and 1 patient (2.6%) sustained tendon or nerve injury **(Figure 2).**

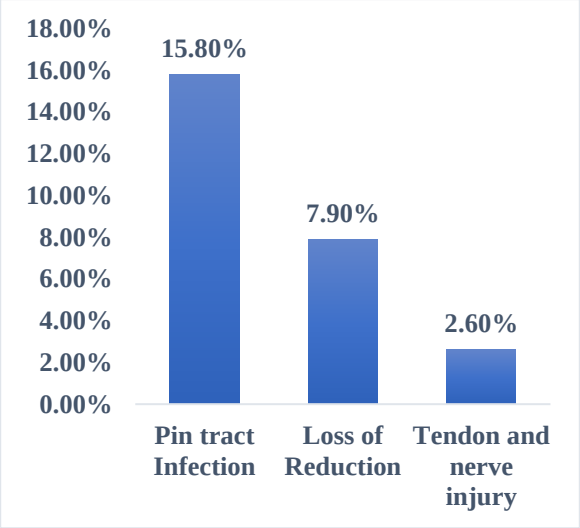

Figure 2: Common Complications after spanning EX. Fix for distal radius

Mohammed Saleh AlSaifi[1]*, Khaled Mohammed Swailem[2], Randa Ahmed AlSalahi[3], Anwer Abdulqader Mahyoub[2], Mohammed Nagi Zaid[4]

All patients included in the study exhibited nearly normal values in the radiographic parameters of the distal radius, as indicated in **Table 5.**

Table 5: Postoperative radiological parameter

Postoperative Radiological parameters	Frequency	Percentage %	Mean Value
Radial Height or Length (PA view)			
<11 mm	11	28.9	12.5 ± 2
>11mm	27	71.1	
Radial Inclination (PA view)			
<20	17	44.7	21 ± 3
>20	21	55.3	
Palmar TILT (Lateral View)			
<15	24	63.2	10 ± 3
>15	14	36.8	
Intraarticular Step Off	We tried to keep the step equal to or less than 2mm for all the cases.		

Based on the modified Green and O'Brien clinical rating system, the treatment outcomes were assessed, and the results are summarized in **Table 6**. Among the cases, 21 (55%) were classified as having an excellent result, 11 cases (29%) were rated as good, 4 cases (11%) as fair, and 2 cases (5%) as poor.

Table 6: Outcome assessment using Modified Green and O'Brien score

Modified Green and O'Brien Score	Frequency	Percentage %
Excellent	21	55
Good	11	29
Fair	4	11
Poor	2	5

Discussion

DRFs pose significant challenges in terms of treatment and are commonly encountered by orthopedic surgeons [6]. Surgical management of these fractures can benefit from using ligamentotaxis in conjunction with external fixators as it allows for fracture alignment, preservation of radial length, and adequate reduction under fluoroscopy. However, it is essential to note that achieving anatomical repair of the articular surface may not always be feasible with this approach. Late metaphyseal collapsing and the time required for new bone development to fill the fracture voids can limit the ability to achieve precise anatomical restoration [7]

The current study presented 38 patients with comminuted intraarticular DREs. Most of the patients in this study were males, accounting for 84% (32 cases), with a mean age of 32 years (range 20-50 years). The fractures were classified as AO-23C3 in 17 cases (45%) and AO-23C2 in 21 cases (55%). Falling was identified as the most common cause of fracture, occurring in 32 cases (84%), while road traffic accidents accounted for 6 cases

(16%). Advanced age and severe comminution were identified as predictors of unexpected outcomes in DRFs treated with SEF. The results of this study are compatible with the results of a study made by [8], which reported that most of the patients were males and depended on AO on fracture classification. This study is also congruent with the study of [9]in the sense that the most common cause of DRFs was falling down.

Maintaining radial inclination and volar tilt in the wrist joint is essential, as even minor deviations in these angles can significantly impair wrist flexion and other movements [10]. Research has demonstrated a positive correlation between the preservation of radial height and functional outcomes, with a radial height of 6 mm or less being considered suboptimal [11]. In the present study, 71% of patients achieved a post-treatment radial height of 11 mm or less, which aligns with the desired target in the surgical management of distal radius fractures (DRFs) and is associated with favorable functional outcomes. In contrast, a comparison of functional and radiological outcomes between DRFs treatment, utilizing bone marrow injection combined with ligamentotaxis versus ligamentotaxis alone, revealed that both techniques effectively preserved radial height, radial inclination, and volar tilt throughout the application of the external fixator [12] Moreover, all patients in the current study exhibited distal radius radiographic parameters within or near the normal range, in association with the favorable outcomes recommended in previous studies.

In this study, the average duration of the operation was 15 minutes, ranging from 15 to 25 minutes, which is considered a fast time when compared with the time reported in the study made by Attia et al. (2022)[13]. The external fixator was typically removed after an average of seven weeks, which lasted two weeks more when compared with the results of the study done by Leung et al. (1990)[14]. In the present study, excellent outcomes were observed in 55% of cases, while 29% achieved good results. Additionally, 11% and 5% of cases reported fair and poor outcomes respectively, based on the modified Green and O'Brien score. These results are lower than those reported by Bradway et al. [15], who documented an excellent outcome rate of 65%. However, our study demonstrated a lower percentage of fair and poor outcomes. The variation in scores between studies may be attributed to differences in fracture severity, which could influence treatment outcomes and overall functional recovery.

In cases where the fracture involves the articular or metaphyseal surfaces or is accompanied by significant periarticular damage, external fixation alone may be insufficient to achieve proper alignment of fracture fragments and maintain reduction stability [16]. To address this limitation, Rectenwald et al. [17] demonstrated that the combination of external fixation with Kirschner wires (K-wires) enhances stability and preserves the achieved reduction until bone callus formation. In the present study, K-wire fixation was frequently utilized alongside spanning external fixation to ensure optimal alignment and secure fixation. This approach aligns with the recommendations of

previous studies, supporting its efficacy in managing complex DRFs.

In the present study, postoperative complications were reported in 6 cases (15.8%). Pin tract infection was observed in 3 patients (7.9%), loss of reduction occurred in 2 cases (5.35%), and tendon or nerve injury was noted in 1 case (2.6%). These findings are consistent with previous studies that reported similar complication rates [18,19]. Additionally, long-term patient complaints were primarily associated with intraarticular fragments and osteopenia, which were attributed to prolonged implant use.

A 32-year-old patient experienced a closed comminuted right distal radius fracture following a road traffic accident (RTA). The fracture was managed through closed reduction and external fixation, further reinforced by the addition of K-wires within the spanning external fixation.

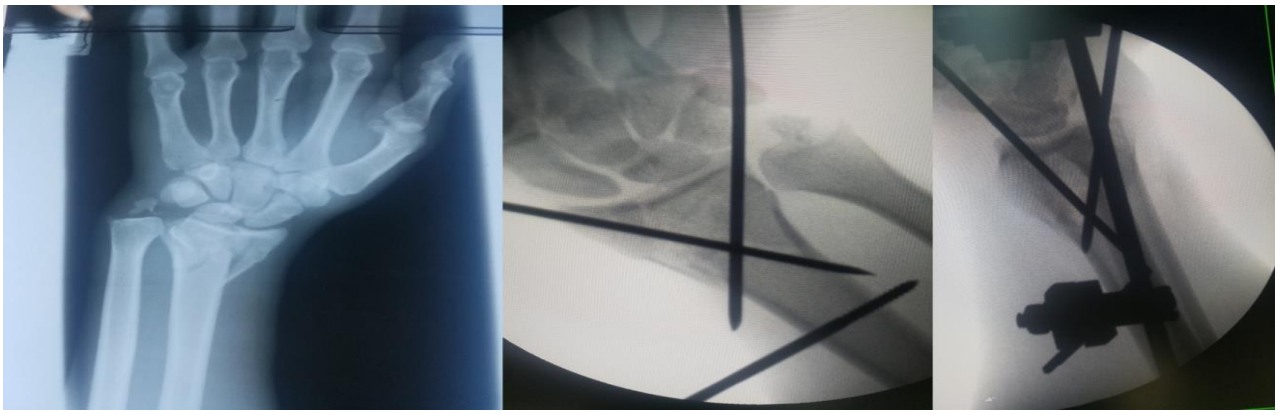

Figure 3: Closed reduction & Ex. Fix. augmented by cross K-wires done by spanning EX. FIX

Similarly, a 48-year-old patient suffered multiple trauma, including a closed comminuted right distal radius fracture due to RTA. The fracture was treated through closed reduction followed by applying spanning external fixation and K-wire.

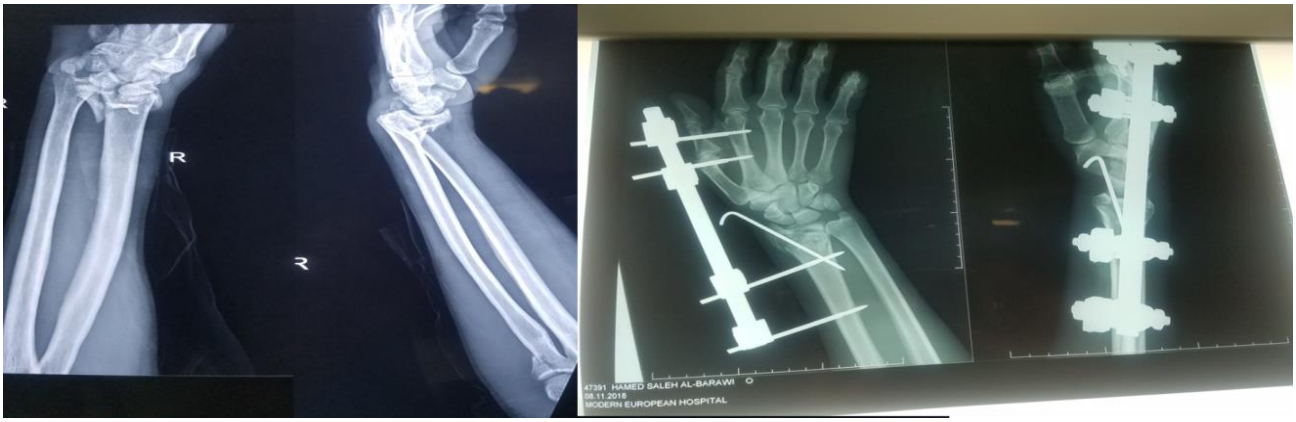

Figure 4: Closed reduction and spanning Ex. Fix. and K-wire

Existing literature indicates that comminuted intraarticular DRFs present significant challenges in achieving articular congruity when managed solely with external fixation [8,20,21] . This limitation arises from the inability of external fixation to function without soft tissue hinges or to restore the volume of compressed cancellous bone. Consequently, supplementary techniques are often required to enhance the effectiveness of external fixation in treating these fractures. These adjunctive approaches may include the use of Kirschner wires (K-wires) [8,22], limited open reduction with or without bone grafting [23] and arthroscopically assisted reduction [24].

Conclusion

SEF is an effective and minimally invasive treatment modality for comminuted distal radius fractures which successfully restores key radiological parameters of the distal radius while providing satisfactory clinical and functional outcomes.

Limitations and Future Directions

This study confirms that SEF is an effective and minimally invasive approach for the treatment of comminuted DRFs, restoring key radiological parameters and providing satisfactory clinical outcomes. However, certain limitations should be acknowledged. First, the relatively small sample size may limit the generalizability of the findings of this study, necessitating larger-scale studies to validate these results. Second, the retrospective study design introduces potential biases in data collection and interpretation. Prospective, randomized controlled trials would provide stronger evidence regarding the efficacy of spanning external fixation compared to other treatment modalities. Additionally, longer follow-up periods are needed to assess long-term functional outcomes and complication rate

Reference

1. Nellans KW, Kowalski E, Chung KC. The Epidemiology of Distal Radius Fractures. Hand Clinics [Internet]. 2012 May [cited 2025 Mar 8];28(2):113–25. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0749071212000029

2. Egol KA, Walsh M, Romo-Cardoso S, Dorsky S, Paksima N. Distal Radial Fractures in the Elderly: Operative Compared with Nonoperative Treatment. Journal of Bone and Joint Surgery [Internet]. 2010 Aug 4 [cited 2025 Mar 8];92(9):1851–7. Available from: https://journals.lww.com/00004623-201008040-00006

3. Abdelsala AE, Metwally OM, Abd El Kader SM, Alfirjani EMA. Treatment of Comminuted Distal Radius Fractures Using Spanning External Fixator. The Egyptian Journal of Hospital Medicine [Internet]. 2022 Jan 1 [cited 2025 Mar 8];86(1):372–8. Available from: https://ejhm.journals.ekb.eg/article_212841.html

4. Perugia D, Guzzini M, Civitenga C, Guidi M, Dominedò C, Fontana D, et al. Is it really necessary to restore radial anatomic parameters after distal radius fractures? Injury [Internet]. 2014 Dec [cited 2025 Mar 8];45:S21–6. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0020138314005038

5. Arora R, Lutz M, Deml C, Krappinger D, Haug L, Gabl M. A Prospective Randomized Trial Comparing Nonoperative Treatment with Volar Locking Plate Fixation for Displaced and Unstable Distal Radial Fractures in Patients Sixty-five Years of Age and Older. Journal of Bone and Joint Surgery [Internet]. 2011 Dec 7 [cited 2025 Mar 8];93(23):2146–53. Available from: https://journals.lww.com/00004623-201112070-00002

6. Talmaç MA. Comparison of three surgical methods in the treatment of intraarticular comminuted distal radius fractures: Volar locking plate, non-bridging external fixator, and bridging external fixator. Eklem Hastalik Cerrahisi [Internet]. 2019 Oct 24 [cited 2025 Mar 10];30(3):224–32. Available from: http://www.tevak.org/pdf/dergi/2019/pdfsno3/30_3_224_232.pdf

7. Raju P, Kini S. Loss of correction in unstable comminuted distal radius fractures with external fixation and bone grafting -a long term followup study. J Orthop Surg Res [Internet]. 2011 [cited 2025 Mar 10];6(1):23. Available from: http://josr-online.biomedcentral.com/articles/10.1186/1749-799X-6-23

8. Biz C, Cerchiaro M, Belluzzi E, Bortolato E, Rossin A, Berizzi A, et al. Treatment of Distal Radius Fractures with Bridging External Fixator with Optional Percutaneous K-Wires: What Are the Right Indications for Patient Age, Gender, Dominant Limb and Injury Pattern? JPM [Internet]. 2022 Sep 18 [cited 2025 Mar 10];12(9):1532. Available from: https://www.mdpi.com/2075-4426/12/9/1532

9. Jia Z, Wang S, Jiang W, Li C, Lin J, Liu Q, et al. The treatment of complex intra-articular distal radius fractures with turning radius and distal volaris radius plate fixation. Eur J Med Res [Internet]. 2020 Dec [cited 2025 Mar 10];25(1):66. Available from: https://eurjmedres.biomedcentral.com/articles/10.1186/s40001-020-00470-x

10. Liu Y, Bai Y. Efficacy of non-bridging external fixation in treating distal radius fractures. Orthopaedic Surgery [Internet]. 2020 Jun [cited 2025 Mar 10];12(3):776–83. Available from: https://onlinelibrary.wiley.com/doi/10.1111/os.12677

11. Chilakamary VK. Osteosynthesis in Distal Radius Fractures with Conventional Bridging External Fixator; Tips and Tricks for Getting Them Right. JCDR [Internet]. 2016 [cited 2025 Mar 10]; Available from: http://www.jcdr.net/article_fulltext.asp?issn=0973-709x&year=2016&volume=10&issue=1&page=RC05&issn=0973-709x&id=7048

12. Assistant Professor in Orthopaedics, Govt Medical College, Thiruvananthapuram, R DS. Ligamentotaxis and Bone Marrow Injection to Prevent Late Metaphyseal Collapse in Distal Radius Fractures. jmscr [Internet]. 2017 Jun 30 [cited 2025 Mar 10];05(06):23935–43. Available from: http://jmscr.igmpublication.org/v5-i6/190%20jmscr.pdf

13. Attia UF, El Soufy M, ElHewala T, Abdelrazek MA. Management of Comminuted Distal Radial Fractures Using Volar Plating versus External Fixation Augmented by K wires. The Egyptian Journal of Hospital Medicine [Internet]. 2022 Jan 1 [cited 2025 Mar 10];86(1):420–6. Available from: https://ejhm.journals.ekb.eg/article_212852.html

14. Leung KS, Shen WY, Tsang HK, Chiu KH, Leung PC, Hung LK. An effective treatment of comminuted fractures of the distal radius. The Journal of Hand Surgery [Internet]. 1990 Jan [cited 2025 Mar 10];15(1):11–7. Available from: https://linkinghub.elsevier.com/retrieve/pii/S036350230991098X

15. Bradway JK, Amadio PC, Cooney WP. Open reduction and internal fixation of displaced, comminuted intra-articular fractures of the distal end of the radius. J Bone Joint Surg Am. 1989 Jul;71(6):839–47.

16. Tang JB. Distal Radius Fracture. Clinics in Plastic Surgery [Internet]. 2014 Jul [cited 2025 Mar 10];41(3):481–99. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0094129814000443

17. Rectenwald JP, Bentley KA, Murray PM, Saha S. Strain as a Function of Time in Extrinsic Wrist Ligaments Tensioned Through External Fixation. Hand (New York, N,Y) [Internet]. 2018 Jan [cited 2025 Mar 10];13(1):60–4. Availablefrom:https://journals.sagepub.com/doi/10.1177/1558944717692091

18. Anderson JT, Lucas GL, Buhr BR. Complications of treating distal radius fractures with external fixation: a community experience. Iowa Orthop J. 2004;24:53–9.

19. Burke EF, Singer RM. Treatment of Comminuted Distal Radius With the Use of an Internal Distraction Plate: Techniques in Hand & Upper Extremity Surgery [Internet]. 1998 Dec [cited 2025 Mar 10];2(4):248–52. Available from: http://journals.lww.com/00130911-199812000-00004

20. Augé WK, Velázquez PA. The application of indirect reduction techniques in the distal radius. Arthroscopy: The Journal of Arthroscopic & Related Surgery [Internet]. 2000 Nov [cited 2025 Mar 10];16(8):830–5. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0749806300561726

21. Strelzow JA. Comminuted Articular Distal Radius Fractures. In: Distal Radius Fractures [Internet]. Elsevier; 2021 [cited 2025 Mar 10]. p. 119–45. Available from: https://linkinghub.elsevier.com/retrieve/pii/B9780323757645000214

22. Micic I, Kholinne E, Sun Y, Kwak JM, Jeon IH. The Role of Additional K-Wires on AO Type C Distal Radius Fracture Treatment with External Fixator in Young Population. Advances in Orthopedics [Internet]. 2019 Jan 1 [cited 2025 Mar 10];2019:1–6. Available from: https://www.hindawi.com/journals/aorth/2019/8273018/

23. Skochdopole A, Tarabishy S, Hermiz S, Mailey B, Herrera FA. Open Reduction Internal Fixation of Distal Radius Fractures: Retrospective Cohort Analysis of the Geriatric Population Using the NSQIP Database. Hand (New York, N,Y) [Internet]. 2022 Mar [cited 2025 Mar 10];17(2):319–25.

24. Rīga Stradiņš University, Krustiņš U. Comparison of the Results after Arthroscopically Assisted Surgeries of the Articular Distal Radius Fractures with Internal and External Fixation Methods. Summary of the Doctoral Thesis [Internet] [Ph.D.]. [Rīga]: Rīga Stradiņš University; 2021 [cited 2025 Mar 10]. Available from: https://dspace.rsu.lv/jspui/handle/123456789/7061

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Original Research Article

Incidence, Clinical Profile and Prognostic Indicators for Visual Outcome in Traumatic Cataract Surgery in Yemen.

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Abstract

Background: Traumatic cataract is an important cause of monocular blindness. It poses a formidable challenge to ophthalmologists for achieving optimal visual acuity as visual prognosis shows highly unpredictability and the injured lens is not the only determining of visual outcome.

Objective: The study was conducted to assess the incidence, clinical characteristics, and prognostic indicators for visual outcomes in traumatic cataract surgery.

Methodology: Medical records of 832 patients presented with traumatic cataract and underwent surgical intervention during the study period at Magrabi Eye Hospital, Sana'a, Yemen were reviewed retrospectively. χ^2 test, odds ratios, and 95% confidence intervals were used to figure out the prognostic factors for visual acuity ≥ 6/18 at final follow-up after cataract surgery.

Results: The incidence rate of cataract was 0.78 %, or 7.8, patients per 1000 patients of eye OPD. The mean age was 20.51 ± 13.16 SD years old with the majority (83.5%) were ≤ 30 years old and 42.9% ≤18 years old. Males were 82.6%. Open globe injury was the most prevalent trauma type (70%). Cornea damage was the predominant concurrent injury in (58.2%). Anterior capsule rupture

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presented in 32.3% and was statistically indicator for presence in 46.7% of 122 eyes with posterior capsule rupture (χ^2 = 13.64, p = < 0.001). Anterior surgical cataract removal approach performed in 61.4% and 38.6% performed pars plana vitrectomy with lensectomy (PPLV). Intraocular lens implanted 75.6%, with 89.5% placed at capsular bag. Posterior capsule opacity was the most late postoperative complication (8.3%). 47% of eyes achieved ≥ 6/18 and 27% were blind in the injured eye < 3/60. Better initial visual acuity (VA) was statistically significant indicator for achieving final VA≥ 6/18, (χ^2= 29.4, p = <0.001). Correlation was found between final VA ≥ 6/18 and age and sex, female patients and younger than 18 years old had the best prognosis. Closed globe injury had satisfactory final VA ≥ 6/18 in 58% comparing to open globe injury 46.3%, (χ^2= 8.944, p = 0.003). Retinal detachment, endophthalmitis, vitreous hemorrhage, posterior capsule rupture or IOFB and no IOL implanted carried the poorest prognosis for final VA ≥ 6/18, (p = <0.001). A statistically favorable final VA ≥ 6/18 was obtained in anterior approach cataract removal than PPLV (χ^2= 102.3, p = < 0.001), capsular bag IOL than non PCIOL (χ^2= 11.5, p = < 0.001) and primary IOL than secondary IOL implantation (χ^2= 9.9, p = 0.002). No difference was detected between simultaneous globe repair with cataract removal and two-step surgical procedure (χ= 0.926, p = 0.336). Posterior segment complications and significant corneal scaring were responsible for blind eyes (<3/60) in 72% and 39.1% respectively, (p = <0.001).

Conclusion: Traumatic cataract remains a frequent sequel of ocular injuries with nearly one third of patients have monocular blindness with the overwhelming predominance of male, age group (1-30) years old, and open globe injury. About half of cases have a satisfactory vision after surgical intervention. The worst indicator factors for poor visual outcome are initial VA ≤ 1/60, open globe injury, coexisting posterior segment pathology, posterior capsule rupture, and remained the eye aphakia.

Keywords: Traumatic Cataract, Ocular Morbidities, Cataract Surgery, Visual Outcome, Yemen.

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Introduction

Human crystalline lens has unique structure and function that are essential for normal eye function and visual system. Despite its typical anatomical and well protected position, up to 65% of eye traumas lead to cataract formation [1]. Ocular trauma is the most common presentation among ocular emergency, nearly 75% [2]. Traumatic lens damage is caused by mechanical injury (blunt and penetrating) and by physical forces such as chemicals and electrical current [3]. Lens opacification is either an acute event or as a late sequela [3]. Hence, patients may present to the ophthalmologist immediately after sustaining an injury or a long time after the injury.

Several studies draw attention to the demographic profile of traumatic cataract that affects patients of all ages, particularly younger than 30 or 40 years old with male predominance [4]. Trauma is the most common cause of unilateral cataract in children [5]. The main treatment of traumatic cataract is surgical removal with intraocular lens (IOL) implantation. In contrast to the high success rate of age-related cataract surgical removal, traumatic cataract poses a formidable challenge to ophthalmologists for restoring vision or achieving optimal visual acuity and preventing vision impairment [3,6,7]. The major obstacle to achieve that goal is concomitant injuries, such as corneal scar and posterior segment involvement. Additionally, the presence of inflammation, elevated intraocular pressure, ability to follow up, an afferent pupillary defect, posterior capsular tear, iridodialysis, zonulolysis, and poor visualization, are linked consistently to greater risk of poor visual outcomes [3,6,7]. Further, obtaining reliable intraocular lens (IOL) power calculation and implanting intraocular lens (IOL) due to irregular cornea and absence of adequate capsular support, respectively, are important challenges [3,6,7]. The aphakic eye and amblyopia have to be addressed carefully, particularly in an immature visual system [3,6,7]. Obviously, the prognosis of visual gain following surgery for traumatic cataracts is a complex issue.

The literature is full of studies on the clinical characteristics and outcomes of traumatic cataract either among pediatric or adults, whereas very little data exists about the incidence and visual prognostic indicators of traumatic cataract among all ages [7,8]. Moreover, eye injury has been studied scantily in Yemen, with no studies on traumatic cataract. For those reasons, the current study was conducted in Sana'a City at Magrabi Eye Hospital, the main tertiary eye hospital in Yemen, to assess the incidence, clinical profile, and prognostic indicators for visual outcome in traumatic cataract surgery.

Material and Methods

This retrospective hospital-based study analyzed medical records of all patients who presented with traumatic cataract and underwent surgical intervention from 26th March 2015 to 26th March 2019 at Magrabi Eye Hospital, Sana'a, Yemen. A total of 4,806 patients with recent eye injuries were documented and 1,367 patients' eyes were diagnosed as traumatic cataract during the research period. Only 843 patients, who had performed eye surgical intervention, were selected. Traumatic cataract cases post rupture globe repaired with NPL, cataract for

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observation, patients Left Against Medical Advice (LAMA), old trauma cases and those with early loss to follow up were excluded. The parameters extracted from the medical files were recorded in a structured questionnaire, which included patient demographic information (age, sex and occupation), laterality, trauma details (etiology, type of trauma, patient location at time of injury and causative agents), associated ocular damage, initial and final visual acuity, surgical procedures, IOL implantation, and complications.

For the suitable presentation of the causative agents, some causative agents with similar characteristics were classified into one group. Objects such as bomb, mine, mortar shell, missile, fireworks, TNT, light bulb, chemical acid battery, and lighter were included together in one group of secondary explosion. On the other hand, objects such as metallic fragment, scissors, knives, syringe/sawing needles, nails, steel rod, and metal wire were included together in one group of metallic or steel objects. Besides, pencils and rulers were classified together as one group of school supplies. Moreover, hand blow, leg kick, fingers fist, body blow, wooden stick, tree branch, door, and thorn were included in the wood objects group.

Most patients were assessed preoperatively, which included trauma history, physical eye examination, and intraocular lens power calculation with ultrasound biometry. Wherever IOL power calculation was not possible in the injured eye, it was performed using the biometry of the fellow eye. B-scan and other relevant investigations: CT scan, slit lamp photography, and VEP were also done, and routine investigations were also made before surgery for general medical condition.

With the exception of traumatic uveitis and rising IOP presentations that were initially treated with topical steroids and cycloplegics and intraocular pressure (IOP) lowering agents, the main management of traumatic cataract was surgical removal. Various surgical interventions were performed under local or general anesthesia by different subspeciality surgeons; anterior segment, pediatric or vitreoretinal, and depend on the status of traumatic cataract. Initially, anatomical integrity of the globe was restored, except in cases with ruptured anterior capsule with lens material into the anterior chamber. Lens aspiration and IOL implantation has been performed at the time of primary repair of corneal laceration. Otherwise, a two-step surgical approach was performed and traumatic cataract surgery is performed months after primary repair.

The standard surgical procedure performed was lens aspiration or phacoemulsification through limbal incision with posterior chamber IOL implantation. Lens aspiration, primary posterior capsulotomy, anterior vitrectomy with posterior chamber IOL implantation was the major procedure done in patients below 5 years old. Extracapsular cataract extraction (ECCE) and PCIOL was performed in hard cataract or with lenticular subluxation or partial zonulolysis. Cases of intraocular foreign body (IOFB) or retinal detachment association or posterior lens dislocation, pars plana lensectomy and vitrectomy (PPLV) was done. In cases with marked lenticular subluxation and/or with

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zonular dialysis of more than half or anterior lens dislocation, intra-capsule cataract extraction (ICCE) with anterior vitrectomy was performed. An anterior vitrectomy was performed when preoperative or intraoperative posterior capsule rupture, vitreous prolapse was determined. Primary posterior chamber intraocular lens (PCIOL) implantation was performed only in patients with adequate capsular support or into the sulcus in patients with inadequate capsular-bag support with adequate remnant of anterior capsule. Patients without any capsular support and children below one year were kept aphakic. Anterior chamber IOL was implanted in dislocated cases and as secondary operation after three months. In addition, Scleral-fixated IOL (SFIOL) was performed as secondary operation in patients with inadequate capsular support.

The study was approved by the Research and Ethics committee of Yemen Magrabi Eye Hospital, and the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional or regional), and with the Helsinki Declaration of 1975, as revised in 2000. The risks of surgical intervention were fully explained to the patients or their guardians in accordance with the Declaration of Helsinki, and verbal informed consent was obtained for inclusion in the study.

Data analysis was carried out using IBM-SPSS version 21. Frequencies and percentages were calculated for categorical data. Chi square test was employed to evaluate the role of each variable and odds ratios (ORs). 95% confidence intervals (CIs) were computed to evaluate the strength of association between various independent factors, such as age, gender, type of ocular injury, associated ocular damage, initial visual acuity, surgical procedures, IOL implantation and complications, with the dependent variable was vision ≥ 6/18 at final follow-up after cataract surgery. P-value of less than >0.05 was considered significant. Visual acuity less than 3/60 was considered as blind in the injured eye according to WHO.

Results

There were 175,655 new cases registered at OPD clinic during the study period in which 5,264 (2.99%) cases presented with ocular trauma with different causes. Only 1,367/5,264 (26%) eyes were accounted to traumatic cataract and only 843 eyes underwent cataract surgery, (61.7%). The incidence rate of cataract was 0.78 % or 7.8 patients per 1,000 patients of eye OPD. There was a unilateral traumatic cataract preponderance with 821 patients (98.7%), and bilateral involvement of both eyes' with 11 patients (1.3%). There was no difference between right and left eye involvement, 49.8% vs 50.2% respectively.

Demographics

A total of 843 eyes of 832 traumatic cataract patients were included in the study. The mean age of the patients was 20.51 ± 13.16 SD years old, ranging between 1 and 75 years old. Most cases belonged to the age group of 11-20 years old constituted about 33.3% of all cases of traumatic cataract and the pediatric cases less than 18 years old constituted about 42.9% of all cases of traumatic cataract. Moreover, the age group ranged between 1 to

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30 years old included 695 patients, (83.5%). The majority of patients were male, 687 (82.6%), while 145 (17.4%) of them were female, with a male to female ratio was 4.7: 1. Out of a total 832 traumatic cataract patients, 259 (31.1%) were students, 246 (29.6%) were soldiers, and 104 (12.5%) were too young. The housewives represented 58 (7%) of all cases. Laborers and farmers accounted to 6.5% and 2.6%, respectively **Table (1)**.

Table (1) Demographic characteristics of patients performing traumatic cataract surgery.

Age distribution	n (%)
1-10 years old	203 (24.4)
11-20 years old	277 (33.3)
21-30 years old	215 (25.8)
31-40 years old	75 (9)
41-50 years old	34 (4.1)
51-60 years old	21 (2.5)
61 years old and above	7 (0.8)
Gender	
Male	687 (82.6)
Female	145 (17.4)
Occupation	
Student	259 (31.1)
Solider	246 (29.6)
None/Too young	104 (12.5)
Not recorded	69 (8.3)
Housewife	58 (7)
Laborer / Workman	54 (6.5)
Farmer	22 (2.6)
Others	20 (2.4)

Eye Injury Details

Regarding eye globe injury, open globe injury constituted nearly two thirds of cases (590 eyes, 70 %) and one third for closed globe injury (253 eyes, 30%). According to trauma etiology, most of the patients 283 (33.6%) were injured throughout warfare at combat zones, followed by domestic accidents 156 (18.5%), agricultural accidents 136 (16.1%), children accidentally injured while playing 102 (12.2%), other occupational accidents 63 (7.5%), assault accidents 41 (4.9%), adults accidentally injured while walking in the street 7 (0.7%), and road traffic accident 2 (0.2%). Most open globe injuries were of the penetrating type and involved cornea (corneal-scleral limbus) zone. The most common agents causing traumatic cataract in open globe injury were fragments secondary to explosion in 227 (38.4%) eyes, followed by wood objects in 139 (23.5%) eyes, while stones in 69 (27.4%) eyes and contusion effect of explosion in 56 (22.2%) eyes were the common traumatic agents in closed globe injury **Table (2)**.

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Table (2) Eye injury details among patients performing traumatic cataract surgery.

Variable	Open n = 590		Closed n= 253		Total n = 843	
Patient Location at Time of Injury	**N**	**(%)**	**n**	**(%)**	**n**	**(%)**
Combat Zone/ Battle Field	235	39.8	39	15.5	274	32.5
Home	110	18.6	57	22.6	167	19.8
Road	60	10.2	91	36.1	151	17.9
Farm	121	20.5	15	6	136	16.1
Work	45	7.6	17	6.7	62	7.4
Not recorded	20	3.4	33	13.1	53	6.3
Etiology of trauma	**N**	**(%)**	**n**	**(%)**	**n**	**(%)**
Warfare accidents	243	41.1	40	15.9	283	33.6
Domestic Accidents	98	16.6	58	23	156	18.5
Agricultural Accidents	121	20.5	15	6	136	16.1
Accidents while playing	33	5.6	69	27.4	102	12.2
Other Occupational Accidents	46	7.8	17	6.7	63	7.5
Not recorded	20	3.4	33	13.1	53	6.3
Assault	24	4.9	17	6.7	41	4.9
Accidents while walking	5	0.8	2	0.8	7	0.7
Road traffic accident	1	0.2	1	0.4	2	0.2
Agents causing ocular trauma	**N**	**(%)**	**n**	**(%)**	**n**	**(%)**
Secondary to explosion	227	38.4	56	22.2	283	33.6
Wood Objects	139	23.5	33	13.1	172	20.4
Stone	38	6.4	69	27.4	107	12.7
Metallic or steel objects	73	12.4	13	5.2	86	10.2
Undetermined blunt object	13	2.2	40	15.9	53	6.3
Gunshot (fragments/ bullet back)	46	7.8	2	0.8	48	5.7
Undetermined Sharp object	28	4.7	0	0	28	3.3
Not recorded	7	1.2	13	5.2	20	2.4
Glass Material	8	1.4	0	0	8	0.9
Body blow	2	0.3	6	2.4	8	0.9
Toys (Pistol beads, plastic toy, ball)	2	0.3	5	2	7	0.8
School supplies	5	0.9	0	0	5	0.6
Plastic material	0	0	6	2.4	6	0.7
Others	3	0.5	9	3.6	12	1.4

Hisham Alakhlee[*1,3], Nabil Taresh[1,3], Mahfouth Bamashmus[2,3], Mohammed Al-Hemyari[2,3], Mahammed AlShekeil[3], Saleh Altheeb[1,3], Amal Aldhobhani[2,3], Mohammad Alqubaty[3], Tariek Aldoais[3,4], Abdulrahman Noman[3], Marwan H Farhan[1,3].

Lens Injury Pattern and Associated Ocular Injuries

Preoperatively clinical findings regarding lens condition indicated that majority of traumatic cataract was observed in normal anatomical position with intact zonules in 775 eyes, (91.9%). Moreover, 51 (6%) eyes presented with subluxated lens, 12 (1.4%) eyes presented with dislocation, 3 eyes presented with anterior dislocation, 9 eyes presented with posterior dislocation, and 5 (0.6%) cases presented with intra-lenticular FB. Anterior capsule ruptured with lens matter in anterior chamber reported in 272 (32.3%) of the cases. Regarding ocular morbidities associated with traumatic cataracts, the most associated ocular damage was corneal injury in 491 (58.2%) cases, followed by posterior segment pathology in 359 (42.6%) eyes, and iris injury in 194 (23%) eyes of the cases. In addition, hyphema and raised IOP were recorded in 5.9% and 0.8% of the cases, respectively. Among the associated corneal damage, a full-thickness corneal laceration was present in 117 eyes and full-thickness corneal and scleral laceration was in 15 eyes; 132 eyes total. 178 (21.1%) eyes had a small self-sealed wound secondary to penetrating injury. Preoperative findings concerning iris included traumatic mydriasis in 8.1% of eyes, iris tears/iris dialysis in 6.5% of eyes, posterior synechiae in 5.5% of eyes, iris prolapse in 2.1% of eyes, and anterior synechiae in 1.07% of eyes. Posterior segment pathology included IOFB in 31.9% of the cases, vitreous hemorrhage in 28.6% of the cases, RD in 5.8% of the cases, and endophthalmitis in 3.4% of the cases. **Table (3)**

Table (3) Associated ocular morbidities among patients performing traumatic cataract surgery.

Associated ocular damage	NO
Orbital involvement (FB, fracture)	3
Laceration of lid margin	3
Corneal injuries	491
Corneal-scleral full thickness laceration	132
Sealed Corneal tear	178
Corneal partial thickness laceration	20
Corneal blunt trauma caused edema	6
Corneal wound sutured or scar	152
Corneal burn	3
Iris injuries	194
Sphincter damage/ traumatic mydriasis	68
Iris tears / Iris dialysis	55
Posterior synechia	46
Iris prolapse	18
Anterior synechiae	9
Hyphema	50
Glaucoma raised IOP	7
Posterior Segment pathology	359
IOFB	269
Vitreous hemorrhage	241
Endophthalmitis	29
RD	49

Hisham Alakhlee[*1,3], Nabil Taresh[1,3], Mahfouth Bamashmus[2,3], Mohammed Al-Hemyari[2,3], Mahammed AlShekeil[3], Saleh Altheeb[1,3], Amal Aldhobhani[2,3], Mohammad Alqubaty[3], Tariek Aldoais[3,4], Abdulrahman Noman[3], Marwan H Farhan[1,3].

Surgical Interventions and Complications

Primary surgical globe repair was performed firstly in 220 eyes, in which, 154 (18.3%) cases had surgery done outside and referred to our hospital for cataract extraction and 66 eyes had surgery done in our hospital firstly. 66 (7.8%) eyes had corneal rupture and repaired with cataract removal simultaneously. The majority of traumatic cataract, 518 (61.4%), had anterior surgical approach intervention, while posterior approach (PPLV) in 325 (38.6%) eyes had lens injury with posterior segment involvement which included vitreous hemorrhage, IOFB, endophthalmitis, posterior dislocation, and retinal detachment. As anterior approach, lens aspiration and irrigation were the main operation for traumatic cataract with 40.9%, followed by phacoemulsification in 18.6%, ICCE in 1.1%, and ECCE in 0.8% of eyes. Anterior vitrectomy was required in 146 (17.3%) eyes with ruptured posterior capsule and vitreous loss. Elective primary posterior capsulotomy with anterior vitrectomy was performed in 53 (6.3%) eyes. Patients' eyes were remained aphakia in 206 (24.4%) and IOL implantation was performed in 637 (75.6%) eyes, in which 541 (84.8%) eyes had primary IOL implantation and 97 (15.2%) eyes had IOL implant as secondary operation. The position of IOL mostly at the bag of posterior capsule in 567 (89.5%) eyes, followed by ACIOL in 43 (6.8%) eyes, 13 (2%) at sulcus, and secondary scleral fixation in 14 (2.2%) eyes **Table (4)**.

Table (4) Cataract surgery approach and pattern of IOL implantation among traumatic cataract patients.

Cataract Surgery Approach n = 843 (%)	
Anterior Approach	518 (61.4)
Lens Aspiration	345 (40.9)
Phacoemulsification	157 (18.6)
Intracapsular Cataract Extraction	9 (1.1)
Extracapsular Cataract Extraction	7 (0.8)
Posterior Approach (PPLV)	325 (38.6)
IOL implantation	n =638 (75.6)
Primary Operation	541 (84.8)
Secondary Operation	97 (15.2)
PCIOL	567 (89)
ACIOL	43 (6.8)
Sulcus IOL	13 (2)
Scleral Fixation	14 (2.2)

In terms of complications and secondary surgical interventions in the studies patients, it was found that posterior capsule ruptures (122 eyes, 14.5%) was the most common intraoperative complication either secondary to trauma or surgery. The most late postoperative complication was posterior capsule opacity (PCO) 70 (8.3%), followed by glaucoma 21 (2.5%), retinal detachment 19 (2.3%), phthisis bulbi 17 (2%), amblyopia 4 (0.5%), and endophthalmitis 3 (0.4%). Berlin's edema was discovered postoperatively in 9 eyes, while 5 eyes had macular scar and one patient had macular hole when edema cured. Further, postoperative findings of retinal comorbidity included macular scar in 25 eyes, macular

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hole in 2 cases, and traumatic optic neuropathy in 6 cases **Table (5).**

Table (5) Late postoperative complication among traumatic cataract patients.

Complications	Count (%)
PCO	70 (8.3)
Glaucoma	21 (2.5)
Retinal Detachment	19 (2.3)
Phthisis bulbi	17 (2)
Corneal complication (decompensation/ band keratopathy/ melting)	9 (1.1)
Amblyopia	4 (0.5)
Endophthalmitis	3(0.4)
IOL related complication	3(0.4)
Subluxated IOL	1(0.1)
Dislocated (drop) IOL	1(0.1)
Decompensated cornea secondary to AC IOL	1(0.1)
Cystoid macular edema	1 (0.1)
Hyphema	1 (0.1)
Traumatic hypotony	1(0.1)

The most secondary surgical operation was IOL implantation in 97 eyes, followed by 9 PPV + silicone operations for management 2 endophthalmitis and 7 retinal detachments. Nd-Yag capsulotomy was performed in 31 patients and surgical capsulotomy was performed for 7 children. Evisceration was done for 4 patients due to 2 eyes developed phthisis bulbi and 2 painful blind eyes (glaucoma secondary to silicone, melting cornea). One patient had severe cystoid macular edema which was detected postoperatively and intravitreal Avastin injection was given. One case developed intraocular lens displacement into vitreous due to inadequate support for intraocular lens and secondary scleral fixation was done. One patient had subluxated IOL and IOL corrected into sulcus. One patient developed corneal decompensation because of AC IOL and surgically IOL was removed. One patient developed hyphemia and AC wash was done.

Visual Acuity and Prognostic Factors

Pre-operative visual acuity was recorded in 795 patients while 48 5.7% of the patients could not be assessed because they were children less than 4 years. Majority of the patients, 713 (84.6%), had vision worse than (3/60) at presentation, in which counting fingers, hand movement, and perception of light were present in 142 (16.9%), 348 (41.3%), and 223 (26.6%) of cases respectively. The majority of patients achieved best corrected visual acuity at the end of follow-up better than (3/60) in 567 (67.3%) eyes, in which, 33.8% achieved ≥ 6/12, and 47% achieved ≥ 6/18. Postoperative monocular blindness, world Health organization <3/60, was represented in 228 (27%) eyes. **Table (6).**

Table (6) The Distribution of Postoperative final visual acuity among traumatic cataract patients.

Postoperative vision	Count (%)
≥ 6/18	396 (47)
6/24 to 3/60	171 (20.3)
< 3/60	228 (27)
can't assist	48 (5.7)

Hisham Alakhlee[*1,3], Nabil Taresh[1,3], Mahfouth Bamashmus[2,3], Mohammed Al-Hemyari[2,3], Mahammed AlShekeil[3], Saleh Altheeb[1,3], Amal Aldhobhani[2,3], Mohammad Alqubaty[3], Tariek Aldoais[3,4], Abdulrahman Noman[3], Marwan H Farhan[1,3].

Most patients presented with vision worse than 3/60 preoperatively achieved a best corrected visual acuity better or equal than 3/60 in 68.9% of the cases while the remaining patients maintained their vision less than 3/60 i.e., 31.1% monocular blindness. Only 6 patients whose vision preoperative was better than or equal to 3/60; loss their vision to less than 3/60 due to complications; 3 eyes retinal detachment, 2 eyes band keratopathy secondary to silicon and one eye developed glaucoma. Initial visual acuity was statistically significant factor for improving the final visual acuity ≥ 6/18, (χ= 20.399, p = <0.001). Other significant factors influence the final visual acuity ≥ 6/18 and causes of monocular blindness of 228 patients are shown in **Table (7)**.

Table (7): Factors affecting final visual acuity ≥ 6/18 and monocular blindness percentage among traumatic cataract patients.

Variable	Examined	≥ 6/18		< 6/18		OR (95% CI)	χ2 Statistics [df]*	P value	< 3/60
		Number	%	Number	%				
Gender	Male	311	47.5	344	52.2	0.52 (0.39-0.84)	8.16 [1]	0.004	29.3
	Female	79	61.2	50	38.8				24.8
Age (years)	< 18	172	55.7	137	44.3	1.48 (1.11-1.97)	7.15 [1]	0.008	23.9
	≥ 18	218	45.9	257	54.1				31.6
Initial VA	≥ 3/60	64	78	18	22	4.10 (2.38-7.06)	29.42 [1]	<0.001	7.3
	< 3/60	331	46.4	382	53.6				31.1
Injury type	Open globe	259	46.3	301	53.8	0.63 (0.46-0.85)	8.94 [1]	0.003	31.6
	Closed globe	136	57.9	99	42.1				21.7
Anterior capsule rupture	Yes	144	57.8	105	42.2	1.61 (1.19-2.18)	9.62 [1]	0.002	24.9
	No	251	46	295	54				30.4
Posterior capsule rupture	Yes	34	30.4	78	69.6	0. 39 (0.25-0.59)	19.48 [1]	<0.001	45.5
	No	361	52.9	322	47.1				25.9
IOFB	Yes	89	33.1	180	66.9	0.36 (0.26-0.48)	44.82 [1]	<0.001	39.4
	No	306	58.2	220	41.8				23.2
Vitreous hemorrhage	Yes	66	27.7	172	72.3	0.27 (0.19-0.37)	65.495 [1]	<0.001	44.1
	No	329	59.1	228	40.9				22.1
Endophthalmitis	Yes	4	14.8	23	85.2	0.17 (0.06-0.49)	13.595 [1]	<0.001	59.3
	No	391	50.9	377	49.1				27.6
Retinal detachment	Yes	4	8.2	45	91.8	0.08 (0.03-0.23)	36.013[1]	<0.001	69.4
	No	391	52.4	355	47.6				26.0
Surgical Approach	Anterior	305	64.5	168	35.5	4.68 (3.44-6.37)	102.27 [1]	<0.001	17.3
	Posterior	90	28	232	72				45.3
Surgical procedure	One-step	23	36.5	40	63.5	1.15 (0.64-2.07)	0.217 [1]	0.64	44.4
	Two-step	69	33.3	138	66.7				37.7
Lens implant	Yes	369	62.9	224	37.1	18.6 (10.9-31.9)	173.15 [1]	<0.001	16.6
	No	16	8.3	176	91.7				66.7
Lens implant	Primary	333	65.4	176	34.6	2.02 (1.29-3.13)	9.90 [1]	0.002	15.1
	Secondary	46	48.4	49	51.6				25.3
IOL site	PCIOL	349	65.2	186	34.8	2.38 (1.43-3.96)	11.52 [1]	0.001	15
	Others	30	44.1	38	55.9				29.4
Corneal scar	Yes	97	32.7	200	67.3	0.33 (0.24-0.44)	54.98 [1]	<0.001	39.1
	No	298	59.8	200	40.2				22.5
PCO	Yes	47	73.4	17	26.6	3.04 (1.72-5.40)	15.71 [1]	<0.001	7.8
	No	348	47.6	383	52.4				30.5
Retina complication	Yes	3	3.5	83	96.5	0.29 (0.01-0.09)	82.32 [1]	<0.001	73.3
	No	392	55.3	317	44.7				23.3

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Discussion

Vision is the most dominant of the five senses and plays a crucial role in every facet of our lives [5]. Traumatic cataract is an important cause of monocular blindness and contributes significantly to short-term and long-term vision impairment on the global scale. It is a result of mechanical or physical force that cause the crystalline lens position, stability, clarity, and capsular integrity to change. The main management of traumatic cataract is surgery as other types of cataracts, however, visual prognosis after traumatic cataract shows high unpredictability, and represents a huge challenge for ophthalmologists [3,7]. To the best of the researchers" knowledge, this is the first research about traumatic cataract in Yemen. This retrospective study was designed to report the incidence, clinical profile, and prognostic indicators for visual outcome in traumatic cataract surgeries. A striking result in this study is the highest incidence of traumatic cataract (0.78%), i.e. 7.8 patients per 1000 patients of eye OPD, in comparison to the results of previous studies which reported 6.9, 4.3, and 3 patients per 1000 patients of eye OPD [8-10]. On the other hand, this study showed that traumatic cataract represents 26% of sustained eye injury during study period, which is consistent with what has been found in previous studies [11-12]. In contrast, several studies reported lower incidence of traumatic cataracts than in the current study which ranged between 14.76% and 3.3% [2,10,14,15]. There is a difference in the literature concerning the incidence of traumatic cataracts.

In the present study, patients younger than 30 years old were the most affected with traumatic cataract (83.5%0; particularly in the age group (11-20) with 33.3% and 42.9% were children less than 18 years old, in addition to a noticeable male predominance (82.6%). Thus, male children and younger adults have been more frequently affected by traumatic cataract. Most researchers concerning demographic data about traumatic cataract reported similar findings [16-20]. This issue may be attributed to numerous reasons, as children are prone to such injuries due to low attention, inadequate risk assessment, and their significant activity at home and outdoor. For younger adult males, it can be attributed to their dangerous work pattern as soldiers, laborers, or farmers. Another reason contributes to sustain children with ocular trauma is the fact that 46% of the Yemeni population is under 15 years old according to 2021 estimates [21]. A study by Al-Shabooti and Bamashmus mentioned that children (≤16 years) constituted 61.1% of admitted and operated on eye injuries cases [22]. Aslami et al. reported that 50% of traumatic cataracts were less than 15 years while Dakshayani et al and Sofi et al. reported that 54-50% of them were in the age group below 20 years [23-25]. Hence, traumatic cataract secondary to ocular trauma is one of the main causes of visual loss in pediatric age group.

Our results demonstrated that about one third of the patients were students and 29.6% of

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them were soldiers. These results do not concord well with previous studies wherein most suffering traumatic cataract were either students or farmers [18,26,27]. However, when comparing our results to previous studies, it must be pointed out that none of them mentioned included soldiers as a targeted group compared with civilian people.

Important evidence from this study is that open globe injury was the commonest injury pattern with fragments secondary to explosion and wooden objects; with thorns were the prevalent causative agents. On the other hand, one third of cases represented closed globe injury; with stones and contusion effect of explosion were the common traumatic agents. An addition, the most common circumstances of injury were throughout warfare at combat zones in 32.5% of cases, followed by domestic accidents at home in 19.8% and agricultural accidents in 16.1% of cases. Our results are supported by Viswanathan et al.'s findings regarding injury type as open-globe injuries (70%) vs closed-globe injuries (30%), and that trauma exposure at battlefield was the most serious risk environment (62%) [28]. Shah et al. also reported results similar to our study concerning injury pattern, however, wooden sticks and stones were the main causative agents of trauma and occurred while playing and home activity [29]. Li et al. documented that the number of eye injuries in Yemen had upward trends as a consequence of wars or conflicts over the past three decades [30].

The associated ocular tissue damage with traumatic cataract is considered a major risk for visual loss and a determining factor in decision making for traumatic cataract management. Our study showed that the majority of injuries are associated with 58.2% of corneal injury; in the forms of a full-thickness laceration (15.7%), a small self-sealed wound (21.1%), and corneal scar post-repaired (18%). These in turn obstruct the visual axis and impact visual prognosis. On the other hand, a striking finding in this study was the presence of posterior segment association (42.6%), in the forms of IOFB (31.9%), vitreous hemorrhage (28.6%), retinal detachment (5.9%), and endophthalmitis (3.4%). Furthermore, iris injury was the third common tissue accompany traumatic cataract, 23%. A similar pattern of results was obtained in a study conducted by Som et al. among small size sample of 50 patients, in which the main associated ocular tissue was 56% corneal injury, 44% posterior segment pathology, in decreasing order; vitreous hemorrhage, retinal detachment, and IOFB was commonly associated 28%, 14%, 2% and 38% uveal tissue injury [16]. Nadeem et al. and Mangane et al. demonstrated that 54% corneal injuries and injury to iris 28%, but they exclude posterior segment pathology in their studies [17,23]. There is a difference in the literature because of disparate methodology of traumatic cataracts concerning selecting sample, inclusion, and exclusion criteria. Another important element of preoperative evaluation of traumatic cataract should aim at determining the anterior and posterior capsule integrity. Hence, understanding the sequels of these is very important in surgical planning. In this study, it is interesting to note that anterior capsule ruptured with lens matter in

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anterior chamber was reported in 32.3% of the cases while posterior capsule rupture was reported in 14.5% of the cases that mostly occurred in agricultural accidents and domestic accidents through thorn, tree branch, and sharp steel object. The presence of anterior capsule rupture is a significant indicator for presence posterior capsule rupture, 46.1% (χ^2 = 11.640, p value = < 0.001). Choudhury et al. showed that cataract with ruptured lens capsule and posterior capsular tear were found in 35.6% and 24.1% of cases respectively [10]. Dakshayani et al. demonstrated that 28% of cases had rupture of the anterior capsule and 14% of cases had posterior capsule rupture [24]. Memon et al. reported that anterior capsular rupture and pre-existing posterior capsular defects were observed in 44% and 14.6% of cases respectively [31]. Moreover, the status of lens has a role in decision the correct surgical approach. In this study, 6% of the cases presented with subluxated lens and 1.4% of them with dislocation; 3 cases anterior dislocation and 9 cases posterior dislocation. These findings are lower than the results found in the related literature that range between 17.2% to 7.5% [10,16,32,33].

Beside ocular comorbidity with traumatic cataract and obtaining accurate IOL measurement, surgical removal of lens poses considerably over complex than standard cataract surgery. Nevertheless, the main goal of management of traumatic cataract is to improve vision and prevent disability, the visual result and success rate usually reduce due to coexisting ocular damage either anterior or posterior segment pathology. Moreover, the choice of anterior or posterior surgical approach relies on surgeon experience and preoperative assessment. This study reported that several surgical interventions depend on the status of traumatic cataract and ocular tissue comorbidity. The majority of traumatic cataracts had anterior surgical approach intervention (61.4%) as lens aspiration was the main operation for traumatic cataract with 40.9%, followed by phacoemulsification in 18.6%, ICCE in 1.1%, and ECCE in 0.8% of cases. On the other hand, posterior approach (PPLV) was performed in 38.6% of cases for lens injury with posterior segment involvement that included vitreous hemorrhage, IOFB, endophthalmitis, posterior dislocation and retinal detachment. Anterior vitrectomy was required in 146 (17.3%) eyes, whereas elective primary posterior capsulotomy with anterior vitrectomy was performed in 53 (6.3%) eyes. Numerous valuable articles concerning traumatic cataract management are available. Nevertheless, there is a large discrepancy between our results and others' reports. This could be due to our large number of traumatic cataracts coexist with posterior segment pathology and different trauma circumstances in our study. For instance, Dakshayani et al. reported that anterior approach was accounted to 94% mainly via small incision with PCIOL and 6% by PPLV [24], whereas Shah et al. reported that lens aspiration underwent in 50.9%, lensectomy and vitrectomy in 19.1%, and delivery and vitrectomy in 31.7% [24-29]. Another study conducted by Ojeda et al reported that phacoemulsification/phacoaspiration was the main procedure in 96.25 %, followed by 2.5

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% extracapsular cataract extraction, 1.25 % underwent intracapsular cataract extraction and automated anterior vitrectomy was done in 22.5 %. [32]. In contrast to our study, Chuang et al. reported that 60% underwent PPLV and 40% lens aspiration or ECCE [34]. Intraocular lens implantation is a critical step in traumatic cataract surgery and important for vision rehabilitation, particularly in children to counteract the issue of amblyopia. Lens implant is either done as primary at the time of cataract removal or as a secondary implant during a second setting depending on intact of lens posterior capsule. This study revealed that intraocular lens was implanted in 75.6% of cases; with most of the cases (84.8%) performed as primary at the time of cataract removal and 24.4% were remained aphakia. A similar pattern of results was obtained in two studies carried out by Shah et al. and Akpolat et al., in which an intraocular lens was implanted in 77.27% to 81.6%, whereas 22.72% to 18.4% were left as aphakic, respectively [29-35]. For optimal vision rehabilitation, the position of IOL was mostly placed at the bag of posterior capsule in 89.5%, followed by ACIOL in 6.8%, 2% at sulcus and secondary scleral fixation in 2.2% of the cases. Ojeda et al. reported that in most of the patients, IOL was located in the capsular bag in 66.25%, in 25% it was located in the sulcus, 7.5% remained in aphakia, and in 1.25% IOL was implanted in a second procedure with iris fixation [32].

One of the causes that the eye remained aphakia was poor vision improvement due to massive coexisting trauma and postoperative complication as diffused central corneal opacity, retinal complications as macular scar or hole. In addition, 3 patients were age less than one years, 10 patients developed phthisis bulbi and 37 patients lost follow up. Unfortunately, keeping eye aphakia means some patients could be developing complication, as in this study 8 cases had glaucoma, 7 eyes had retinal detachment, and 6 eyes decompensated cornea (bullous keratopathy). Thus, primary IOL implantation is a key for prevention from these complications. Moisseiev et al. mentioned that a favorable vision outcome and a low rate of postoperative complication were associated with primary implantation of posterior chamber lenses after penetrating ocular trauma [36].

The most late postoperative complication was posterior capsule opacity (8.3%), followed by glaucoma (2.5%), retinal detachment (2.3%), Phthisis bulbi (2%), amblyopia (0.5%) and endophthalmitis (0.4%). Bekibele et al. reported posterior capsule opacity (12.5%), retinal detachment (9.4%), glaucoma (6.9%), and phthisis bulbi (3.1%), whereas Choudhury et al. reported posterior capsular opacification (9.2%), decentration of IOL (9.2%), and secondary Glaucoma (3.4%) [10,37].

From the data reported in this study, it is important to highlight the fact that a satisfactory visual outcome obtained after traumatic cataract removal and IOL implantation despite the coexisting troublesome ocular damage with lens injury. In our study, 67.3% of the eyes achieved a final VA of ≥ (3/60), in which, 33.8% achieved (≥ 6/12), and 47% (≥ 6/18). While 27% had poor vision less than < 3/60, i.e. blind in the injured eye. There is a wide

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agreement that excellent vision defined as 6/18 or better visual acuity after cataract surgery [8,29]. A similar pattern of our results was obtained in many others articles concerning the final visual acuity after traumatic cataract surgeries [23,29,38,39].

It is worth discussing the significant factors, as revealed in this study, that cause poor improvement in the final visual acuity in traumatic cataract patients ≥ 6/18 and lead to blindness in the injured eye < 3/60. One of the main reasons for poor visual recovery in this study was the initial visual acuity ≤ 1/60 which was statistically significant for non-improving the final visual acuity in 31.1% (χ^2= 20.399, p = <0.001) whereas initial visual acuity ≥ 3/60 was significant indicator for achieving ≥ 6/18 visual acuity postoperatively, (χ^2= 29.423, p = <0.001). Previous studies had similar results on initial visual acuity as predictive factor [16,26,27,29,40,41].

In our study, the percentage of blind eyes (< 3/60) with open globe injuries was 31.6%, more than closed globe injuries (21.7%), and there was a correlation between injury type and final visual acuity, (χ^2= 7.940, p = 0.005). Therefore, patients with closed globe injuries had satisfactory final visual acuity ≥ 6/18 in 58%, comparing to open globe injuries 46.3%, (χ^2= 8.944, p = 0.003). A similar pattern of results was obtained in many studies, though others have shown that open globe injuries had a more favorable prognosis for satisfactory > 20/60 visual recovery after management of traumatic cataracts [16,23,26,29,35,40]. Sofi et al. found that there was no significant difference in final visual outcome of traumatic cataracts caused by penetrating or blunt trauma (p = 0.73) [25].

The present study confirmed the findings of some previous researches that patients less than 18 years old gained significantly final visual acuity better than adults ≥ 18 years old, (x 2 = 7.146, P = 0.008) [7,8,25]. However, a study conducted by Som et al. suggested a favorable outcome in visual outcome was better in adult population as compared to pediatric population, where the difference was statistically insignificant. Özbilen et al. and Mangane et al. observed that there was no significant difference among adult and pediatric age group [16,39,40]. In spite of male predominance, female patients were significantly better than males according to final visual acuity, (x 2 = 8162, P = 0.004). Shah et al. and Özbilen et al. reported that there was no significant difference in visual outcome between males and females [7,40].

Other significant causes of no improvement in final visual acuity include presence of posterior segment pathology, in decreasing order: retinal detachment, endophthalmitis, vitreous hemorrhage, and IOFB, (p = <0.001). This is consistent with what has been found in previous studies [16,18,20,24,37, 41].

In addition, the unsuccess to gain good vision is attributed to the presence of posterior capsule rupture and remaining the eye without IOL implantation, (p = <0.001). Ojeda et al. mentioned that the presence of rupture posterior capsule increased the risk of vitreous prolapse with the possibility of more complications during and after surgery [32].

The results of our study disclosed that a clear support for obtaining favorable satisfactory

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final visual acuity is performing traumatic lens removal, with primary IOL implanted at capsular bag via anterior surgical producers mainly lens aspiration, lensectomy with primary posterior capsulotomy, phacoemulsification, and extracapsular cataract extraction, (χ^2= 9.900, p = 0.015 significant for primary IOL implantation) and (χ^2= 173.794, p = < 0.001) significant for cataract surgery procedures. On the other hand, posterior cataract surgical approach via PPLV carried a poor visual acuity ≥ 6/18 in 28% and 45.3% had blind eye (< 3/60), (χ^2= 102.274, p = < 0.001) comparing with anterior surgical approach.

It is important to highlight the fact that different cataract removal procedures had different visual outcomes as well as different places of the IOL implantation [26]. IOL implanted in the capsule is the ideal position for vision and the success of visual rehabilitation in traumatic cataract cases without adequate capsular support depends upon the choice of the surgical procedure, the experience of the surgeon, and the preferred type of IOL [26,32,35]. Qi et al. documented that phacoemulsification had significantly better visual acuity than those with other procedures (x 2 = 92.3, P < 0.01) whereas Özbilen et al. and Rumelt et al reported no difference among surgical techniques [26,41,42]. Despite literature documentation is that IOL implantation is better done in a second session for visual prognosis, Yiğit et al. and Moisseiev reported that primary IOL implantation had good visual prognosis [8,20]. On the other hand, Singhal et al reported that IOL is the treatment of choice for improving vision and poor results associated with delayed surgery [36]. These findings support our results regarding the preference to implant IOL primarily during the extraction of the cataract than later in a secondary procedure (χ^2= 9.900, p = 0.015).

It is also notable that simultaneously primary repair of anatomical integrity of the globe and traumatic cataract removal is more prone to achieve poor vision than a two-step surgical procedure, however, a significant relationship was not found in this study (χ= 0.926, p = 0.336). This result is consistent with Yiğit et al [20]. In contrast, Özbilen et al. and Rumelt et al. obseved no difference between simultaneous and secondary surgeries (p = 0.413) and (p = 0. 0.32), respectively [40,42]. Finally, this study found that the presence of posterior segment complications and significant corneal scaring following ocular injuries were the main factors responsible for blind eyes (<3/60) in 72% and 39.1% respectively, (p = <0.001). Overall, these findings are in accordance with findings reported in some previous studies [27,31,37,43].

Conclusion

The present study revealed that nearly a one third of the patients sustained ocular injuries had traumatic cataract with the overwhelming predominance of male, age group (1- 30) years old, involving children particularly, open globe injuries and concurrent injury to the cornea. Traumatic cataract surgery is a highly successful procedure for achieving good visual acuity (≥6/18) in about half of the patients (47%). The foremost step in management traumatic cataract is identifying the prognostic factors that influence the final

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visual acuity via carefully preoperative examination to determine the suitable surgical technique and inform the patient the potential of visual outcome postoperatively. The study concludes several prognostic factors that could represent guidelines for ophthalmologists in traumatic cataract surgery. Young age, femininity, initial visual acuity ≥ 3/60, closed globe injuries, anterior surgical producers mainly lens aspiration, phacoemulsification, and ECCE with primary IOL implanted in intact capsular bag were found favorable factors for achieving good visual acuity (≥6/18). On the contrary, adulthood, masculinity, initial visual acuity ≤ 1/60, open globe injuries, posterior segment involvement (retinal detachment, endophthalmitis, vitreous hemorrhage or IOFB), anterior or posterior capsule rupture, remaining the eye without IOL implantation, PPLV, and secondary IOL implantation were found statistically significant prognostic indicators for poor visual outcome after traumatic cataract surgery. Posterior segment complications and significant corneal scaring following ocular injuries were the main factor responsible for blind eyes (<3/60).

In sum, traumatic cataract remains a frequent sequel of ocular injuries with a high incidence rate among ophthalmic outpatients. It is also an important cause of monocular vision loss which highlights for establishing an effective preventive measure through increasing the awareness and encourage health education, as traumatic cataract is a major public health issue resulting in longstanding blindness if not treated properly.

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References

1. Tabatabaei SA, Rajabi MB, Tabatabaei SM, Soleimani M, Rahimi F and Yaseri M. Early versus late traumatic cataract surgery and intraocular lens implantation. Eye. 2017; 31:1199–1204. DOI: 10.1038/eye.2017.57
2. Mishra A, Verma A, Baranwal V, Aggarwal S, Bhargava N, Parihar J. The pattern of ocular trauma in a large zonal hospital in a non-operational role: A 36 months retrospective analysis. Journal of Clinical Ophthalmology and Research. 2014;2(3):141-44. DOI: 10.4103/2320-3897.138856
3. Shah M, Shah S, Upadhyay P, Agrawal R. Controversies in traumatic cataract classification and management: a review. Can J Ophthalmol. 2013;48(4):251–58. DOI: 10.1016/j.cjo.2013.03.010.
4. Lamkin JC, Azar DT, Mead MD, and Volpe NJ. Simultaneous corneal laceration repair, cataract removal, and posterior chamber intraocular lens implantation. Am J Ophthalmol. 1992;113:626-31.
5. World report on vision (2019), World Health Organization. CC BY-NC-SA 3.0 IGO; https://creativecommons.org/licenses/by-nc-sa/3.0/igo, www.who.int/publications-detail/world-report-on-vision

6. Kuhn F.Traumatic cataract: what, when, how. Graefes Arch Clin Exp Ophthalmol. 2010; 248:1221–23. DOI: 10.1007/s00417-010-1387-9
7. Shah M, Shah S, Gupta L, Jain A, Mehta R. Predictors of visual outcome in traumatic cataract. World J Ophthalmol. 2014; 4(4): 152-59. DOI: 10.5318/wjo.v4.i4.152
8. Singha A, Sharma A, Sasirekha M. Visual outcome in patients operated for traumatic cataract: A prospective hospital-based study. Indian Journal of Clinical and Experimental Ophthalmology. 2020;6(4):563–67. https://doi.org/10.18231/j.ijceo.2020.118
9. Doutetien C, Tchabi S, Sounouvou I, Yehouessi L, Deguenon J, Bassabi S. Traumatic cataract at the Cotonou, hospital (Benin): epidemiological, clinical and therapeutic considerations. J Fr Ophtalmol. 2008 May;31(5):522-6. DOI: 10.1016/s0181-5512(08)72470-7.
10. Choudhury D and Behera R. Cataract Following Mechanical Trauma: A Single Centre Experience. International Journal of Pharmaceutical and Clinical Research. 2023; 15(4); 685-96
11. Peleja M, Cunha F, Peleja M and Rohr J. Epidemiology and prognosis factors in open globe injuries in the Federal District of Brazil, BMC Ophthalmology. 2022; 22:111. https://doi.org/10.1186/s12886-021-02183-z
12. Alem K, Weldegiorgis S, Agaje B and Arega D. Pattern, Presentation and Risk Factors of Ocular Trauma Among Patients Treated at Hawassa University, Referral Hospital. The Open Ophthalmology Journal. 2018;12: 300-307.
13. Grau M, Ceca G, and Álvarez P. Ocular trauma in an urban Spanish population: epidemiology and visual outcome. Int J Ophthalmol. 2021;14(9): 1327-33. www.ijo.cn DOI: 10.18240/ijo.2021.09.06
14. Poonam N, Kalyanpad, Chhaya A, Shinde. Incidence of traumatic cataract in ocular injuries: a prospective observational study. International Journal of Recent Trends in Science and Technology. 2014; 12(1): 110-113.
15. Mundada R, Shinde S, Pathan M,and Badaam K. Traumatic Cataract Epidemiology at Tertiary Care Hospital in Aurangabad Maharashtra India: An Observational Study. International Journal of Recent Trends in Science and Technology. 2014; 9(3): 403-405.
16. Som V, Yadav N, and Kumar K. Traumatic cataract- factors affecting visual outcome. Tropical Journal of Ophthalmology and Otolaryngology 2019-July; 4(3): 193-201.
17. Mangane M, Pujari M, and Murthy C, Clinical study of traumatic cataract and its management. Medica Innovatica. 2016-July; 5(1): 20-24.
18. Mishra S, Dora J, Behera S, et al. Socio-demographic profile of traumatic cataract in western Odisha: A study at a tertiary care hospital. J. Evid. Based Med. Healthc. 2016; 3(49):2514-2517.
19. Bada G, and Patil S. A Clinical Study of Traumatic Cataract and Associated

Ocular Injuries. Ophthalmology and Allied Sciences. 2018; 4(2): 93-96.

20. Yiğit M, Tök L, and Tök Ö. Our Visual Results in Traumatic Cataract Cases. International Journal of Clinical Science and Medical Research. 2022-November; 2(11): 87-89.DOI:https://doi.org/10.55677/IJCSMR/V2I11-01/2022
21. Demographics of Yemen. https://en.m.wikipedia.org/wiki/Demographics_of_Yemen
22. Al-Shabooti A, Bamashmus MA. Profile of ocular trauma in Sana'a, Yemen. Saudi J Ophthalmol. 2002;16(3):195-198.
23. Aslami A, Prakas J, tava S, and Iqbal J. Visual Outcome of Traumatic Cataract at a Tertiary Eye Care Centre in North India: A Prospective Study. Journal of Clinical and Diagnostic Research. 2016-Jan;10(1): 05-08**.**
24. Dakshayani, and Rakesh. Analysis of visual prognosis after surgery in traumatic cataract. J of Evidence Based Med & Hlthcare. 2014; 1(8): 1036.
25. Sofi IA, Aziz R, Wani JS. Factors affecting visual outcome in traumatic cataract and its associated ocular injuries – A hospital-based study. *Int J Med Res Rev* 2016;4(5):839-844. DOI: 10.17511/ijmrr. 2016.i05.30.
26. Qi Y, Zhang Y F, Zhu Y, Wan M G, Du SS, and Yue ZZ. Prognostic Factors for Visual Outcome in Traumatic Cataract Patients. Journal of Ophthalmology. 2016;2016(1):1-6. http://dx.doi.org/10.1155/2016/1748583
27. Nadeem S, and Naeem B. Traumatic Cataract: Our Experience, Ophthalmology Update. 2016; 14(2):38-43.
28. Viswanathan M, Gu W, Blanch R, and Groves L. Cataracts after Ophthalmic and Nonophthalmic Trauma Exposure in Service Members, U.S. Armed Forces. *Military Medicine*. 2024-May/June;189(5-6):1009–1015. https://doi.org/10.1093/milmed/usad414
29. Shah M, Shah S, Shah S, Prasad V, Parikh A. Visual recovery and predictors of visual prognosis after managing traumatic cataracts in 555 patients. Indian J Ophthalmol. 2011;59:217-22. DOI: 10.4103/0301-4738.81043
30. Li C, Fu Y, Liu S, Yu H, Yang X, Zhang M, and Liu L. The global incidence and disability of eye injury: an analysis from the Global Burden of Disease Study 2019. e Clinical Medicine. August- 2023;62: 1-11. https://doi.org/10.1016/j.eclinm.2023.102134
31. Memon M, Narsani A and Nizamani N. Visual Outcome of Unilateral Traumatic Cataract. Journal of the College of Physicians and Surgeons Pakistan. 2012;22(8): 497-500.
32. Serna-Ojeda J, Cordova-Cervantes J, Lopez-Salas M, Abdala-Figuerola A, Jimenez-Corona A, Matiz-Moreno H, and Chavez-Mondragon E. Management of traumatic cataract in adults at a reference center in Mexico City. Int Ophthalmol. 2015; 35:451–458.
33. Bhuyan J, Deka B, and Gogoi D. A Clinical Study on Management of

Traumatic Cataract - A Research Article. International Journal of Health Sciences and Research. 2020-April; 10(4); 29-36 Bhuyan J,

34. Deka B, Gogoi D. A clinical study on management of traumatic cataract - a research article. Int J Health Sci Res. 2020; 10(4):29-36.
35. Chuang LH, and Lai CC. Secondary intraocular lens implantation of traumatic cataract in open-globe injury. Canadian Journal of Ophthalmology. 2005;40(4):454–459. DOI:10.1016/S0008-4182(05)80005-5
36. Akpolat C, Evliyaoglu F, Kurt M, Karadas A, Cinhuseyinoglu M, and Elcioglu M. Traumatic cataract study. Surgical outcomes of blunt versus penetrating ocular injuries. Medicine Science. 2019;8(1):37-41. DOI: 10.5455/medscience.2018.07.8914
37. Moisseiev J, Segev F, Harizman N, Arazi T, Rotenstreich Y, Assia E I. Primary cataract extraction and intraocular lens implantation in penetrating ocular trauma. Ophthalmology.2001Jun;108(6):1099-103.DOI: 10.1016/s0161-6420(01)00575-9.
38. Bekibele CO and Fasina O. Visual outcome of traumatic cataract surgery in Ibadan, Nigeria. Nigerian Journal of Clinical Practice. 2008-December; 11(4):372-375.
39. Srivastava U, Lalramhluni R, Rawa P, Bhaisare V. Clinical evaluation of post traumatic cataract in tertiary care hospital. International Journal of Scientific and Research Publications. 2014- October; 4(10): 1-6. www.ijsrp.org
40. Manjula Mangane and Vikas Aili. A prospective clinical evaluation and management of traumatic cataract. International Journal of Medical Ophthalmology 2019; 2(2): 01-05 DOI: https://doi.org/10.33545/26638266.2020.v2.i2a.31
41. Özbilen K, and Altınkurt E. Impact of the possible prognostic factors for visual outcomes of traumatic cataract surgery. Int Ophthalmol. 2020 Nov;40(11):3163-3173. DOI: 10.1007/s10792-020-01502-5. Epub 2020 Jul 10.
42. Murmu S, Lakra M, Kumari T, and Sawaiyan S. Incidence and Prognostic Factors for Visual Outcome in Patients Having Cataract Surgery with Traumatic Cataract Visiting Tertiary Care Centre, Jharkhand. International Journal of Contemporary Medical Research. May -2020; 7(5):1-3 DOI: http://dx.doi.org/10.21276/ijcmr.2020.7.5.28
43. Rumelt S, and Rehany U. The influence of surgery and intraocular lens implantation timing on visual outcome in traumatic cataract. Graefes Arch Clin Exp Ophthalmol. 2010 Sep;248(9):1293-7. DOI: 10.1007/s00417-010-1378-x.
44. Khalid M, Rizwan M, Imran M and Khan N. Frequency of Visual Improvement after Traumatic Cataract Surgery. P J M H S. JAN – MAR 2016; 10(1): 291-293

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Original Research Article

Clinical Presentation Variants of Chronic Subdural Hematoma Cases

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Abstract

Background: Chronic subdural hematoma (CSDH) is a prevalent condition in neurosurgical practice, predominantly affecting the elderly. However, there is a paucity of data concerning the characteristics of CSDH patients within Middle Eastern populations including Yemen.

Aim of study: This study aims to systematically evaluate the clinical presentations of patients diagnosed with chronic subdural hematoma.

Methodology: A retrospective descriptive study was obtained from registry medical records of patients with CSDH in Al-Thawra Modern General Hospital (TMGH) over a period of six years from January, 2017 to November, 2022. The collected data encompassed demographic and clinical characteristics including clinical presentation, Glasgow Coma Scale (GCS) at admission, etiology, laterality of the hematoma, management approaches and patient outcomes.

Results: A total of 113 CSDH cases were analyzed, with 77.9% of the patients being male. The mean age was 61.8 years. Motor symptoms were the most common presenting feature, observed in 79.6% of cases, followed by symptoms of increased intracranial pressure (54.0%) and altered consciousness (46.0%). At admission, the majority of patients (54%) had a normal GCS score of 15, while 30.1% had GCS scores between 13 and 14. Left-sided hematomas were identified in

44.2% of patients, whereas 22.1% had bilateral presentations. The etiology remained unidentified in 45.1% of cases, with 30.1% having a history of a ground-level fall and 16.8% having a history of traffic accidents. Surgical intervention via burr hole was performed in 92.9% of patients, with a favorable outcome observed in the majority. The mortality rate was 3.5%.

Conclusion: Chronic subdural hematoma exhibits a wide spectrum of clinical manifestations, with motor symptoms being the most prevalent. The condition predominantly affects elderly males. Most patients were successfully managed through burr hole surgery, with favorable outcomes in the majority. This single-institution, retrospective study presents findings consistent with global data. However, larger, multi-center studies are necessary to better elucidate the epidemiological profile and variable clinical presentations of CSDH.

Keywords: *Clinical Presentation, Chronic Subdural Hematoma, Yemen*

Introduction

Chronic subdural hematoma (CSDH), defined as an intracranial, extra-axial accumulation of blood persisting for more than three weeks, is a frequently encountered form of intracranial hemorrhage [1-3]. The incidence of CSDH escalates with advancing age, rising from 3.4 per 100,000 in individuals younger than 65 years to a reported range of 8–58.1 per 100,000 in those aged 65 years and older [1-3]. This increased prevalence in the elderly population is primarily attributed to a higher risk of falls and the widespread use of antithrombotic medications [2]. Minor or blunt head trauma often precipitates the development of CSDH. In the elderly, cerebral atrophy leads to the stretching of bridging veins that traverse the potential subdural space to drain into the venous sinuses. These fragile veins are particularly susceptible to tearing after even minor trauma, resulting in slow bleeding into the subdural space. The subsequent osmotic expansion of this collection increases its volume, eventually causing a mass effect and leading to clinical deterioration [4]. The clinical manifestations of CSDH are varied, ranging from mild symptoms, such as headaches and dizziness, to severe symptoms, including hemiplegia, coma, or death. These symptoms may differ according to the patient's age. Younger individuals typically present with signs of increased intracranial pressure, such as progressive headache, nausea, and vomiting [5,6]. Conversely, in older patients, particularly those over 65 years, cognitive and mental changes are more frequently observed [7]. A high index of suspicion is essential for the diagnosis of CSDH. It should be considered in any patient, regardless of trauma history, who presents with altered mental status, worsening of pre-existing neurological or psychological conditions, focal neurological deficits, or headaches with or without associated neurological deficits. Computed tomography (CT) of the brain should be strongly recommended in these cases to rule out CSDH [8]. Given the variability in clinical presentations and the frequent lack of initial suspicion, this study aims to explore the different presentations of CSDH

and their relationship to patient age. The incidence of CSDH is on the rise, likely reflecting the aging population, and is associated with a one-year mortality rate of up to 32% [9]. CSDH presents clinically with a range of non-specific symptoms, which are influenced by the patient's age and the presence of concurrent chronic diseases. Few studies have detailed the characteristics of CSDH in Middle Eastern populations, including Yemen.

Methodology

Study Setting and Design: This study was a retrospective descriptive analysis based on medical records from Al-Thawra Modern General Hospital (TMGH) in Sana'a, Yemen. The study focused on all cases diagnosed with CSDH over a period of nearly six years from January, 2017 to November, 2022.

Data Collection: The data were extracted from hospital medical records, including demographic details such as patient name, age, gender, admission date and file number. Clinical data related to CSDH were also collected, including Glasgow Coma Scale (GCS) at admission, presenting neurological symptoms, associated etiological factors (e.g., trauma, fall), specific hematoma characteristics like the side of hematoma within the cranium, management strategies and outcomes.

Inclusion Criteria and Exclusion Criteria: The study included patients of any age and gender who were diagnosed with CSDH and admitted to TMGH in Sana'a, Yemen between January 2017 and November 2022. Cases with insufficient data were excluded from the study. Additionally, patient with acute subdural hematoma, spinal subdural hematoma, brain contusion or epidural hematoma were also excluded.

Statistical Analysis: Data was analyzed by SPSS v25.0. Descriptive statistics were employed to describe participants' demographic characteristics. Continuous data were reported as mean ± SD for normally distributed variables, while categorical data were presented as frequencies and percentages. The associations between two qualitative variables were measured using proportion, and the difference of the proportions across subgroups were tested for significance using the Chi-square, with p-value < 0.05 considered statistically significant.

Ethical Considerations: Approval for the study was obtained from TMGH following the current ethical guidelines for retrospective studies.

Results

Patient characteristics

This study included a total of 113 file of patients with CSDH who were admitted to the hospital. 77.9% of them were males and 22.1% were females. The mean age was 61.8 years. The predominant age group were patients older than 60 years 60.2% in comparing to 23% of patients aged between 41-60 years, 11.5% were between 20-4years and only 5.3% were younger than 20 years, **Table 1**.

Table 1: Demographic and Clinical Characteristics of Study Sample.

Variables		No.	%
Gender	Male	25	22.1
	Female	88	77.9
Age Group	< 20	6	5.3
	20-40	13	11.5
	41-60	26	23.0
	> 60	68	60.2
Consciousness Level	Confused	34	30.1
	Loss of consciousness	18	15.9
	Normal	61	54.0
Motor Symptoms	Right and left-sided hemiplegia	2	1.8
	Right and left-sided hemiparesis	8	7.1
	Left -sided hemiplegia	2	1.8
	Left-sided hemiparesis	32	28.3
	Right-sided hemiplegia	3	2.7
	Right-sided hemiparesis	43	38.1
	No motor symptoms	23	20.4
Raised ICP symptoms	Yes	61	54
	No	52	46
Headache	Yes	59	52.2
	No	54	47.8
Convulsion	Yes	4	4
	No	108	96
Ataxia	Yes	3	2.7
	No	110	97.3
Sphincter Incontinence	Stool	2	1.8
	Urine	9	8
	Both	6	5.3
	Normal	96	85
Sensory symptoms	Anesthesia	1	0.9
	Numbness	4	3.5
	Normal	108	95.6
State of Speech	Slurred	23	20.4
	Aphasia	6	5.3
	Normal	84	74.3
Other Symptoms	Dizziness	5	4.4
	Easy fatigability	1	0.9
	Epistaxis	1	0.9
	Hallucinations	2	1.8
	No other symptoms	104	92.0
Total		**113**	**100**

*No.= Number, %= Percent

Frequency of presenting symptoms:

The majority of the patients 54% had normal level of consciousness, 30.1% were confused, and 15.9% had a loss of consciousness. **Table 1**.

In term of motor symptoms, 38.1% patients had right-sided hemiparesis, 28.3% had left-sided hemiparesis, 7.1% had both right and left-sided hemiparesis, in contrast to 2.7% patients who had right-sided hemiplegia, 1.8% had left-sided hemiplegia, 1.8% had both right and left-sided hemiplegia. About 20.4% patients had no motor symptoms.

More than half of patients 54% showed spectrum of raised intracranial pressure (ICP) symptoms. Headache was the most frequent symptom 52.2% either presented alone or in association with other symptoms. On the other hand, only 4.4% of patients were complaining of convulsions either alone or along with other symptoms, while most patients 95.6% were free from convulsions. Among all cases, only 2.7% developed ataxia. The majority of patients 85% had normal sphincteric control, in contrast to 8% who had urinary incontinence, 1.8% had stool incontinence, and 5.3% cases had incontinence for both stool and urine. **Table 1.**

The sensory system was intact in the majority of patients 95.6%, with only 3.5% experiencing unilateral arm numbness, and one patient presented with complete loss of sensation on the right side of the body. Speech function was preserved in 74.3% of patients, while 20.4% had slurred speech, and 5.3% were aphasic. Additionally, some patients reported dizziness 4.4%, hallucinations 1.8%, epistaxis 0.9%, or easy fatigability 0.9%. Further details can be found in .

Common Clinical Presentations:

Motor symptoms were the most common presenting symptoms. It affected approximately 79.6% of cases in the form of paresis or paralysis. 54% of patients were complaining from raised ICP symptoms. Headache was the most frequent symptom 52.2%, while only 4.4% of patients were complaining of convulsions. 46.0% of patients reported alteration in consciousness level in contrast to 15.9% who had complete loss of consciousness. Frequencies of speech abnormalities, sphincter incontinence, other symptoms and sensory abnormalities were as fallowing 25.7%, 15.0%, 10.0% and 4.4% respectively. The least documented symptom in our study was gait disturbance with 2.7% of patients were suffering from ataxia. **Figure 1** shows the various presenting sympto

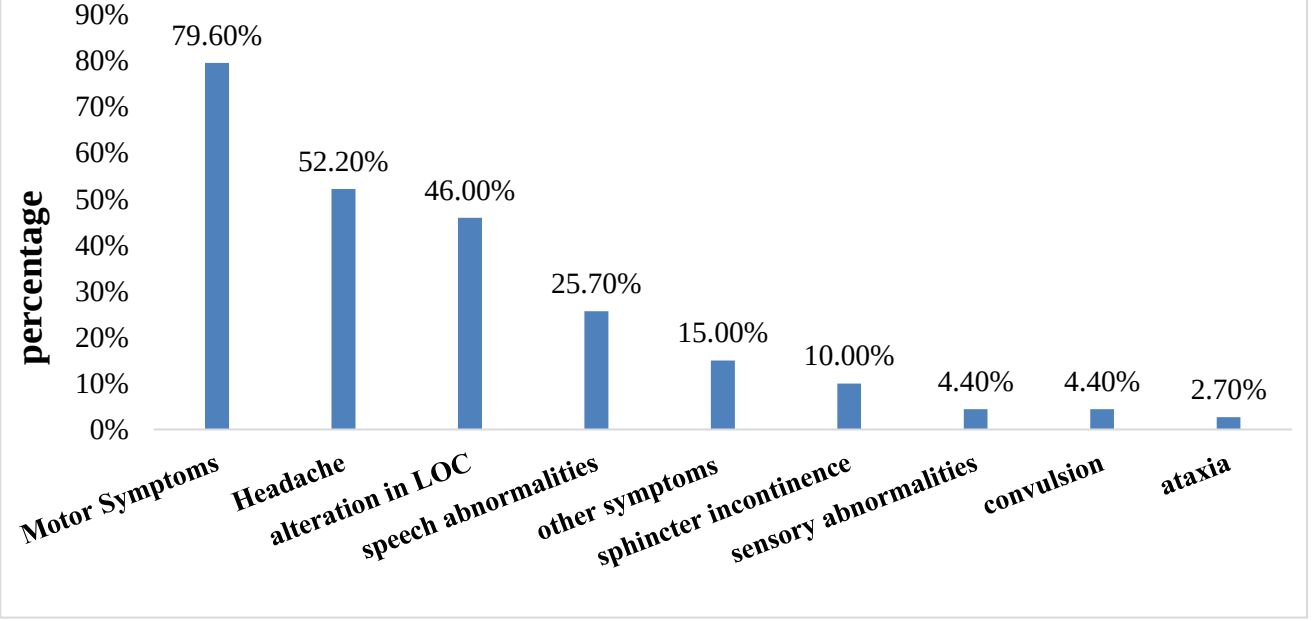

Figure 1: Frequencies of Clinical Presentation in Patients with Chronic Subdural Hematoma

Etiologies

Approximately half of the cases had identifiable etiological factors contributing to the development of CSDH. These included minor head injuries due to falls in 30.1% of patients, traffic accidents in 16.8%, and cranial surgeries in 1.8%. Additionally, 6.2% of patients had a recurrence of CSDH post-operation. However, in 45.1% of cases, no specific cause could be identified. **Figure 2**.

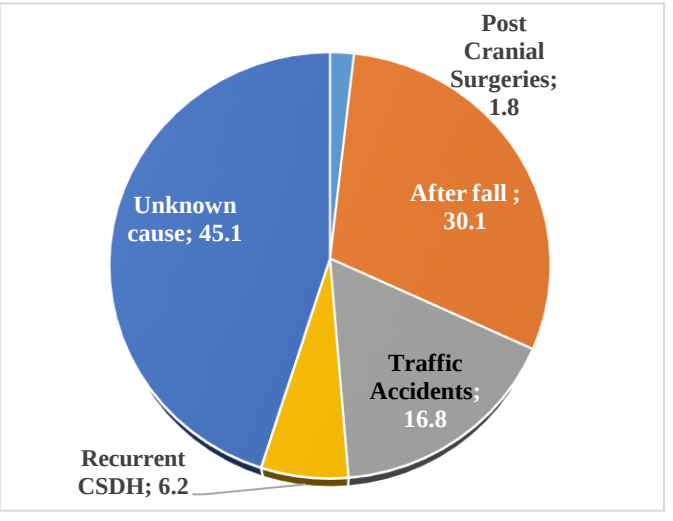

Figure 2: Frequencies of Etiological Factor Associated with development of Chronic Subdura Hematoma

Table 2: Distribution of Study Sample by GCS at Admission

GCS at Admission	No.	%
< 9	4	3.5
12-9	14	12.4
14-13	34	30.1
15	61	54.0
Total	113	100.0

No. = Number, % = Percent

Glasgow Coma Scale (GCS) at Admission

Table 2 shows the Glasgow coma scale (GCS) at the time of admission, which was distributed as follows: 15/15 in 54.0%, 14-13/15 in 30.1%, 12-9/15 in 12.4%, and less than 9/15 in 3.5%.

Hematoma Side:

Figure 3 shows the distribution of CSDH according to the side of the hematoma in cranial cavity, 44.2% of CSDH localized on the left side of the cranial cavity. In comparison to 33.6% had CSDH on the right side of cranial cavity, and 22.1% exhibited bilateral hematomas.

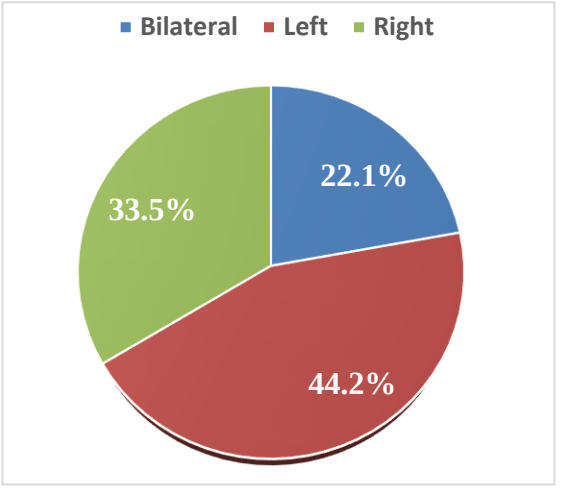

Figure 3: Distribution of Sample by Laterality of The Hematoma within the cranial cavity.

Management Strategies and Outcome

As depicted in **Figure 4**, the predominant management strategy for CSDH was burr hole surgery performed in 92.9% of cases.

Craniotomy was utilized in 5.3%, while 1.8% were managed conservatively. The prognosis for the majority of patients was favorable, with 96.5% showing positive outcomes, whereas only 3.5% resulted in mortality, as shown in **Figure 5**.

Relationship between Clinical

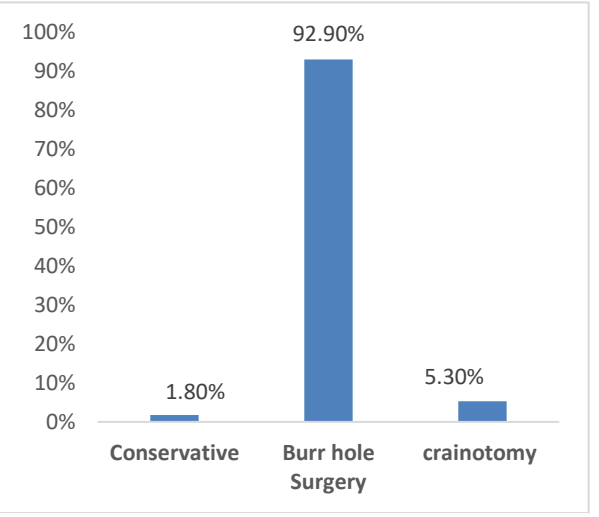

Figure 4: Management Strategies of Chronic Subdural Hematoma Cases.

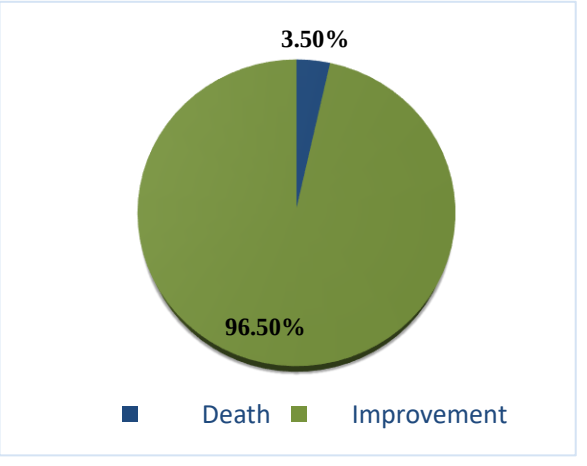

Figure 5: Distribution of Study Sample by Outcomes.

Presentation and Variables

Table 3 reveals a statistically significant association between motor symptoms and age groups within the study sample (p-value = 0.009). Additionally, a statistically significant relationship was observed between convulsions and age groups (p-value = 0.006). However, no statistically significant associations were found between age groups and other variables, such as consciousness level, gait disturbance, speech, sphincter incontinence, headache, sensory symptoms, or other symptoms (p-values > 0.05). **Table 3** provides further details on the relationship between these variables and age groups.

Table 3: Relationship between Clinical Presentation and Age Groups, Outcome

Clinical Presentation			Age groups (Years)				Total	*P.* Value	*Outcome*		Total	*P.*Value
			20<	20-40	41-60	60>			Death	Improve		
Consciousness level	Confused	No.	2	4	5	23	34	0.329	1	33	34	0.003
		%	1.8	3.5	4.4	20.4	30.1		0.9	29.2	30.1	
	Loss of consciousness	No.	0	2	8	8	18		3	15	18	
		%	0.0	1.8	7.1	7.1	15.9		2.7	13.3	15.9	
	Normal	No.	4	7	13	37	61		0	61	61	
		%	3.5	6.2	11.5	32.7	54		0	54	54	
Motor symptom	Both limbs paralysis	No.	0	0	1	1	2	**0.009**	**0**	**2**	**2**	**0.479**
		%	0	0	0.9	0.9	1.8		0	1.8	1.8	
	Both limbs weakness	No.	0	1	4	3	8		1	7	8	
		%	0	0.9	3.5	2.7	7.1		0.9	6.2	7.1	
	Left limbs paralysis	No.	0	0	1	1	2		0	2	2	
		%	0	0	0.9	0.9	1.8		0	1.8	1.8	
	Left limbs weakness	No.	0	1	5	26	32		1	31	32	
		%	0	0.9	4.4	23.0	28.3		0.9	27.4	28.3	
	Right limbs paralysis	No.	0	1	1	1	3		0	3	3	
		%	0	0.9	0.9	0.9	2.7		0	2.7	2.7	
	Right limbs weakness	No.	1	4	9	29	43		0	43	43	
		%	0.9	3.5	8.0	25.	38.1		0	38.1	38.1	
	No Motor Symptoms	No.	5	6	5	7	23		2	21	23	
		%	4.4	5.3	4.4	6.2	20.4		1.8	18.6	20.4	
Gait disturbance	No	No.	5	13	25	67	110	0.143	4	106	110	0.737
		%	4.4	11.5	22.1	59.3	97.3		3.5	93.8	97.3	
	Yes	No.	1	0	1	1	3		0	3	3	
		%	0.9	0.	0.9	0.9	2.7		0	2.7	2.7	
Speech	Aphasia	No.	1	0	1	4	6	0.619	0	6	6	0.876
		%	0.9	0.	0.9	3.5	5.3		0	5.3	5.3	
	Slurred	No.	0	2	5	16	23		1	22	23	
		%	0.0	1.8	4.4	14.2	20.4		0.9	19.5	20.4	
	Normal	No.	5	11	20	48	84		3	81	84	
		%	4.4	9.7	17.7	42.5	74.3		2.7	71.7	74.3	
Sphincter Incontinence	Stool	No.	0	0	0	2	2	0.507	0	2	2	0.323
		%	0.0	0	0	1.8	1.8		0	1.8	1.8	
	Urine	No.	0	0	1	8	9		0	9	9	
		%	0	0.	0.9	7.1	8.0		0	8	8	
	Both	No.	0	0	3	3	6		1	5	6	
		%	0	0.	2.7	2.7	5.3		0.9	4.4	5.3	
	Normal	No.	6	13	22	55	96		3	93	96	
		%	5.3	11.5	19.5	48.7	85.0		2.7	82.3	85	
Headache	Yes	No.	5	10	14	30	59	0.062	2	57	57	0.923
		%	4.4	8.8	12.4	26.5	52.2		1.8	50.4	52.2	
	No	No.	1	3	12	38	54		2	52	54	
		%	0.9	2.7	10.6	33.6	47.8		1.8	46	47.8	
Convulsion	Yes	No.	0	3	0	2	5	**0.006**	**0**	**5**	**5**	**0.661**
		%	0	2.7	0	1.8	4.4		0	4.4	4.4	
	No	No.	6	10	26	66	108		4	104	108	
		%	5.3	8.8	23.0	58.4	95.6		3.5	92	95.6	
Sensory symptoms	Anesthesia	No.	0	0	0	1	1	0.952	0	1	1	0.908
		%	0	0	0	0.9	0.9		0	0.9	0.9	
	Numbness	No.	0	1	1	2	4		0	4	4	
		%	0	0.9	0.9	1.8	3.5		0	3.5	3.5	
	normal	No.	6	12	25	65	108		4	104	108	
		%	5.3	10.6	22.1	57.5	95.6		3.7	96.3	100	

No. = Number, % = Percent

Table 4 demonstrates a statistically significant correlation between GCS at admission and the management approach (p-value = 0.035). Moreover, it highlights a significant relationship between GCS at admission and patient outcomes (p-value < 0.001). **Table 5** further reveals a statistically significant association between the chosen management strategy and patient outcomes (p-value < 0.001).

Table 4: Relationship between Management, Outcomes and GCS at Admission.

Variables			Management			Total	*P.Value*	Outcomes		Total	*P.Value*
			Conservative	Surgical burr hole	Surgical craniotomy			Death	Improve		
GCS at admission	< 9	N	1	3	0	4	**0.035**	2	2	4	**0.001**
		%	0.9	2.7	0.0	3.5		1.8	1.8	3.5	
	12-9	N	0	13	1	14		1	13	14	
		%	0.0	11.5	0.9	12.4		0.9	11.5	12.4	
	14-13	N	0	32	2	34		1	33	34	
		%	0	28.3	1.8	30.1		0.9	29. 2	30. 1	
	15	N	1	57	3	61		0	61	61	
		%	0.9	50.4	2.7	54.0		0	54	54	

No. = Number, % = Percent

Table 5: Relationship between Outcomes and Management.

Variables			**Outcomes**		**Total**	***P*.Value**
			Death	**Improve**		
Management	**Conservative Management**	**N**	1	1	2	**0.001**
		%	0.9	0.9	1.8	
	Burr hole Surgery	**N**	3	102	105	
		%	2.7	90.3	92.9	
	craniotomy	**N**	0	6	6	
		%	0.0	5.3	5.3	
Total		**N**	4	109	113	
		%	3.5	96.5	100.0	

No. = Number, % = Percent

Discussion

This retrospective study analyzed 113 medical records of patients diagnosed with chronic subdural hematoma (CSDH) to investigate the variations in clinical presentation among this study. The sociodemographic data revealed that CSDH predominantly affects older males, with 60.2% of the patients being over 60 years old, and a mean age of 61.8 years. These findings align with a similar study conducted in Uganda, where the mean age was reported as 60.2 years [10]. The gender distribution in our study showed that 77.9% of the cases were male and 22.1% female, a pattern consistent with research from Kosovo, which reported 77.3% male predominance [11]. Motor symptoms, manifesting as either weakness or paralysis, were the most common presenting features, observed in 79.6% of the patients. This was followed by symptoms of increased intracranial pressure (ICP) in 54.0% of cases,

headaches in 52.2%, convulsions in 4.4%, altered consciousness in 46.0%, complete loss of consciousness in 15.9%, speech abnormalities in 25.7%, sphincter incontinence in 15%, sensory impairments in 4.4%, and gait disturbances in 2.7%. These findings are in concordance with study conducted at CHU Sylvanus Olympio (Lome), where motor weakness was the most frequent clinical presentation (56.1%), followed by headache (51.5%) and confusion (34.8%) [12].

Similarly, another study in Uganda reported headaches as the most common symptom 89.6%, followed by confusion 71.7% and limb weakness 70%. The Lagos University Teaching Hospital study also identified headache 89% as the most prevalent symptom, followed by motor deficits 63%, fluctuating consciousness levels 54.2%, inappropriate speech 16.6%, seizures 10.4% and incontinence 6.3% [13].

In this study, head trauma was identified as the primary etiological factor in 46.9% of patients, with falls accounting for 30.1% and road traffic accidents for 16.8% o cases. Recurrence of CSDH was noted in 6.2% of patients, and 1.8% reported CSDH following cranial surgery. However, in 45.1% of cases, no specific cause could be identified. This is consistent with another study, which reported a definite history of head injury in 57% of patients and a past neurosurgical history in 8%, with 29% of cases having no identifiable cause [14]. Regarding the laterality of the hematoma, our study found that 77.9% of patients had unilateral hematomas, with 44.2% on the left side, 33.6% on the right side, and 22.1% exhibiting bilateral hematomas. These findings are in line with similar studies that reported CSDH on the left side in 52% of cases, on the right in 30.4%, and bilateral in 17.6% [14]. Another study reported right-sided hematomas in 42.3% of cases, left-sided in 36.3%, and bilateral in 21.4% [10].

The majority of patients (92.9%) in this study were managed surgically with burr hole drainage, followed by craniotomy in 5.3% and conservative management in 1.8% of cases. This treatment pattern is consistent with other studies, such as one reporting burr hole surgery in 95.3% of patients and craniotomy in 4.7% [15].

Statistical analysis revealed significant associations between motor symptoms and age groups (p-value = 0.009), and between convulsions and age groups (p-value = 0.006). There was also a significant relationship between convulsions and management strategies (p-value = 0.006), and between GCS at admission and both management strategies (p-value = 0.035) and outcomes (p-value = 0.001). These findings are in agreement with a South African study that found a significant relationship between GCS at presentation and patient outcomes (p-value = 0.002) [16]. Similarly, a 2017 study in Korea demonstrated a strong association between initial GCS scores and patient prognosis ($p < 0.001$) [17].

This study has several limitations. The sample size was restricted to 113 patients, which may limit the generalizability of the findings and possibly either overestimate or underestimate the true frequencies of clinical presentations, injury mechanisms, and outcomes. Additionally, the study was

conducted at a single referral hospital in Sana'a, Yemen, limiting the applicability of the results to more urbanized or rural populations. Furthermore, the retrospective nature of the study, relying on patient records, led to missing data in some cases.

Conclusion

Chronic subdural hematoma (CSDH) typically presents with a range of symptoms, predominantly motor symptoms, and predominantly affects elderly males. The condition predominantly affects elderly males. Most patients were successfully managed through burr hole surgery, with favorable outcomes in the majority. This single-institution retrospective study yielded results comparable to those observed in other global studies. However, larger, multicenter studies are necessary to provide a more precise epidemiological characterization and to identify the diverse clinical presentations of CSDH. Additionally, prospective studies are recommended to assess long-term outcomes and to develop health education programs, conferences, and training for healthcare professionals. Improving the quality and completeness of medical records is also crucial.

References

1. Asghar, M., Adhiyaman, V., Greenway, M., Bhowmick, B. K., & Bates, A. (2002). Chronic subdural haematoma in the elderly—a North Wales experience. Journal of the royal society of medicine, 95(6), 290-292.
2. Kostanian, V., Choi, J. C., Liker, M. A., Go, J. L., & Zee, C.-S. (2000). Computed tomographic characteristics of chronic subdural hematomas. Neurosurgery Clinics of North America, 11(3) 489-479.
3. Kudo, H., & Kuwamura, K. (1992). Chronic subdural hematoma in elderly people: Tokyo.
4. Sah, S., & Rawal, D. (2018). Craniotomy does have its share in the management of chronic subdural hematoma. Indian Journal of Neurotrauma, 15(02/03), 057-061.
5. Bartek Jr, J., Sjåvik, K., Dhawan, S., Sagberg, L. M., Kristiansson, H., Ståhl, F., . . . Jakola, A. S. (2019). Clinical course in chronic subdural hematoma patients aged 18–49 compared to patients 50 years and above: a multicenter study and meta-analysis. Frontiers in neurology, 10, 311.
6. Sousa, E. B., Brandão, L. F., Tavares, C. B., Borges, I. B., Neto, N. G. F., & Kessler, I. M. (2013). Epidemiological characteristics of 778 patients who underwent surgical drainage of chronic subdural hematomas in Brasília, Brazil. BMC surgery, 13(1), 1-7.
7. Ye, H. H., Kim, J. H., Kim, Y. S., Cho, C. W., & Kim, D. J. (2008). Cognitive impairment in the elderly with chronic subdural hematoma. Journal of Korean Neurotraumatology Society, 4(2), 66-69.
8. Lee, K.-S., Bae, W. K., Bae, H. G., Doh, J., & Yun, I. (1997). The computed tomographic attenuation and the age of subdural

hematomas. Journal of Korean medical science, 12(4), 353-359.

9. Wang, S., Ma, Y., Zhao, X., Yang, C., Gu, J., Weng, W., . . . Feng, J. (2019). Risk factors of hospital mortality in chronic subdural hematoma: a retrospective analysis of 1117 patients, a single institute experience. Journal of Clinical Neuroscience, 67, 46-51.

10. Kitya, D., Punchak, M., Abdelgadir, J., Obiga, O., Harborne, D., & Haglund, M. M. (2018). Causes, clinical presentation, management, and outcomes of chronic subdural hematoma at Mbarara Regional Referral Hospital. Neurosurgical focus, 45(4), E7.

11. Mekaj, A. Y., Morina, A. A., Mekaj, Y. H., Manxhuka-Kerliu, S., Miftari, E. I., Duci, S. B., . . . Kelmendi, F. M. (2015). Surgical treatment of 137 cases with chronic subdural hematoma at the university clinical center of Kosovo during the period 2008-2012. Journal of neurosciences in rural practice, 6(02), 186-190.

12. Doléagbénou, K. A., Kpélao, E., Békéti, A. K., Ahanogbé, K. H., Moumouni, A., & Egu, K. (2020). Clinical Aspects, Surgical Management and Outcome of Chronic Subdural Hematoma at CHU Sylvanus Olympio (Lome). HEALTH SCIENCES AND DISEASE, 21(5).

13. Bankole, O., Yusuf, A., Kanu, O., Ukponwan, E., Nnadi, M., & Arigbabu, S. (2011). Chronic subdural haematoma: clinical presentation, surgical treatment and outcome at the Lagos University Teaching Hospital. African Journal of Neurological Sciences, 30.(1).

14. Mori, K., & Maeda, M. (2001). Surgical treatment of chronic subdural hematoma in 500 consecutive cases: clinical characteristics, surgical outcome, complications, and recurrence rate. Neurologia medico-chirurgica, 41(8), 371-381.

15. Sundblom, J., Sandberg, E., & Ronne-Engström, E. (2022). Trauma mechanisms and surgical outcomes in the elderly patient with chronic subdural hematoma. Canadian Geriatrics Journal, 25(1), 40.

16. Mosadi, B., Kelly, A., & Lekgwara, P. (2019). Profile and outcomes of patients admitted with chronic subdural hematomas-A single center report from an Academic Hospital in Pretoria, Gauteng, South Africa. Interdisciplinary Neurosurgery, 18, 100531.

17. Park, H. S., Park, E. S., Park, J. B., Kwon, S. C., Lyo, I. U., Kim, M.-h., & Sim, H. B. (2014). Chronic subdural hematomas: comparison between unilateral and bilateral involvement. Korean journal of neurotrauma, 10(2), 55-59.

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Original Research Article

Epidemiological Description of Primary Brain Tumors: A Single-Center Retrospective Study of 75 Cases, Yemen

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Abstract

Background: Primary brain tumors represent one of the most devastating tumors, characterized by high significant morbidity and mortality with a high rate of neurological sequelae. Only limited studies have described the burden of CNS tumors in Yemen.

Objective: Description of the epidemiological trends of primary brain tumors in a single institution.

Materials and methods: A retrospective study was obtained from registry records of patients with primary brain tumors based on clinical and radiological data or histopathological report at 48 Model Hospital, Sana'a, over a period of 4 years from January 1, 2020 to December 31, 2023. The collected data encompassed demographic and tumor characteristics including patient's gender and age, and type and site of tumor, as well as WHO grade.

Results: 75 cases of primary brain tumors were reviewed. There were 43 (57.3%) females. Adults were the highest age group involved (68%). The majority of tumors (77.3%) were supratentorial. Gliomas constituted the most common neoplastic category (48%). However, meningiomas was the most common single entity (32%).

Conclusion: This is an institution-based, detailed, and descriptive epidemiological study of Yemeni patients with primary brain tumors. In spite of our study's matching with most worldwide studies results, the definitive epidemiological rates in reality need a bigger multi-centric and histopathological based studies to be carried out. Limitations of our study included the clinically and radiologically based diagnosis of most cases.

Keywords: Primary Brain Tumor, Prevalence, Yemen.

Introduction

Primary brain tumors represent one of the most devastating tumors, characterized by high significant morbidity and mortality with a high rate of neurological sequelae [1-3]. These tumors may originate from various structures, including meninges, brain tissues, cranial nerves, pituitary gland, or germinal cells [4]. Despite the advancements in oncological therapies, brain cancer remains an enduring challenge in such communities due to its aggressive nature. The American Cancer Society suggests that by 2040, cancer incidence will rise substantially, potentially reaching approximately 27.5 million cases. of the total cancer-related deaths, approximately 3% of them are attributed to central nervous system (CNS) tumors, with a higher mortality rate observed among men [7,8]. Furthermore, brain cancer is notably one of the most common malignancies with a distressingly high mortality rate among pediatric populations [9].

According to the GLOBOCAN 2020 estimates, Yemen reported 16,476 new cancer cases, with CNS tumors accounting for 4.9% (803 cases) of all cancer types, making them the 7th most common malignancy in the country. CNS tumors predominantly affect males, comprising 59.5% (478 cases) of the total and ranking as the 6th most common cancer among men. The total number of cancer-related deaths in Yemen was 12,103, with CNS tumors contributing to 5.7% (689 cases) of these fatalities, making them the 7th leading cause of cancer mortality.

However, these figures are estimations, given the lack of a comprehensive statistical system and the limited scope of studies on tumors in Yemen. The true burden of CNS tumors in the Yemeni population remains difficult to ascertain due to the country's weak healthcare infrastructure, ongoing economic crisis, and prolonged civil conflict. This study, aims to describe the epidimiological and clinical characterstics of primary brain tumors cases who had been attending the outpatient clinic or admitted to neurosurgical department for management.

Methods

Study Design and Setting: A retrospective study was carried out for all cases diagnosed with primary brain tumor using the clinical, radiological data, and histopathology studies at 48 Model Hospital, Sana'a, Yemen, over a 4-year period between January 2020 and December 2023. The epidemiology and clinical data of the tumors, including age, gender, the anatomical site of primary brain tumor, histopathological diagnosis, and WHO grade were obtained from the hospital's database, medical records, radiological films, and histopathological reports.

Inclusion Criteria: All cases diagnosed with primary brain tumors of any age and sex were included based on the availability of full clinical records and radiological data or histopathological diagnosis. Furthermore, patients should be registered in neurosurgery clinic or admitted to neurosurgery center, including those who underwent surgical operations in the center.

Exclusion Criteria: Any case with insufficient clinical or radiological data was excluded from our study. Additionally, any non-neoplastic brain lesions, secondary metastases to brain or scalp, and skull tumors with intracranial extension were all excluded as well.

Statistical Analysis: Analysis was performed using the Statistical Package for Social Sciences (SPSS) (V.26.0, International Business Machines Corporation (IBM), Armonk, New York, USA. Data were reported using appropriate statistics, including counts, means, frequencies, ratios, and proportions. Correlation test was used to determine correlation between primary brain tumors patients and independent variables, and P-value <0.05 was considered statistically significant.

Ethical Approval: The ethical approval was obtained from the Medical Research and Ethics Committee at 48 Model Hospital. Further, all data, including patient identification, have been kept confidential. The patients' consent was not required.

Results

Seventy-five patients met the inclusion criteria and were diagnosed with primary brain tumors based on clinical evaluations and radiological findings, or histopathological reports. Of these cases, only 21 patients (28%) underwent surgical procedures15 cases (20%) had gross total tumor excision, and 6 cases (8%) underwent diagnostic biopsy—while the remaining 54 patients (72%) did not receive surgical intervention **Figure 1**.

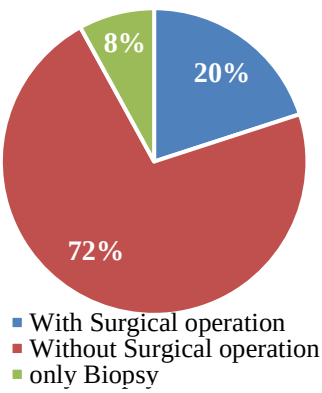

Figure 1: The percentage of primary brain tumors patients sorted by type of

Among the 75 patients, 43 were female (57.3%) and 32 were male (42.7%). The average age of the patients was 36.23 years, with a standard deviation of 21.9 years. Most patients (68%) were adults between the ages of 19 and 70, as detailed in **Table 1**.

Table 1 : Socio-demographic and tumor characteristics of the patients (n = 75)

Variables	Frequency	%
Gender		
Male	32	42.7
Female	43	57.3
Age Group		
< 18 years	20	27
19-70 years	51	68
>70 years	4	5
Tumor Location		
Supratentorial	58	77.3
Infratentorial	17	22.7
Tumor Type		
Glioma	36	48
Non-Glioma	39	52
High/Low Grade		
Low Grade	56	74.7
High Grade	19	25.3
Total	75	100%

In most patients, the tumor was located in the supratentorial region (n=58; 77.3%), while 22.7% had tumors in the infratentorial region. The majority of cases involved meningeal tumors (n=24; 32%), with approximately 16% located in the frontal lobe and 17.3% in the cerebellum, brainstem, and cerebellopontine angle. **Figure 2** shows the various locations of tumors within the brain.

Nearly 74.7% of the tumors were classified as low-grade, whereas 25.3% were high-grade. The results are presented in Figure 2. Nearly 74.7% of patients had low-grade tumors, whereas 25.3% had high-grade tumors. Approximately 52% of the patients were diagnosed with non-glioma tumors, while 48% (n=36) had gliomas. Meningioma emerged as the most prevalent type of primary brain tumor, accounting for 32%

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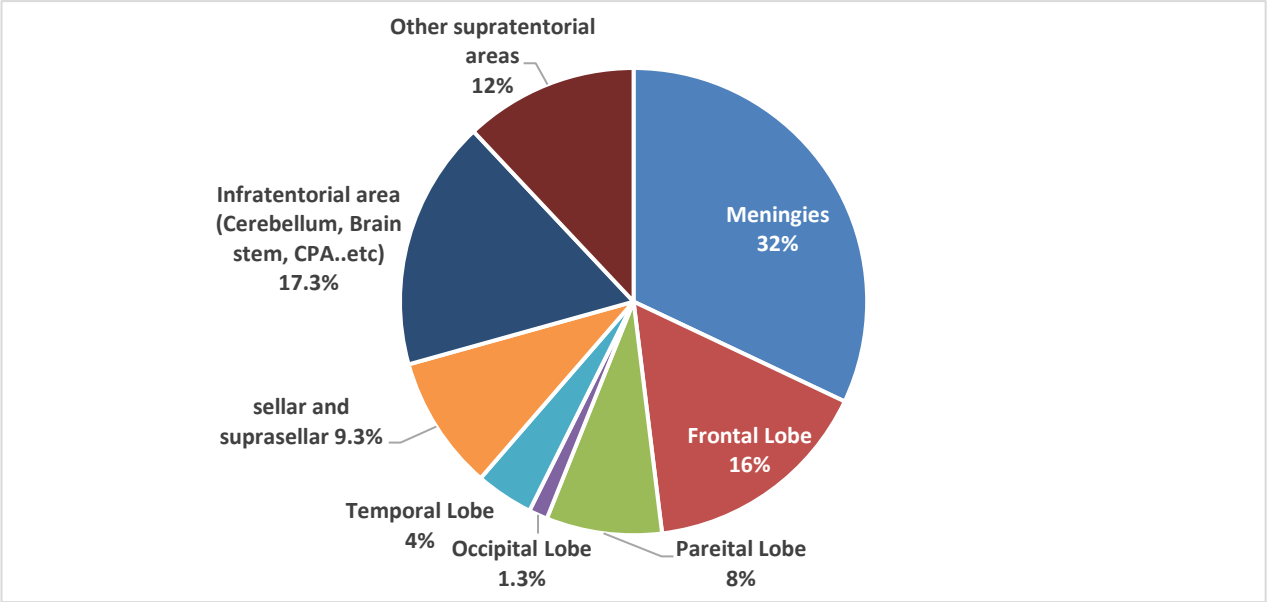

Figure 2: The distribution of primary brain tumors locations

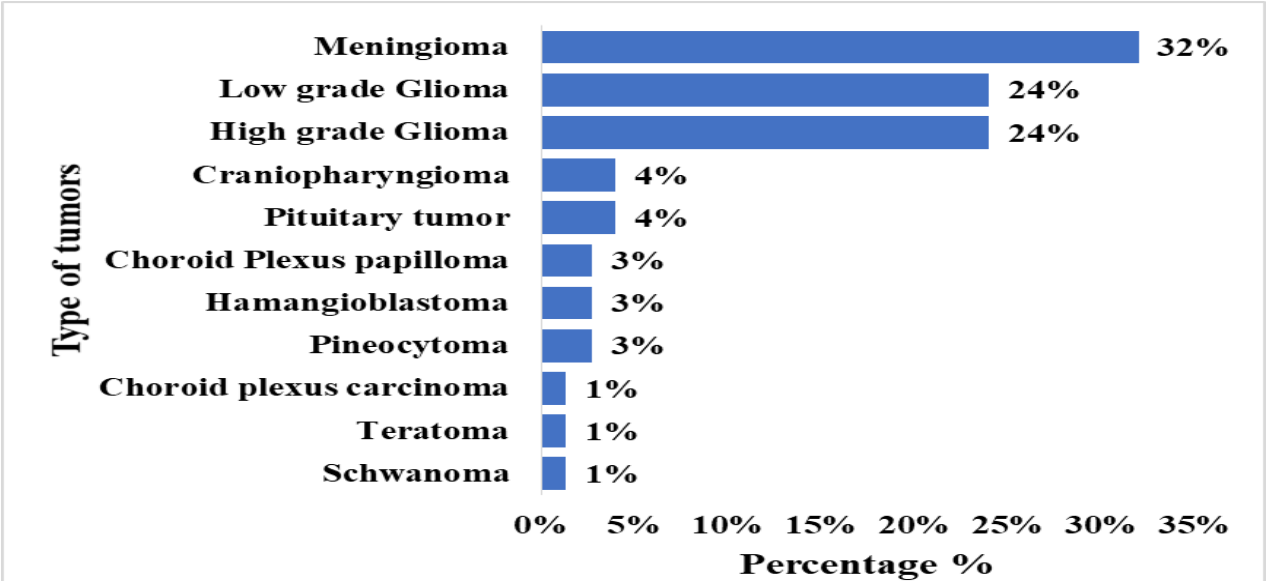

Figure 3: Distribution of tumors according to type of tumors

(n=24) of cases. Gliomas constituted 48% of the tumors and were equally divided between high-grade (n=18; 24%) and low-grade (n=18; 24%) gliomas. Other less common tumor types included craniopharyngioma (4%) and pituitary tumors (4%). **Figure 3** further illustrates the distribution of these and other less frequent tumor types, underscoring the wide variety of primary brain tumors encountered in clinical practice.

Primary brain tumors in relation to Gender and Age

In males, glioma was the most common tumor, representing 25.3% of cases, followed by meningioma at 9.3%. Among females, meningioma and glioma were equally prevalent, each accounting for 22.7% of cases. As previously mentioned, the majority of patients were adults aged 19 to 70 years (68%). In this age group, meningioma was the most frequently observed tumor, occurring in 30.7% of cases, followed closely by glioma at 29.3%. Conversely, glioma was the most common tumor among pediatric patients, representing approximately 14.7% of all primary brain tumors. These relationships are detailed in Table 2.

Table 2: The frequency of primary brain tumor in relation to gender and age groups.
(N=number,%=percent)

Type of tumors	Gender N (%)		Age group (Years) N (%)			Total N (%)
	Male	Female	18<	19-70	70>	
Meningioma	7 (9.3)	17 (22.7)	0	23 (30.7)	1 (1.3)	24 (32)
Glioma	19 (25.3)	17 (22.7)	11 (14.7)	22 (29.3)	3 (4)	36 (48)
Choroid Plexus papilloma	1 (1.3)	1 (1.3)	2 (2.7)	0	0	2 (2.7)
Choroid plexus carcinoma	0	1 (1.3)	1 (1.3)	0	0	1 (1.3)
Craniopharyngioma	2 (2.7)	1 (1.3)	2 (2.7)	1 (1.3)	0	3 (4)
Pituitary tumor	0	3 (4.0)	1 (1.3)	2 (2.7)	0	3 (4)
Hemangioblastoma	1 (1.3)	1 (1.3)	0	2 (2.7)	0	2 (2.7)
Teratoma	1 (1.3)	0	1 (1.3)	0	0	1 (1.3)
Pineocytoma	1 (1.3)	1 (1.3)	1 (1.3)	1 (1.3)	0	2 (2.7)
Schwannoma	0	1 (1.3)	1 (1.3)	0	0	1 (1.3)
Total	32(42.7)	43 (57.3)	20 (26.7)	51 (68)	4 (5.3)	75 100)

Correlations between brain tumors and variables

Table 3 presents a robust positive correlation (1.000) within the gender variable, indicating that changes in gender are closely related to one another. When examining the specific site variable, a statistically significant negative correlation (-0.239) with a p-value of 0.041 is observed, suggesting that as the specific site of the tumor varies, there is a corresponding decrease in another variable. Notably, the table also highlights a highly significant negative correlation (-0.568) between the specific site and tumor location, with a p-value of 0.000. This indicates a strong statistical relationship, wherein changes in the specific tumor site are closely associated with changes in the tumor's location, whether it is in the supratentorial or infratentorial region. Additionally, the table reveals a statistically significant positive correlation (0.229) between age groups and the patient's age, with a p-value of 0.050. This suggests that as

the age group increases, the patient's age also tends to increase. By carefully analyzing these statistically significant correlations, valuable insights can be drawn regarding the relationships between various factors associated with primary brain tumors within this academic and scientific framework.

Table 3: Correlations between the type of primary brain tumor and variables

Variables	Correlation	Gender	Age group	Specific site	Tumor Location (supratentorial/ infratentorial	Age years
Gender	Correlation	1.000				
	P-value					
Specific site	Correlation	-0.239	-0.013			
	P-value	**0.041**	0.911			
Tumor Location	Correlation	-0.080	-0.146	-0.568		
	P-value	0.499	0.215	**0.000**		
Age groups	Correlation	0.169	0.242	-0.484	0.439	0.229

Discussion

According to the GLOBOCAN 2020 report, brain and central nervous system tumors rank as the 7th most prevalent type of cancer in Yemen, representing approximately 4.9% (803 cases) of all cancers. These tumors predominantly affect males, accounting for 59.5% (478 cases), positioning them as the 6th most common malignancy among men. CNS tumors are also the 7th leading cause of cancer-related mortality in Yemen, with 5.7% (689 cases) of deaths attributed to these conditions.

The lack of comprehensive statistical data on tumor prevalence and incidence, particularly brain tumors, in Yemen is attributable to several factors. These include inadequate medical record-keeping, limited diagnostic facilities, a subpar health and statistical infrastructure, and an ongoing economic crisis exacerbated by persistent civil conflict. National cancer registry centers in Yemen are sparse and only track cases that present for chemotherapy or radiotherapy. Consequently, many patients with benign tumors, those with advanced malignant diseases resistant to conventional treatments, or those residing in rural areas, may not be represented in these statistics. This underrepresentation is further compounded by the unavailability of advanced diagnostic tools such as gamma knives and the lack of a systematic approach to cancer reporting. However, recent years have shown an increase in brain tumor cases at our institution, reflecting growing awareness of the importance of medical documentation and electronic record systems. While there are limited studies on tumors in Yemen [11-13], with only one focusing on CNS tumors, [14] this rising trend underscores the need for improved data collection and reporting.

This study indicates that a substantial proportion of patients (72%) did not undergo surgical intervention for their primary brain tumors. This suggests reliance on alternative treatments modalities such as radiation therapy, chemotherapy, or conservative management based on tumor characteristics and patient conditions. In contrast, only 20% of patients received surgical treatment, highlighting the complexities and challenges associated with the surgical management of brain tumors. Surgeons must carefully weigh

the potential benefits and risks of surgical interventions, considering factors like tumor location, size, and the patient's overall health status. Additionally, 8% of patients underwent biopsy procedures for diagnostic purposes, indicating that these tumors were either unsuitable for extensive surgery or were managed primarily through non-surgical approaches. Factors contributing to the lack of surgical intervention include small tumors requiring only monitoring, inoperable tumors, diffuse or deep-seated tumors necessitating advanced facilities, and patient-related issues such as associated terminal illnesses or socioeconomic constraints like poverty, or refuse of surgical options by uncooperative patients' relatives.

Study findings reveal that gliomas are the most common category of primary brain tumors (48%), consistent with other studies. [15-17] Meningioma, as a single tumor type, was found to be the most frequent, representing 32% of cases. This prevalence aligns with findings from other studies, [14, 18-20] although the reported rates vary slightly across different regions. These variances had been suggested by El-zine et al that is due to reflecting differences in study methodologies, sample sizes, and reporting practices. [14]

The current study also identified that cerebral meninges is the most common tumor site (32%), followed by the frontal lobe (16%). This is consistent with data from the CBTRUS report, which lists the meninges as the most common tumor site in adults, representing (36.1%) [21,22]. However, some studies suggest the frontal lobe is the predominant site for primary brain tumors,

highlighting variability in tumor site prevalence. [23,24].

This study did not assess the specific subtypes and grades of primary brain tumors due to incomplete data. Systematic reviews have noted inadequate reporting of CNS tumor subtypes in developing countries, [25] recommending the establishment of standardized reporting systems to enhance health management and data accuracy. The development of dedicated histopathological centers with expert teams is crucial for obtaining precise data on tumor subtypes and improving the quality of cancer statistics.

A systematic review study revealed that there is inadequate reporting of CNS tumor subtypes in registries of developing countries. They suggested establishing a unified reporting system to help improve health management for CNS tumors. [22] Unstandardized histology groupings and reporting can lead to different interpretations and incomparable results between different populations. [18]

Limitations

The study is limited by its retrospective design, small sample size, and single-center focus, which may not provide a comprehensive representation of primary brain tumor prevalence in Yemen. Many diagnoses were based on clinical and radiological features rather than histopathological confirmation. Future research should include larger, randomized, multicenter studies to provide more accurate estimates of tumor prevalence and incidence. Additionally, there is a need for improved medical record-keeping to enhance disease tracking and clarity.

Conclusion

Despite its retrospective nature and reliance on clinical and radiological data, this study's

findings are consistent with existing national, regional, and global research. The results offer valuable insights into the epidemiology of primary brain tumors in Yemen. It is recommended that national cancer registries be activated and reorganized to provide a comprehensive overview of brain tumor cases. This effort should be integrated into broader cancer control policies and programs to facilitate larger studies and better reflect the true incidence of tumors in Yemen.

Conflict of Interest Statement:

The authors declare that the article content was composed in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

1. Cheo, S. T. T., Lim, G. H., & Lim, K. H. C. (2017). Glioblastoma multiforme outcomes of 107 patients treated in two Singapore institutions. Singapore medical journal, 58(1), 41.
2. Umana, G. E, Scalia, G., Vats, A., Pompili, G., Barone, F., Passanisi, M.,. Cosentino, S. (2021). Primary extracranial meningiomas of the head and neck. Life, 11(9), 942.
3. Weyer-Jamora, C., Brie, M. S., Luks, T. L., Smith, E. M., Hervey-Jumper, S. L., & Taylor, J. W. (2021). Postacute cognitive rehabilitation for adult brain tumor patients. Neurosurgery, 89(6), 945-953.
4. Howlader, N., Noone, A., Krapcho, M., Garshell, J., Miller, D., Altekruse, S., Tatalovich, Z. (2015). SEER Cancer Statistics Review, 1975-2012, National Cancer Institute. Bethesda, MD.
5. Kaufmann, J. K., & Chiocca, E. A. (2014). Glioma virus therapies between bench and bedside. Neuro-oncology, 16(3), 334-351.
6. Silva, C. O., Pinho, J. O., Lopes, J. M., Almeida, A. J., Gaspar, M. M., & Reis, C. (2019). Current trends in cancer nanotheranostics: metallic, polymeric, and lipid-based systems. Pharmaceutics, 11(1), 22.
7. Feigin, V. L., Nichols, E., Alam, T., Bannick, M. S., Beghi, E., Blake, N.. Ellenbogen, R. G. (2019). Global, regional, and national burden of neurological disorders, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. The Lancet Neurology, 18(5), 459-480.
8. Miranda-Filho, A., Piñeros, M., Soerjomataram, I., Deltour, I., & Bray, F. (2017). Cancers of the brain and CNS: global patterns and trends in incidence. Neuro-oncology, 19(2), 270-280.
9. Pollack, I. F., Agnihotri, S., & Broniscer, A. (2019). Childhood brain tumors: current management, biological insights, and future directions: JNSPG 75th Anniversary Invited Review Article. Journal of Neurosurgery: Pediatrics, 23(3), 261-273.
10. Bawazir, A., Basaleem, H., Badheeb, A., & Abdul Hamid, G. (2022). General Oncology Care in the Republic of Yemen Cancer in the Arab World (pp. 321-338): Springer Singapore Singapore.
11. Alsanabani, J. A., Gilan, W., & Al Saadi, A. (2015). Incidence data for breast cancer among Yemeni female patients with palpable breast lumps. Asian Pacific Journal of Cancer Prevention, 16(1), 191-194.

12. Ba-Saddik, I. A. (2013). Childhood cancer in Aden, Yemen. Cancer epidemiology, 37(6), 803-806.

13. Bawazir, A. A. (2018). Cancer incidence in Yemen from 1997 to 2011: a report from the Aden cancer registry. BMC cancer, 18, 1-10.

14. El-Zine, M. A. Y., Ali, M. A. A., & Al-Shamahy, H. A. (2021). Prevalence of CNS tumors and histological recognition in the operated patients: 10 years experience in Yemen. Universal J Pharm Res, 6(2), 20-27.

15. Laws Jr, E. (1993). Thapar K. Brain tumors. CA, 43, 263-271.

16. Leece, R., Xu, J., Ostrom, Q. T., Chen, Y., Kruchko, C., & Barnholtz-Sloan, J. S. (2017). Global incidence of malignant brain and other central nervous system tumors by histology, 2003–2007. Neuro-oncology, 19(11), 1553-1564.

17. Ullah, S., Qureshi, A. Z., Rathore, F. A., Sami, W., Moukais, I. S., Alibrahim, F. S., Alsuhaibani, A. (2023). Functional outcomes of patients with primary brain tumors undergoing inpatient rehabilitation at a tertiary care rehabilitation facility in Saudi Arabia. International Journal of Environmental Research and Public Health, 20(6), 4679.

18. Almutrafi, A., Bashawry, Y., AlShakweer, W., Al-Harbi, M., Altwairgi, A., & Al-Dandan, S. (2020). The epidemiology of primary central nervous system tumors at the National Neurologic Institute in Saudi Arabia: a ten-year single-institution study. Journal of Cancer Epidemiology,2020.

19. Tamimi, A. F., Tamimi, I., Abdelaziz, M., Saleh, Q., Obeidat, F., Al-Husseini, M., Tamimi, F. (2015). Epidemiology of malignant and non-malignant primary brain tumors in Jordan. Neuroepidemiology, 45(2), 100-108.

20. Dolecek, T. A., Propp, J. M., Stroup, N. E., & Kruchko, C. (2012). CBTRUS statistical report: primary brain and central nervous system tumors diagnosed in the United States in 2005–2009. Neuro-oncology, 14(suppl_5), v1-v49

21. De Robles, P., Fiest, K. M., Frolkis, A. D., Pringsheim, T., Atta, C., St. Germaine-Smith, C., . . . Jette, N. (2015). The worldwide incidence and prevalence of primary brain tumors: a systematic review and meta-analysis. Neuro-oncology, 17(6), 776-783.

22. Ostrom, Q. T., Gittleman, H., Liao, P., Rouse, C., Chen, Y., Dowling, J., Barnholtz-Sloan, J. (2014). CBTRUS statistical report: primary brain and central nervous system tumors diagnosed in the United States in2007–2011. Neuro oncology,16(suppl_4), iv1-iv63.

23. Alnaami, I., Sarhan, L., Alqahtani, A., Alghamdi, A., Alkhashrami, S., & Mostafa, O. (2018). Does brain tumor epidemiology differ from place to another? Saudi single tertiary care center experience. Biomedical Research, 29(14), 2982-2987.

24. Bangash, M. (2011). Incidence of brain tumours at an academic centre in Western Saudi Arabia. East African Medical Journal, 88(4), 138-142.

25. Khan, I., Bangash, M., Baeesa, S., Jamal, A., Carracedo, A., Alghamdi, F. Damanhouri, G. (2015). Epidemiological trends of histopathologically WHO classified CNS tumors in developing countries: systematic review. Asian Pacific Journal of Cancer Prevention, 16(1)

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Review Article

The Role of Clinical Pharmacists in the Detection and Evaluation of Adverse Drug Events: A Review Article

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Abstract

Adverse drug events (ADEs) are a major healthcare systems issue in hospitals. They are difficult to detect because of incomplete or unavailable medication history. Clinical pharmacists have an important role to play in detection and evaluation of adverse drug reactions. The clinical pharmacist's role in medication management should extend beyond simply dispensing drugs, and this article delineates the rationale and proactive approaches for clinical pharmacist detection and assessment of adverse drug reaction (ADRs). This article was designed to overview the role of clinical pharmacists in detecting and evaluating ADRs. Search and analysis of related articles in web sites revealed that clinical pharmacists have an important role in evaluating, identifying, and preventing ADRs, which leads to proper management and decreased number of morbidity and mortality cases. Therefore, healthcare systems need to be redesigned to more fully utilize health information technologies and clinical pharmacists in detecting and responding to ADRs.

Keywords: Adverse drug events, Clinical pharmacists, Detection, Evaluation, Role.

Introduction

Adverse drug reaction (ADR) is defined by the World Health Organization (WHO) as "a response to a drug which is noxious and unintended, and which occurs at doses normally used in patient for the prophylaxis, diagnosis, or therapy of disease, or for the modification of physiological function" [1]. Adverse drug events (ADEs) are responsible for a significant amount of economic burden as well as morbidity and mortality [2]. According to estimates, the annual cost of controlling ADEs in the US might be as high as $30.1 billion [1]. Approximately, 7% of hospital admissions are caused by ADRs [4]. General medicine units address a wide range of acute and chronic medical conditions, typically with the help of a multidisciplinary team that includes a clinical pharmacist. Patients admitted to general medicine units are frequently at risk for drug-related problems (DRPs), which may be linked to higher rates of morbidity and death, as a result of their numerous comorbidities [5]. Clinical pharmacists, as drug experts and the most accessible healthcare providers, are uniquely suited to detect and report ADEs [6]. The role of clinical pharmacists in hospitalized patient care has changed, with a greater focus on collaborative treatment and patient involvement. ADRs, adverse drug events, health-related quality of life, economics, medication appropriateness, and patient satisfaction are all areas in which clinical pharmacists intervene [7]. Besides, the role of clinical pharmacists in medication safety includes preventing ADEs, such as adverse drug reactions,

medication errors and other DRPs, which may occur throughout the medication management pathway [8,9]. The idea of pharmacovigilance and drug safety is based on increasing knowledge of the different impacts of medications [10]. The goal of this article is to provide an overview of ADRs and the role that clinical pharmacists play in lowering them.

Methods

In order to find scientific literature about clinical pharmacists' role in lowering adverse drug reactions, online search engines were utilized. Specifically, the articles published between 2018 and 2024 were searched through PubMed, Google, Research Gate, Google scholar, and Web of Science databases were searched to locate studies that meet the objectives of this systematic review. A number of keywords were also utilized to find any post that might be relevant. Clinical pharmacists' roles, medication error detection, DRPs, medication safety, clinical pharmacist intervention, and medication management were among the keywords that were used. The resulting studies were then first filtered according to their abstracts and titles. The following factors contributed to the exclusion of some studies: ADE case reports of specific medications, research for pharmacy students, models to enhance ADE signal detection, and the absence of clinical pharmacists among the healthcare professionals polled.

Results and Discussion

Adverse Drug Events (ADEs)

Unintended and negative consequences stemming from the use of medications are known as adverse drug effects, and they can

range in severity from minor to severe, perhaps requiring additional medical interventions [11]. ADRs happen every day in hospitals and other healthcare facilities, and they may have an impact on patients' quality of life as well as increased morbidity and mortality [12]. Additionally, ADRs and potentially avoidable prescription errors account for the majority of DRPs, which result in between 44,000 and 98,000 deaths annually in the United States [13]. One individual per 131 outpatients and one individual per 854 inpatients are thought to die as a result of medication errors or issues brought on by drug use during a medical prophylactic or therapeutic regimen [14]. Instead of referring to the sickness itself, DRPs describe situations or occurrences that impede the intended health outcome through the appropriate administration of pharmaceuticals. These issues result in high expenses as well as different kinds of morbidity and death for the people who utilize them to try to get better [14]. ADRs rank among the top 10 leading causes of death in the US, affecting around 3.4 million people each year due to the nature of the resulting medical issue and the requirement for additional corrective action to address these unfavorable drug side effects [15,16]. Research demonstrates that medication therapy management is successful in lowering the incidence of ADRs and in improving the results for patients. Medication therapy management (MTM) services managed by clinical pharmacists, for instance, have been demonstrated to result in fewer hospitalizations owing to ADRs and improved medication adherence [17-20]. ADRs are common in the pediatric, adult and geriatric population as well. Vaccines, anti-infective, and respiratory medications are the medications that cause adverse ADRs in children; while antibiotics, cardiovascular, antineoplastic, immunosuppressive, corticosteroids, anticoagulants, non-steroidal anti-inflammatory drugs, and opiates are the medications that cause ADRs in adults [21,22]. Off-label use of prescribed medication for newborns, children, and infants may raise the risk of adverse drug reactions [23-25]. ADR reports at a major Saudi hospital increased by 40.6% following the implementation of incentives, with a total of 967 ADRs reported over the course of two years [26]. ADRs can range from mild symptoms to severe ones that kill 0.1% to 0.3% of hospitalized patients [27,28]. ADRs, drug-drug interactions, a lower quality of life, and difficulties adhering to medication regimens can all be caused by polypharmacy [29,30]. Interventions by clinical pharmacists can successfully stop these types of errors. The various types of errors demonstrate that clinical pharmacists' actions and ongoing education are necessary [31,32].

Clinical Pharmacists' Contribution to ADR Prevention and Reduction

Clinical pharmacists play a vital role in hospitals as they are responsible for ensuring the safe and effective use of medications. As a crucial part of the healthcare team, clinical pharmacists are vital to patient care and drug administration [33]. They are specialists in medications, and by applying their specific expertise and abilities, they help to improve patient outcomes. Because they are in charge of making sure that drugs are used safely and effectively, clinical pharmacists serve a vital

role in hospitals. To provide patients with the best care possible, they collaborate closely with other medical specialists. Some of the duties and obligations of clinical pharmacists in hospital are listed below.

Medication Counseling: Clinical pharmacists offer patients medication counseling, outlining the drug's intended use, possible adverse effects, and any additional usage instructions or precautions.

Adverse Drug Reaction Monitoring: Clinical pharmacists monitor and detect ADRs in patients. In order to manage and prevent medication-related issues, they work with healthcare practitioners, recognize symptoms of side effects, and inform patients about potential ADRs.

Medication Management: Clinical pharmacists make sure that drugs prescribed by medical professionals are dispensed accurately and safely. They check through prescriptions, look for possible drug interactions or allergies, give patients the right dosage instructions, and educate them how to take their drugs as prescribed.

Drug Information and Education: Clinical pharmacists offer consumers, healthcare providers, and other team members reliable, evidence-based drug information. They are able to offer thorough information about pharmaceutical efficacy, safety, interactions, and appropriate use since they keep up with the most recent findings and recommendations.

Chronic Disease Management: Clinical pharmacists play a vital role in managing chronic diseases, such as diabetes, hypertension, and asthma. They provide information on disease management, medication adherence strategies, lifestyle modifications, and self-monitoring techniques. Clinical pharmacists also play a crucial role in preventing medication errors.

Medication Therapy Management (MTM): In order to maximize drug therapy for patients with complicated prescription regimens or chronic diseases, clinical pharmacists participate in MTM services. They evaluate the efficacy of medications, monitor for side effects, perform thorough medication reviews, and work with medical professionals to modify prescription therapy as needed.

Medication Safety: Clinical pharmacists are responsible for ensuring medication safety in hospitals. They monitor medication orders to prevent errors in dosing, drug interactions, or contraindications.

Clinical Pharmacy Services: Clinical pharmacists provide clinical pharmacy services in hospitals by working with healthcare teams to provide patient-specific drug therapy recommendations [34,35].

Several studies on the epidemiological features (occurrence, prevalence, or incidence) of DRPs, particularly ADRs, have also been published in Iran. These studies have focused on the preventative role that clinical pharmacists play in reducing these types of problems [36-45]. Clinical pharmacists are highly educated and have a professional responsibility in the provision of pharmaceutical care, which includes the identification, prevention, and resolution of DRPs. It is one of their core jobs to ensure the safe use of medicine. Reporting ADRs is equally important [46]. When it comes to ADEs, which have a substantial impact on

patient adherence and general health outcomes, clinical pharmacists play a crucial role. They are essential in modifying medication schedules, keeping an eye out for possible adverse drug events, and providing patient-specific advice to guarantee efficacy and safety [47]. When delivering pharmacotherapeutic services, clinical pharmacists must carefully assess each patient's risk of ADEs; taking into account their specific health status, comorbidities, and concurrent medications [48].

Additionally, clinical pharmacists provide comprehensive patient education to guarantee that people understand their prescriptions, possible adverse effects, and the significance of following treatment. By successfully controlling these side effects, clinical pharmacists enhance therapeutic results and patient safety, guaranteeing that the advantages of taking medication exceed the disadvantages [49]. Last but not least, clinical pharmacists must constantly evaluate the risk-benefit ratio of every drug, particularly for patients receiving high-risk treatments or those with complicated medical conditions. In order to make well-informed clinical decisions and guarantee that patients receive the safest and most effective pharmaceutical regimen for their needs, this comprehensive evaluation is essential [50].

Conclusion

Administrators, academics, and medical professionals must collaborate and offer training on adverse drug reaction reporting in order to create a learning system. This review found a correlation between clinical pharmacists' attitudes, pharmacovigilance knowledge, and ADE reporting. Once a clinical pharmacist's knowledge of how to report ADEs is categorized as insufficient, this lack of knowledge is influenced by the clinical pharmacist's attitude, feeling of obligation, and level of schooling. In order to improve the patient's outcome, clinical pharmacists may also discuss with the doctor the possibility of changing the prescribed drug if it is not suitable for the patient.

References

1. World Health Organization (2020). Safety monitoring of medicinal product: Guidelines for setting up and running a pharmacovigilance centre. Available at: https://who-umc.org/media/1703/24747.pdf (Accessed April 30, 2022).
2. Lazarou J et al. Incidence of adverse drug reactions in hospitalized patients. JAMA 1998; 279: 1200–1205. DOI: 10.1001/jama.279.15.1200
3. Sultana J et al. Clinical and economic burden of adverse drug reactions. J Pharmacol Pharmacother 2013; 4(Suppl 1): S73–S77. doi: 10.4103/0976-500X.120957
4. Pirmohamed M, James S, Meakin S, Green C, Scott A, Walley T, et al. Adverse drug reactions as cause of admission to hospital: prospective analysis of 18820 patients. BMJ. 2004;329:15–9. DOI: 10.1136/bmj.329.7456.15
5. Guignard B, Bonnabry P, Perrier A, Dayer P, Desmeules J, Samer CF. Drug-related problems identification in general internal medicine: The impact and role of the clinical pharmacist and pharmacologist. Eur J Intern Med 2015; 26: 399–406. doi: 10.1016/j.ejim.2015.05.012.

6. Van Grootheest A et al. The role of hospital and community pharmacists in pharmacovigilance. Res Social Adm Pharm 2005; 1: 126–133. doi: 10.1016/j.sapharm.2004.12.009.

7. Kaboli PJ, Hoth AB, McClimon BJ, Schnipper JL. Clinical pharmacists and inpatient medical care: a systematic review. Arch Intern Med. 2006;166:955–64.https://doi.org/10.1001/archinte.166.9.955

   American College of Clinical Pharmacy. The role of the pharmacist in the health care system: preparing the future pharmacist. Pharmacotherapy, 2014, 34(8),e133-e146.

8. K. K. Sharma, Arinjay Jain, Shubham Singh Tyagi, Yash Goel, Sebu and Piyush Mittal. Clinical Pharmacist's Role in Medication Error Detection and Management. AJMPCP, 5(4): 11-20, 2022; Article no. AJMPCP.84554
   Beninger P. Pharmacovigilance: An Overview. Clin Ther. 2018;40(12):1991–2004. 10.1016/j.clinthera.2018.07.012 Edwards, I. R., & Aronson, J. K. Adverse drug reactions: Definitions, diagnosis, and management. Lancet, 2000, 356(9237), 1255– 1259. https://doi.org/10.1016/S0140-6736(00)02799-9

9. Schatz S, Weber R. Adverse drug reactions. Pharm Pract. 2015; 1:1. Institute of Medicine Committee on Quality of Health Care in A; Kohn LT, Corrigan JM, Donaldson MS, editors. To Err is Human: Building a Safer Health System. Washington (DC): National Academies Press (US); 2000.

10. Wittich CM, Burkle CM, Lanier WL. Medication errors: An overview for clinicians. Mayo Clin Proc 2014;89:111625. DOI: 10.1016/j.mayocp.2014.05.007

11. The Pharmaceutical Care Network of Europe. The PCNE Drug related Problems Classification Version 8.01. Available from: https://www.pcne.org/upload/files/215_PCNE_classification_V801.pdf. [Last accessed on 2017 May 05].

12. Iasella CJ, Johnson HJ, Dunn MA. Adverse drug reactions: Type A (Intrinsic) or type B (Idiosyncratic). Clin Liver Dis 2017; 21:7387. DOI: 10.1016/j.cld.2016.08.005

13. Bourgeois FT, Shannon MW, Valim C, Mandl KD. Adverse drug events in the outpatient setting: An 11year national analysis. Pharmacoepidemiol Drug Saf 2010; 19:90110. DOI: 10.1002/pds.1984

14. Fahad Nabi, Mohd Altaf Dar, Abrar Bashir Malik. Guardians of Safety: The Crucial Role of Pharmacists in Reducing Adverse Drug ReactionsJournal of Community Pharmacy Practice ISSN: 2799-1199 Vol: 03, No. 04, June-July 2023

15. Maqbool M, Fekadu G, Jiang X, Bekele F, Tolossa T, Turi E, Fetensa G, Fanta K. An up to date on clinical prospects and management of osteoarthritis. Annals of Medicine and Surgery. 2021 Dec 1; 72:103077.doi:10.1016/j.amsu.2021.103077

16. Majeed A, Bashir R, Farooq S, Maqbool M. Preparation, characterization and applications of nanoemulsions: An insight. Journal of Drug Delivery and Therapeutics. 2019 Mar 15; 9(2):520-7. DOI https://doi.org/10.22270/jddt.v9i2.2410

17. Zehravi M, Maqbool M, Ara I. Healthy lifestyle and dietary approaches to treating polycystic ovary syndrome: a review. Open Health. 2022 May 2;

3(1):60-5. https://doi.org/10.1515/openhe-2022-0008

18. Kongkaew C, Noyce PR, Ashcroft DM. Hospital admissions associated with adverse drug reactions: a systematic review of prospective observational studies. Ann Pharmacother. 2008; 42:1017–25. https://doi.org/10.1345/aph.1L037
19. Bond CA, Raehl CL. Adverse drug reactions in United States hospitals. Pharmacotherapy. 2006; 26:601–8. https://doi.org/10.1592/phco.26.5.601.
20. Neubert A, Dormann H, Weiss J, Egger T, Criegee-Rieck M, Rascher W, et al. The impact of unlicensed and offlabel drug use on adverse drug reactions in paediatric patients. Drug Saf. 2004;27:1059–67.https://doi.org/10.2165/00002018-20042713000006
21. Turner SE, Nunn AJ, Fielding K, Choonara IM. Adverse drug reactions to unlicensed and off-label drugs on paediatric wards: a prospective study. Acta Paediatr. 1999;88:965–8. https://doi.org/10.1111/j.1651-2227.1999.tb00191.x
22. Gill AM, Leach HJ, Hughes J, Barker C, Nunn AJ, Choonara I. Adverse drug reactions in a paediatric intensive care unit. Acta Paediatr. 1995;84:438–41. https://doi.org/10.1111/j.1651-2227.1995.tb13667.x
23. Ali S, Egunsola O, Al-Dossari DS, Al-Zaagi IA. Adverse drug reaction reporting in a large tertiary hospital in Saudi Arabia: results of an incentive strategy. Ther Adv Drug Saf. 2018;9:585–90. https://doi.org/10.1177/2042098618790209
24. Lezarou J, Pomeranz BM, Corey PN. Incidence of adverse drug reaction in hospitalized patient: a meta-analysis of prospective studies. JAMA. 1998;279:1200–5. https://doi.org/10.1001/jama.279.15.1200
25. Pirmohamed M, Breckenridge AM, Kitteringham NR, Park BK. Adverse drug reactions. BMJ. 1998;316:1295–8. https://doi.org/10.1136/bmj.316.7140.1295.
26. Rodrigues MC, Oliveira CD. Drug-drug interactions and adverse drug reactions in polypharmacy among older adults: an integrative review. Rev Lat Am Enfermagem.2016;24. https://doi.org/10.1590/15188345.1316.2800
27. Schatz S, Weber R. Adverse drug reactions. Pharm Pract. 2015;1:1.
28. Solmaz Hassani, Azadeh Eshraghi, Morteza Taheri, Farzaneh Hematian, Zahra Sahraei. Role of Clinical Pharmacists in Early Detection, Reporting and Prevention of Medication Errors in a Medical Ward. J Pharm Care 2015;3(3-4):54-60.
29. Hossein Khalili, Shadi Farsaei, Haleh Rezaee, Simin Dashti-Khavidaki. Role of clinical pharmacists' interventions in detection and prevention of medication errors in a medical ward. Int J Clin Pharm (2011) 33:281–284. doi: 10.1007/s11096-011-9494-1.
30. Abdullah Hamed Alonazi, Faris Abdullah Khalaf Almutairi, Fahad Abdullah Ajab Alshkarah, Meshari Mohammad Alotaibi, Mohammed Abdulaziz Mohammed Alshibreen and Ibrahim Abdullah Mesfer Aldawsari. the role of pharmacists in patient care and medication management. Journal of Population Therapeutics & Clinical Pharmacology: Vol.29 No.4 (2022): JPTCP (2577-2581). DOI:

https://doi.org/10.53555/jptcp.v29i04.5491

31. Yash Gupta, Neeraj Kumar, Amrita Shukla and Vishal Rai. Assessment of the Role of Pharmacists in Preventing Medication Errors in Hospital Settings. Journal for Research in Applied Sciences and Biotechnology: Volume-2 Issue-2, 2023, PP. 212-218. DOI: https://doi.org/10.55544/jrasb.2.2.30
32. Dubey A, Pandey M, Yadav S, Tripathi D, Kumari M, Purohit D, Hypolipidemic and haematological effects of ethanolic extract of Tecoma stans linn(bignoniaceae) seeds in alloxan-induced diabetic albino rats. Korean Journal of Physiology and Pharmacology, 2023:27(1),85-90. DOI:10.25463/kjpp.27.1.2023.8.
33. Baniasadi S, Fahimi F. Adverse drug reactions in a pulmonary teaching hospital: Incidence, pattern, seriousness, and preventability. Curr Drug Saf 2011; 6:2306. DOI: 10.2174/157488611798280942
34. Gholami K, Shalviri G. Factors associated with preventability, predictability, and severity of adverse drug reactions. Ann Pharmacother 1999; 33:23640. DOI: 10.1345/aph.17440
35. Koochak HE, Babaii A, Pourdast A, Golrokhy R, Rasoolinejad M, Khodaei S, et al. Prevalence of adverse drug reactions to highly active antiretroviral therapy (HAART) among HIV positive patients in Imam Khomeini hospital of Tehran, Iran. Infect Disord Drug Targets 2017; 17:1169. doi: 10.2174/1871526517666170117111350.
36. Kourorian Z, Fattahi F, Pourpak Z, Rasoolinejad M, Gholami K. Adverse drug reactions in an Iranian department of adult infectious diseases. East Mediterr Health J 2009; 15:13517. doi: 10.1002/pds.1793
37. Mirbaha F, Shalviri G, Yazdizadeh B, Gholami K, Majdzadeh R. Perceived barriers to reporting adverse drug events in hospitals: A qualitative study using theoretical domains framework approach. Implement Sci 2015; 10:110
38. Mohebbi N, Shalviri G, Salarifar M, Salamzadeh J, Gholami K. Adverse drug reactions induced by cardiovascular drugs in cardiovascular care unit patients. Pharmacoepidemiol Drug Saf 2010; 19:88994. DOI: 10.1002/pds.1916
39. Mokhtari F, Nikyar Z, Naeini BA, Esfahani AA, Rahmani S. Adverse cutaneous drug reactions: Eight year assessment in hospitalized patients. J Res Med Sci 2014; 19:7205.
40. Pourseyed S, Fattahi F, Pourpak Z, Gholami K, Shariatpanahi SS, Moin A, et al. Adverse drug reactions in patients in an Iranian department of internal medicine. Pharmacoepidemiol Drug Saf 2009; 18:10410. doi: 10.1002/pds.1663.
41. Saheb SharifAskari F, Saheb SharifAskari N, Javadi M, Gholami K. Adverse drug reactions reported to the drug and poison information center of Tehran, Iran. PLoS One 2017;12:e0185450. https://doi.org/10.1371/journal.pone.0185450
42. Vaseghi G, Abed A, Jafari E, Eslami N, Eshraghi A. Assessment of adverse drug reaction due to cancer chemotherapy in a teaching oncology hospital in Isfahan, central of Iran. Rev Recent Clin Trials 2016; 11:26672. doi: 10.2174/1574887110666150818112648.
43. Mahmathi Karuppannan, Nur Azzrin Nisha Mohamad Rizal, Kok-Thong Wong, Salmiah Mohd. Ali, Kang-Nee

Ting and Helen Boardman. Pharmacists' experiences on adverse drug reaction: 10 years later. Front. Pharmacol.,2022. Drugs Outcomes Research and Policies Volume 13 - 2022 |https://doi.org/10.3389/fphar.2022.9329

44. Carlqvist, C., Ekstedt, M., & Lehnbom, E. C. Exploring the impact of pharmacistsupported medication reviews in dementia care: experiences of general practitioners and nurses. BMC Geriatrics,2024; 24(1), 1–10. https://doi.org/10.1186/s12877-024-05124-9

45. Olea, A., Grochowski, J., Luetkemeyer, A., Robb, V., & Saberi, P. Role of a clinical pharmacist as part of a multidisciplinary care team in the treatment of HCV in patients living with HIV/HCV coinfection. Integrated Pharmacy Research and Practice, 2018; Volume 7, 105–111. https://doi.org/10.2147/iprp.s169282

46. Saseen, J. J., Ripley, T. L., Bondi, D., Burke, J. M., Cohen, L. J., McBane, S., McConnell, K. J., Sackey, B., Sanoski, C., Simonyan, A., Taylor, J., & Vande Griend, J. P. ACCP Clinical Pharmacist Competencies. Pharmacotherapy, 2017; 37(5),630–636. https://doi.org/10.1002/phar.1923

47. Peloso, C., Baylatry, M.-T., Elefant, E., Fernandez, C., Joly, A.-C., & Isnard, F. 41st ESCP symposium on clinical pharmacy: personalised and safe therapy. International Journal of Clinical Pharmacy, 2013; 35(5), 866–1019. https://doi.org/10.1007/s11096-013-9801-0

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Review Article

Application of Genome-Based Therapy in Clinical Pharmacy Practice: Prospects and Challenges

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Abstract

Genome-based therapy, an innovative approach to personalized medicine, utilizes insights from genomic research to tailor treatments to individual patients. In clinical pharmacy practice, this emerging field holds promise for improving therapeutic outcomes, minimizing adverse drug reactions, and optimizing drug efficacy by integrating pharmacogenomics into patient care. Genome-based therapies include gene editing technologies (e.g., CRISPR-Cas9), gene therapy for rare genetic disorders, and the use of biomarkers for targeted treatments in oncology and other complex diseases. Despite its transformative potential, the application of genome-based therapies faces significant challenges, including ethical concerns, high costs, limited accessibility, and the need for advanced infrastructure and specialized training. Additionally, regulatory hurdles and the scarcity of robust clinical data impede the widespread adoption of these therapies in routine clinical pharmacy practice. This review explores the prospects of genome-based therapies in clinical pharmacy, emphasizing their potential to revolutionize healthcare delivery. It also examines challenges such as ethical dilemmas, policy gaps, and resource limitations, proposing strategies to address these barriers. The integration of genomic tools into clinical pharmacy practice requires a multidisciplinary effort involving pharmacists, clinicians, researchers, and policymakers to ensure equitable access and effective implementation in diverse healthcare settings.

***Keywords*:** Genome-Based Therapy, Clinical Pharmacy, Challenges, A multidisciplinary Effort

Introduction

Genome-based therapy, a cornerstone of precision medicine, uses genetic insights to guide individualized treatment strategies. It represents a transformative approach, particularly in the field of clinical pharmacy, where genetic variations significantly influence drug response and efficacy. From pharmacogenomics to advanced gene-editing techniques like CRISPR-Cas9, genome-based therapy is revolutionizing the management of various diseases, including cancer, rare genetic disorders, and chronic illnesses [1].

Clinical pharmacists are at the forefront of implementing this personalized care model, ensuring that genomic data translate into actionable therapeutic interventions. Despite its potential to enhance treatment outcomes and reduce adverse drug reactions, several challenges limit the widespread adoption of genome-based therapy. These include ethical concerns, high costs, regulatory hurdles, and the need for specialized training among healthcare providers [2].

This review explores the potential of genome-based therapies, focusing on their applications, prospects, and the challenges they pose to clinical pharmacy practice. By addressing these challenges, the integration of genomic medicine into routine healthcare can be accelerated, offering patients more precise and effective treatment options.

Methodology

This review was conducted using a systematic literature search approach. Relevant articles were identified from PubMed, Google Scholar, Scopus, and Web of Science using keywords such as 'genome-based therapy', 'pharmacogenomics in clinical pharmacy', and 'personalized medicine'. Selection criteria included peer-reviewed studies, clinical trials, and review articles published in the last 10 years, focusing on the prospects, challenges, and future directions of genome-based therapy in clinical pharmacy. Data were extracted and analyzed thematically, covering benefits, implementation barriers, and advancements in the field. The review synthesized existing knowledge to provide insights into the integration of genomics in clinical pharmacy practice.

Prospects of Genome-Based Therapy

1. **Precision in Treatment**
   Genome-based therapy allows for highly individualized medical treatments by considering a person's genetic makeup. For instance, pharmacogenomic profiling of cytochrome P450 enzymes (CYP450) can predict drug metabolism and response. Patients with CYP2D6 polymorphisms may require adjusted doses of drugs, such as antidepressants or beta-blockers, to avoid toxicity or inefficacy. This precision ensures a better therapeutic outcome, reduced adverse effects, and higher patient satisfaction [3].

2. **Advances in Gene Editing**
   Revolutionary tools, like CRISPR-Cas9, enable researchers to edit genetic material with unprecedented accuracy. For example:
   Cystic Fibrosis: Targeting mutations in the CFTR gene, CRISPR is being explored as a potential curative treatment.
   Sickle Cell Disease: Gene-editing trials have shown success in reactivating fetal hemoglobin to counteract the effects of sickle hemoglobin.

3. **Duchenne Muscular Dystrophy (DMD):** By repairing mutations in the dystrophin gene, CRISPR offers hope for addressing this debilitating condition [4].
4. **Personalized Oncology**
   Oncology is one of the most advanced fields in genome-based therapy. Examples include:
   HER2-Positive Breast Cancer: Trastuzumab (Herceptin) targets HER2 overexpression, significantly improving survival rates in a subgroup of breast cancer patients [5].
   Lung Cancer: EGFR mutation testing helps identify candidates for tyrosine kinase inhibitors like erlotinib or gefitinib. Pharmacists play an essential role in these therapies by monitoring for resistance mechanisms and ensuring medication adherence [6].
5. **Reduction in Adverse Drug Reactions**
   Incorporating genetic testing preemptively reduces the likelihood of severe drug-related adverse effects. For instance:
   Abacavir Hypersensitivity: Screening for HLA-B*5701 eliminates hypersensitivity risks, a serious side effect in HIV treatment [7].
   Warfarin Therapy: Testing for VKORC1 and CYP2C9 variants assists in personalized anticoagulation regimens, minimizing bleeding risks [8].

6. **Expanding Therapeutic Horizons**
   Genome-based therapies are increasingly applied to diseases beyond traditional genetic disorders:
   Autoimmune Disorders: CAR-T cells are being investigated for autoimmune diseases like lupus, with promising preliminary results.
   Regenerative Medicine: Gene therapies using adeno-associated viruses (AAVs) are showing success in delivering corrective genes for spinal muscular atrophy (SMA) and inherited retinal diseases [9].

Challenges in Implementing Genome-Based Therapy

1 .Ethical and Legal Considerations

Genome-based therapy raises profound ethical questions, including:

Privacy Concerns: Patients' genetic data are sensitive and could be misused if not properly protected. Breaches of such data can lead to discrimination in employment or insurance. Laws, such as the Genetic Information Nondiscrimination Act (GINA) in the U.S., aim to address these concerns but may not cover all situations [10].

Informed Consent: Ensuring patients understand the implications of genetic testing and therapy; however, including the potential for discovering incidental findings is complex [11].

Equity in Access: Ethical dilemmas arise when these expensive therapies are available only to wealthier individuals or regions, exacerbating healthcare disparities[12].

2 .High Costs and Limited Accessibility

Cost of Therapy: Genome-based treatments, such as CAR-T cell therapy (e.g., tisagenlecleucel), can cost hundreds of thousands of dollars per patient. These costs make them inaccessible to most patients, especially in low- and middle-income countries [13].

Genetic Testing Costs: Widespread use of genome-based therapies requires affordable genetic testing, which remains expensive in many healthcare systems.

Healthcare Inequality: Limited access to advanced medical infrastructure and skilled personnel in underserved areas hampers the equitable distribution of these therapies.

3 .Regulatory and Infrastructure Barriers

Regulatory Challenges: Genome-based therapies often face delays due to rigorous regulatory processes. Harmonizing guidelines across countries is critical for accelerating global adoption [14].

Diagnostic Infrastructure: Many regions lack facilities capable of conducting advanced genetic tests, such as next-generation sequencing (NGS), which is essential for identifying therapeutic targets [15].

Scalability Issues: Developing and manufacturing genome-based treatments at scale while maintaining quality is a significant logistical hurdle [16].

4 .Educational Gaps in Clinical Pharmacy and Healthcare

Pharmacists' Expertise: A lack of comprehensive training in pharmacogenomics and genome-based therapies limits clinical pharmacists' ability to interpret genetic data and advise on treatment plans [16].

Interdisciplinary Collaboration: Effective implementation requires collaboration between pharmacists, geneticists, and clinicians, which is hindered by the absence of standardized communication protocols [17].

Patient Awareness: Patients often lack understanding of genome-based medicine, which can lead to resistance or hesitancy in undergoing genetic testing or accepting novel treatments [16].

5. Ethical Use of Gene-Editing Technologies

Potential Misuse: Technologies like CRISPR-Cas9, while revolutionary, pose risks of misuse for non-therapeutic purposes, such as creating 'designer babies '[18].

Off-Target Effects: Unintended genetic modifications could lead to new health issues, raising questions about safety and long-term consequences [9].

6 .Integration with Existing Healthcare Systems

Reimbursement Policies: Many healthcare systems lack reimbursement mechanisms for genome-based therapies, discouraging their adoption [20].

Data Management: Handling vast amounts of genetic data securely and efficiently remains a technical challenge, requiring robust bioinformatics tools and policies [20].

Addressing these challenges requires concerted efforts from governments, healthcare providers, industry stakeholders, and academic institutions. Collaborative frameworks for funding, regulation, and education are essential to realize the full potential of genome-based therapy.

The Role of Clinical Pharmacists in Genome-Based Therapy

Clinical pharmacists are vital in the implementation and success of genome-based therapy. Their expertise in pharmacology, coupled with patient interaction and education skills, positions them to bridge the gap between complex genetic science and practical clinical application. Below is a detailed analysis of their roles: [21].

1 .Educating Patients on Genetic Testing and Genome-Based Therapies

Simplifying Genetic Concepts: Clinical pharmacists explain complex genetic information to patients in an understandable manner, addressing questions about genetic testing and potential outcomes [22].

Counseling on Implications: They guide patients on the implications of genetic testing, including privacy, potential risks, and how genetic insights impact treatment plans.

Informed Consent: Clinical pharmacists ensure patients understand the need for informed consent before genetic testing and therapy, fostering trust and compliance, such as counseling a patient undergoing HLA-B*5701 testing for hypersensitivity, to abacavir ensures they understand the reason for the test and its impact on therapy decisions [22].

2 .Collaboration with Healthcare Teams

Designing Individualized Therapy Plans: Clinical pharmacists collaborate with physicians, geneticists, and other healthcare professionals to interpret genetic data and tailor treatment regimens.

Therapeutic Drug Monitoring: They monitor drug responses, adjusting therapies based on genetic predispositions to optimize efficacy and minimize adverse effects.

Interdisciplinary Integration: As part of multidisciplinary teams, clinical pharmacists contribute pharmacogenomic insights to clinical decision-making processes. Therefore, a clinical pharmacist might work with oncologists to select targeted therapies like HER2 inhibitors for breast cancer based on genetic markers [23].

3 .Enhancing Drug Safety and Monitoring Therapy Outcomes

Predicting Adverse Drug Reactions (ADRs): By leveraging pharmacogenomics, clinical pharmacists identify genetic factors that predispose patients to ADRs, improving drug safety.

Monitoring Treatment Efficacy: Clinical pharmacists assess the effectiveness of genome-based therapies, ensuring that therapeutic goals are met while managing potential side effects.

Adjusting Dosages: Using pharmacogenomic data, clinical pharmacists help fine-tune drug dosages for drugs metabolized by enzymes like CYP2D6 or CYP2C19. For patients on clopidogrel, a clinical pharmacist can recommend alternative therapies if CYP2C19 variants predict poor drug metabolism [24].

4 .Advocacy for Equitable Access and Policy Development

Promoting Accessibility: Clinical pharmacists advocate for policies that reduce the cost of genetic testing and genome-based therapies, ensuring equitable access for all patients.

Shaping Guidelines: They contribute to the development of clinical guidelines for pharmacogenomic testing and genome-based therapy integration into healthcare systems.

Insurance Navigation: Clinical pharmacists assist patients in navigating insurance coverage and reimbursement for genome-based therapies.

A clinical pharmacist might push for inclusion of pharmacogenomic testing in insurance plans, highlighting its long-term cost-saving potential [25].

5 .Educating Future Pharmacists and Healthcare Professionals

Academic Contributions: Clinical pharmacists contribute to the incorporation of pharmacogenomics into pharmacy school curricula, ensuring the next generation of pharmacists is prepared for genome-based therapy.

Continuous Professional Development: They participate in and lead workshops, seminars, and training sessions to educate peers and other healthcare professionals about genome-based therapy. A clinical pharmacist delivering a workshop on CRISPR-based therapies helps other healthcare providers understand the implications of gene-editing technologies [26].

6 .Facilitating Technological Integration

Electronic Health Records (EHRs): Clinical pharmacists work with IT professionals to integrate genetic data into EHRs, enabling seamless access to genetic profiles during therapy design [27].

Utilizing Decision-Support Tools: Clinical pharmacists employ advanced decision-support tools that incorporate pharmacogenomic data to recommend optimized drug regimens.

Bioinformatics Collaboration: Collaborating with bioinformatics specialists, clinical pharmacists ensure accurate interpretation and application of genetic data in clinical practice .

Integrating genetic test results into EHRs allows clinical pharmacists to quickly identify patients who may benefit from specific genome-based therapies.

7 .Advocating Ethical Practices in Genome-Based Therapy

Addressing Ethical Concerns: Clinical pharmacists ensure that genome-based therapies adhere to ethical standards, including maintaining patient confidentiality and preventing genetic discrimination.

Patient Advocacy: They advocate for the ethical use of genetic information, ensuring that it is used solely for therapeutic purposes and not for non-therapeutic or discriminatory reasons [28].

A clinical pharmacist might counsel patients about their rights under laws, such as the Genetic Information Nondiscrimination Act (GINA).

Future Directions of the Application of Genome-Based Therapy in Clinical Pharmacy Practice: Prospects and Challenges

Genome-based therapy is poised to revolutionize clinical pharmacy practice, offering personalized, precise, and effective treatments. However, to unlock its full potential, several areas require development and strategic focus. Below is a detailed exploration of future directions in this transformative field: [29].

1. Expanding Pharmacogenomics Education

Curriculum Integration: Incorporating pharmacogenomics and genome-based therapy into pharmacy school curricula is essential. This ensures future clinical pharmacists are equipped with the knowledge and skills needed to implement these therapies.

Continuing Education Programs: Offering workshops, certifications, and training programs for practicing clinical pharmacists will bridge current knowledge gaps.

Interdisciplinary Training: Collaboration with geneticists and bioinformatics experts during

training can enhance clinical pharmacists' understanding of genetic data interpretation [30] .

Universities are suggested to develop comprehensive pharmacogenomics modules as part of their standard pharmacy programs.

2. Advancing Genomic Testing and Infrastructure

Affordable and Accessible Testing: Reducing the cost of genetic testing is crucial for widespread adoption. Efforts to develop cheaper, faster, and more accurate testing technologies are ongoing.

Widespread Laboratory Facilities: Establishing advanced laboratories in underprivileged and rural areas will expand access to genome-based therapies.

Integration with Healthcare Systems: Linking genomic testing data with electronic health records (EHRs) will enable seamless therapy design and monitoring [31].

Portable genomic testing devices can allow clinical pharmacists in remote areas to conduct genetic analyses and guide therapy.

3 .Improving Policy and Regulatory Frameworks

Harmonizing Regulations: Establishing unified global guidelines for genome-based therapies will facilitate their approval and implementation.

Insurance and Reimbursement Policies: Advocating for insurance coverage of genetic testing and genome-based therapies [32].

Conclusion

Genome-based therapy holds immense potential to transform clinical pharmacy practice, offering a pathway to more effective and safer treatments. However, its full integration into healthcare systems requires overcoming significant ethical, economic, and logistical challenges. Clinical pharmacists, as key healthcare providers, must adapt to this evolving landscape, leveraging their expertise to bridge the gap between scientific innovation and patient care.

References

1. Kohn DB, Chen YY, Spencer MJ. Successes and challenges in clinical gene therapy. Gene Therapy. 2023 Nov;30(10):738-46.
2. Cornetta K, Kay S, Urio F, Minja IK, Mbugi E, Mgaya J, Mselle T, Nkya S, Alimohamed MZ, Ndaki K, Bonamino M. Implementation of a gene therapy education initiative by the ASGCT and Muhimbili University of Health and Allied Sciences. Molecular Therapy. 2023 Sep 6;31(9):2561-5.
3. Kumar H, Miryala SK, Anbarasu A, Ramaiah S. Integrated computational approaches to aid precision medicine for cancer therapy: Present scenario and future prospects. InComputational Methods in Drug Discovery and Repurposing for Cancer Therapy 2023 Jan 1 (pp. 403-424). Academic Press
4. Doudna JA, Charpentier E. The new frontier of genome engineering with CRISPR-Cas9. Science. 2014 Nov 28;346(6213):1258096.
5. Emens LA. Trastuzumab: targeted therapy for the management of HER-2/neu-overexpressing metastatic breast cancer. American journal of therapeutics. 2005 May 1;12(3):243-53.
6. Pozella P. Strategies for increasing EGFR mutation testing of patients with non-small cell lung cancer (Doctoral dissertation, The University of North Carolina at Chapel Hill), 2014, (pp. 1-154).
7. Mallal S, Phillips E, Carosi G, Molina JM, Workman C, Tomažič J, Jägel-Guedes E, Rugina S, Kozyrev O, Cid JF, Hay P. HLA-

B* 5701 screening for hypersensitivity to abacavir. New England Journal of Medicine. 2008 Feb 7;358(6):568-79.

8. Johnson JA, Caudle KE, Gong L, Whirl-Carrillo M, Stein CM, Scott SA, Lee MT, Gage BF, Kimmel SE, Perera MA, Anderson JL. Clinical Pharmacogenetics Implementation Consortium (CPIC) guideline for pharmacogenetics-guided warfarin dosing: 2017 update. Clinical Pharmacology & Therapeutics. 2017 Sep;102(3):397-404.
9. Hosseinkhani H, Domb AJ, Sharifzadeh G, Nahum V. Gene therapy for regenerative medicine. Pharmaceutics. 2023 Mar 6;15(3):856.
10. Knoppers BM. Framework for responsible sharing of genomic and health-related data. The HUGO journal. 2014 Dec;8(1):3.
11. Bredenoord AL, Kroes HY, Cuppen E, Parker M, van Delden JJ. Disclosure of individual genetic data to research participants: the debate reconsidered. Trends in Genetics. 2011 Feb 1;27(2):41-7.
12. Venook AP, Niedzwiecki D, Lenz HJ, Innocenti F, Fruth B, Meyerhardt JA, Schrag D, Greene C, O'Neil BH, Atkins JN, Berry S. Effect of first-line chemotherapy combined with cetuximab or bevacizumab on overall survival in patients with KRAS wild-type advanced or metastatic colorectal cancer: a randomized clinical trial. Jama. 2017 Jun 20;317(23):2392-401.
13. Garrison Jr LP, Jiao B, Dabbous O. Gene therapy may not be as expensive as people think: challenges in assessing the value of single and short-term therapies. Journal of managed care & specialty pharmacy. 2021 May;27(5):674-81
14. McCarthy JJ, McLeod HL, Ginsburg GS. Genomic medicine: a decade of successes, challenges, and opportunities. Science translational medicine. 2013 Jun 12;5(189):189sr4.-
15. Mardis ER. The impact of next-generation sequencing on cancer genomics: from discovery to clinic. Cold Spring Harbor Perspectives in Medicine. 2019 Sep 1;9(9):a036269.
16. Owusu Obeng A, Egelund EF, Alsultan A, Peloquin CA, Johnson JA. CYP 2C19 Polymorphisms and Therapeutic Drug Monitoring of Voriconazole: Are We Ready for Clinical Implementation of Pharmacogenomics?. Pharmacotherapy: The Journal of Human Pharmacology and Drug Therapy. 2014 Jul;34(7):703-18.
17. Weitzel KW, Elsey AR, Langaee TY, Burkley B, Nessl DR, Obeng AO, Staley BJ, Dong HJ, Allan RW, Liu JF, Cooper-DeHoff RM. Clinical pharmacogenetics implementation: approaches, successes, and challenges. InAmerican Journal of Medical Genetics Part C: Seminars in Medical Genetics 2014 Mar (Vol. 166, No. 1, pp. 56-67).
18. Chen JS, Dagdas YS, Kleinstiver BP, Welch MM, Sousa AA, Harrington LB, Sternberg SH, Joung JK, Yildiz A, Doudna JA. Enhanced proofreading governs CRISPR–Cas9 targeting accuracy. Nature. 2017 Oct 19;550(7676):407-10.
19. Tsai SQ, Joung JK. Defining and improving the genome-wide specificities of CRISPR–Cas9 nucleases. Nature Reviews Genetics. 2016 May;17(5):300-12.
20. Mulder NJ, Adebiyi E, Adebiyi M, Adeyemi S, Ahmed A, Ahmed R, Akanle B, Alibi M, Armstrong DL, Aron S, Ashano E. Development of bioinformatics infrastructure for genomics research. Global heart. 2017 Jun 1;12(2):91-8.
21. Alyami SM, Alswedan HY, Al Zamanan YY, Al-Harith MM, Almahamedh HS, Almakhalas AJ, Lasloum SM, Almakhlas MS. Comprehensive Review of Pharmaceutical Innovations: The Role of Pharmacists in Modern Healthcare Systems. Journal of Ecohumanism. 2024 Dec 17;3(8):7558-67.

22. Lee KC, Ma JD, Kuo GM. Pharmacogenomics: bridging the gap between science and practice. Journal of the American Pharmacists Association. 2010 Jan 1;50(1):e1-7.
23. Balogun OD, Ayo-Farai O, Ogundairo O, Maduka CP, Okongwu CC, Babarinde AO, Sodamade OT. The role of pharmacists in personalised medicine: a review of integrating pharmacogenomics into clinical practice. International Medical Science Research Journal. 2024 Jan 8;4(1):19-36.
24. Fritsche E, Elsallab M, Schaden M, Hey SP, Abou-El-Enein M. Post-marketing safety and efficacy surveillance of cell and gene therapies in the EU: A critical review. Cell Gene Ther. Insights. 2019;5(11):1505-21.
25. Gaviglio AM, Skinner MW, Lou LJ, Finkel RS, Augustine EF, Goldenberg AJ. Gene-targeted therapies: Towards equitable development, diagnosis, and access. InAmerican Journal of Medical Genetics Part C: Seminars in Medical Genetics 2023 Mar (Vol. 193, No. 1, pp. 56-63). Hoboken, USA: John Wiley & Sons, Inc.
26. AlRasheed MM, AlAli H, Alsuwaid AF, Khalaf S, Ata SI, BinDhim NF, Bakheet D, Khurshid F, Alhawassi TM. Gene therapy knowledge and attitude among healthcare professionals: a cross-sectional study. Frontiers in Public Health. 2021 Nov 15;9:773175.
27. Ohno-Machado L, Kim J, Gabriel RA, Kuo GM, Hogarth MA. Genomics and electronic health record systems. Human molecular genetics. 2018 May 1;27(R1):R48-55.
28. Morrissey C, Walker RL. The ethics of general population preventive genomic sequencing: rights and social justice. In The Journal of Medicine and Philosophy: A Forum for Bioethics and Philosophy of Medicine 2018 Jan 12 (Vol. 43, No. 1, pp. 22-43). US: Oxford University Press
29. .Rajakumari K, Shri KK, Logesh R, Meenambiga SS, Vivek P, Romauld SI. Global Perspectives on Pharmacogenomics and Drug Discovery. InGenomics-Driven Drug Discovery Through Pharmacogenomics 2025 (pp. 123-166). IGI Global Scientific Publishing.
30. Weitzel KW, Aquilante CL, Johnson S, Kisor DF, Empey PE. Educational strategies to enable expansion of pharmacogenomics-based care. American Journal of Health-System Pharmacy. 2016 Dec 1;73(23):1986-98.
31. Lennerz JK, McLaughlin HM, Baron JM, Rasmussen D, Shin MS, Berners-Lee N, Batten JM, Swoboda KJ, Gala MK, Winter HS, Schmahmann JD. Health care infrastructure for financially sustainable clinical genomics. The Journal of Molecular Diagnostics. 2016 Sep 1;18(5):697-706.
32. ang J, Griffiths E, Tounekti O, Nemec M, Deneault E, Lavoie JR, Ridgway A. Canadian regulatory framework and regulatory requirements for cell and gene therapy products. Regulatory Aspects of Gene Therapy and Cell Therapy Products: A Global Perspective. 2023 Aug 2:91-116.

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Case Report

Lumbosacral Nerve Root Compression by Gravid Uterus as a Cause of Sciatica in Pregnancy: Diagnosis by Exclusion

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Abstract

A 29-year-old pregnant woman presented with severe left sciatica for three days, which was exacerbated by standing and walking. The patient, who was 11 weeks pregnant, was considering termination of pregnancy due to the debilitating pain. The patient was referred by a neurosurgeon for a lumbar spine MRI (Magnetic Resonance Imaging) as the analgesics did not help much. MRI of the lumbar spine did not reveal any structural abnormalities. The patient's symptoms were significantly relieved by lying on her right side for a few hours. The diagnosis was made by exclusion, as the patient's symptoms were not attributable to any identifiable spinal pathology. The patient was managed conservatively with positioning techniques, and her symptoms greatly improved. This case highlights the importance of considering compression of the lumbosacral nerve roots by the gravid uterus as a potential cause of sciatica in pregnant women, especially when other spinal pathologies have been excluded.

Keywords: Sciatica, Female, Pregnancy, MRI

Introduction

Sciatica is a common complaint during pregnancy, affecting approximately 16.9% of women, as reported by several studies [1-3]. The symptoms of sciatica, including radiating pain, numbness, and tingling in the lower extremities, can significantly impact a woman's quality of life and daily activities. While lumbar disc herniation is a common culprit for sciatica in the general population, the growing uterus presents a unique challenge in pregnant women. This case report explores lumbosacral nerve root-compression by the gravid uterus as a potential cause of sciatica in pregnancy, highlighting the importance of diagnosis by exclusion.

Case Description:

A 29-year-old pregnant woman presented with a chief complaint of severe left-sided sciatica for the past three days. The patient was 11 weeks pregnant.

The patient reported excruciating, shooting pain radiating down her left lower extremity, accompanied by numbness, tingling and weakness. The pain was significantly exacerbated by standing or walking, and she was considering undergoing an induced abortion to relieve the symptoms. The patient was referred by the neurosurgeon for a lumbar spine MRI as the analgesics did not help much.

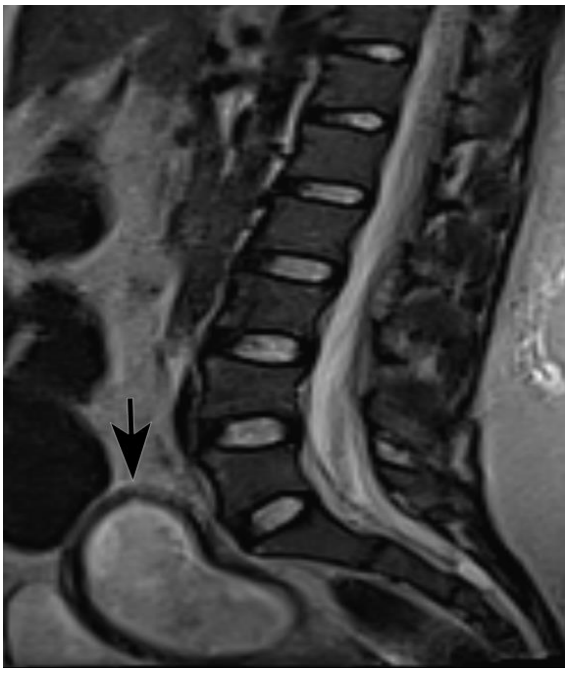

Fig 1 Normal spinal canal and a gravid uterus (black arrow) anterior to L5 and S1 Vertebrae.

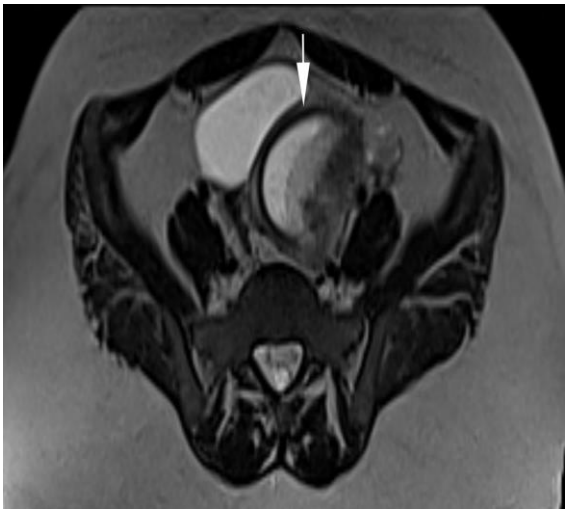

Fig 2 Gravid uterus (white arrow) in the left side of the pelvic cavity.

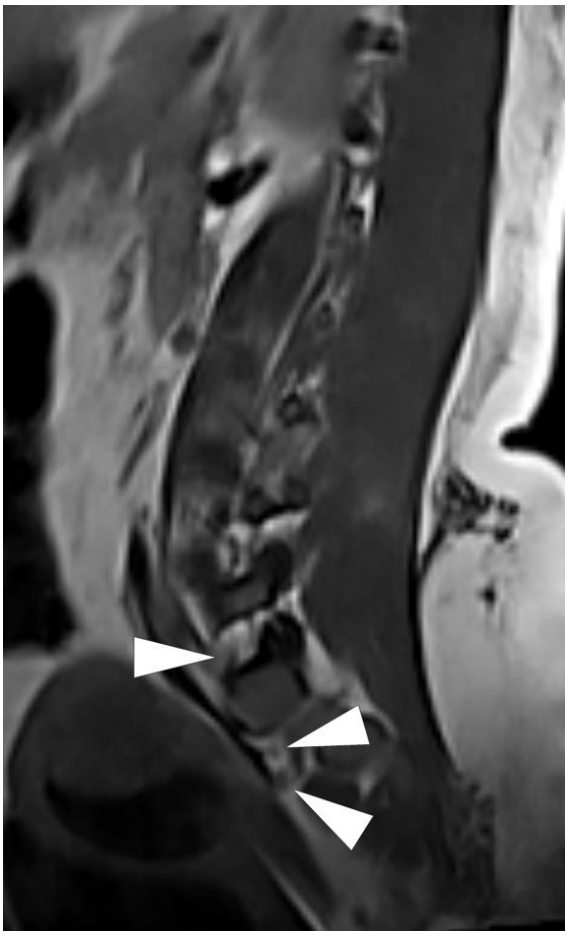

Fig 3 Left lumbosacral nerve roots in close contact to the posterior uterine wall.

Magnetic resonance imaging of the lumbar spine was performed and revealed the gravid uterus anterior to L5 and S1 vertebrae (Fig 1) in the left side of the pelvis (Fig 2) in close proximity to the left lumbosacral nerve roots (Fig 3).

The MRI did not reveal any disc herniation, spinal stenosis, or other structural abnormalities that could account for the patient's symptoms.

Given the lack of identifiable spinal pathology and the position of the uterus on the left side of the pelvis in close proximity to the left lumbosacral nerve roots, compression of the left lumbosacral nerve roots by the gravid uterus was suspected to be the cause of the left sciatica. The patient was advised to maintain a right lateral recumbent position as much as possible to alleviate pressure on the lumbosacral nerve roots.

Over the next few hours, the patient's symptoms gradually improved with the conservative management approach. The severe shooting pain and numbness in the left lower extremity subsided, and she was able to ambulate with minimal discomfort. The patient was closely monitored throughout the remainder of her pregnancy, and she did not require any further intervention.

Discussion

This case report describes a pregnant woman experiencing sciatica attributed to lumbosacral nerve root compression by the gravid uterus. While lumbar disc herniation and other musculoskeletal conditions are more common causes of sciatica in the general population, this case demonstrates the importance of considering pregnancy-specific factors during diagnosis.

The growing uterus can exert pressure on the lumbosacral nerve roots as it enlarges throughout pregnancy [4]. This compression can irritate the nerves, leading to the characteristic symptoms of sciatica, including radiating pain, numbness, and weakness in the leg [5].

As with this case, diagnosing lumbosacral nerve root compression by the gravid uterus often relies on a process of

exclusion. A thorough history and physical examination are essential to rule out other common causes of sciatica, such as lumbar disc herniation, piriformis syndrome, and sacroiliac joint dysfunction [6].

Imaging studies like MRI is a useful tool in some cases as it is considered to be safe during pregnancy if clinically indicated [7].

Fortunately, most cases of sciatica in pregnancy resolve spontaneously with conservative management [8]. This typically includes activity modification to avoid positions that aggravate pain, physical therapy with a focus on core strengthening and stretching exercises, and analgesics like acetaminophen for pain relief [9].

In this case, the patient's prompt response to conservative therapy aligns with the typical course of sciatica due to nerve compression from the gravid uterus.

References:

1. WebMD. (n.d.). Sciatic Nerve Problems and Pregnancy: What to Do. Retrieved from https://www.webmd.com/baby/what-to-do-about-sciatic-nerve-problems-during-pregnancy
2. International Journal of Science and Healthcare Research. (2022). Prevalence of Sciatica in 3 Pregnancy and Its Impact on Quality of Life. Retrieved from https://ijshr.com/IJSHR_Vol.7_Issue.2_April2022/IJSHR019.pdf
3. What to Expect. (n.d.). Sciatica During Pregnancy: What Causes It and How to Find Relief. Retrieved from https://www.whattoexpect.com/pregnancy/sciatica/
4. Lee DH, Byun JM, Kim JS, et al. Magnetic resonance imaging findings of the lumbosacral spine in pregnant women with low back pain. Spine (Phila Pa 1976). 2004;29(13):1434-1439. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3956604/
5. Bigos SJ, Bowyer DR, Bracy D, et al. Acute low back pain. Clinical practice guidelines No. 14. Quick reference summary for physicians. AHCPR Publication No. 95-0058. Rockville, MD: Agency for Health Care Policy and Research, Public Health Service, U.S. Department of Health and Human Services. 1995. https://www.aafp.org/pubs/afp/issues/2012/0215/p343.html
6. Cesarczyk A, van den Berg MA, Grijalva-Noriega A, et al. Painful sciatica during pregnancy: diagnosis and management. Arch Gynecol Obstet. 2010;282(2):157-163. https://www.lancastergeneralhealth.org/health-hub-home/motherhood/your-pregnancy/sciatic-nerve-pain-during-pregnancy
7. ACR–SPR Practice Parameter for the Safe and Optimal Performance of Fetal Magnetic Resonance Imaging (MRI) Res. 13 – 2010, Amended 2014. American College of Radiology (acr.org), Reston, VA.
8. American College of Obstetricians and Gynecologists Committee on Obstetric Practice. Guidelines for the use of contrast media during pregnancy. Int J Obstet Gynecol.

2010;109(1):1-3. https://www.acog.org/clinical/clinical-guidance/committee-opinion/articles/2017/10/guidelines-for-diagnostic-imaging-during-pregnancy-and-lactation

9. Cesarczyk A, van den Berg MA, Grijalva-Noriega A, et al. Painful sciatica during pregnancy: diagnosis and management. Arch Gynecol Obstet. 2010;282(2):157-163.

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Original Research Article

A study of drug-drug interactions involving direct oral anticoagulants for discharged patients in Sana'a city, Yemen

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Abstract

Background: Direct oral anticoagulants (DOACs) are fast-acting agents for blood clots, offering a favorable risk-benefit profile with significant reductions in stroke, intracranial hemorrhage, and mortality compared to warfarin. However, combining treatments can lead to drug-drug interactions (DDIs), affecting DOACs' exposure or pharmacological activities. The risk and severity of DDIs vary among DOACs, and they are particularly concerning for patients with major comorbidities requiring additional therapies.

Objective: To evaluate the prevalence and severity of the potential DDIs of DOACs among adult patients (18 years or older) who have received DOACs therapy at hospital discharge.

Methodology: This cross-sectional study was conducted at two hospitals in Sana'a from January 2022 to January 2023. The study data included demographic, clinical, and drug-therapy-related variables, which was collected from paper medical records. Drug interactions were identified using updated Lexicomp online software.

Results: Out of 146 patients, there were 140 (95.9%) individuals who had a total of 733 clinically significant DDIs. Specifically, 113 (77.4%) individuals had a total of 184 clinically significant DDIs with DOACs. 165 (89.7%) of which were category D, 14 (7.6%) of which were category X, and only 5 (2.7%) of which were category C DDIs with DOACs. There was also an association between advanced age, co-morbidities, and concomitant drug with the presence of DDI with DOACs.

Conclusion: The most potential drug interactions with DOACs was with aspirin (54.3%), clopidogrel (33.2%), Enoxaparin (6%)) and diltiazem (1.1%). It was also noticed that category D DDIs with DOACs was the most common, followed by category X DDIs with DOACs.

Keywords: Concomitant therapies Direct oral anticoagulants, Drug-drug interactions, Lexicomp

Introduction

Blood coagulation and platelet-mediated primary hemostasis have evolved as important defense mechanisms against bleeding. The coagulation system is triggered in response to rupture of endothelium, which allows exposure of blood to the extravascular tissue. The responses of the coagulation system are coordinated with the formation of the platelet plug that initially occludes the vascular lesion. Anticoagulant mechanisms ensure careful control of coagulation and, under normal conditions, they prevail over the procoagulant forces. Disturbances of the natural balance between the procoagulant and anticoagulant systems due to genetic or acquired factors may result in bleeding or thrombotic diseases [1].

Anticoagulants drugs are used for treating and preventing embolic events and derive their effect by acting at different sites of the coagulation cascade. Some act directly by enzyme inhibition, while others indirectly, by binding to antithrombin or by preventing their synthesis from the liver. Drug-drug interaction (DDI) is defined as the change in the drug effect when a second drug is taken concurrently. Many drugs interact with each other in many ways. When two drugs interact with each other, this interaction results in either increasing the effect of one or both of them or in preventing one or both of them from doing their activity. Types, mechanisms, and yields of DDIs vary variably [2].

DDIs may be either pharmacokinetic (PK) or pharmacodynamical (PD). Pharmacokinetic drug-drug interaction occurs when one drug hinders either: the absorption, distribution, metabolism, or excretion of the other drug. Pharmacodynamical drug-drug interaction, on the other hand, occurs when two drugs are administered and one of them alters the pharmacologic effect of the other, either by increasing or decreasing it. Decreasing the activity of a drug (antagonism) usually ends up with therapeutic failure, while increasing (synergism or addition) the activity of the drug results in increasing its toxicity [3].

Some risk factors contribute to increased DDIs. Using multiple medications at the same time is surely the main reason. Patients who have multiple conditions (comorbidities) are more subjected to DDIs due to the use of multiple drugs at the same time (polypharmacy). Impaired kidney or liver functions make the body unable to get rid of excess concentrations of medication substances. Some medical conditions make the patients susceptible to DDIs as well [4].

DDIs vary in severity and risk levels. Some drugs, if given together, yield a life-threatening interaction. In such cases, the drugs should not have given together and an alternative agent should be used instead. Other drugs would cause an interaction but that interaction is not that serious, and the drugs can be given and monitoring for signs of the interactions is required. Still, some drugs can cause mild interactions and nothing serious would happen if they were given together. DDIs vary in severity levels according to the mechanism by which they interact [3].

When two drugs interact with each other resulting in altering the process that each one should cause and undergo, this is called DDIs. These interactions vary depending on many factors and mechanisms. The severity of DDIs also varies. DDIs can reduce a

drug's effectiveness, induce unanticipated adverse effects, or enhance a drug's action. It occurs when a patient's response to a drug is altered by food, medication, or illness. When two or more medications react with one another, this is referred to as a drug-drug interaction. Drug interactions are a frequent cause of adverse medication responses and increased patient hospitalization rates. Drug interactions are more common among patients with co-morbidities, especially the elderly [3].

The most common chronic conditions from which the older adults suffer often include cardiovascular disease, diabetes mellitus, and chronic kidney disease. Cardiovascular disease is common in older adults and atrial fibrillation (AF) is the most common type of cardiac arrhythmia worldwide and its prevalence is increasing due to the ageing population and other risk factors and comorbidities [5].

The direct oral anticoagulants (DOACs), dabigatran, rivaroxaban, apixaban, and edoxaban are becoming the most commonly prescribed drug for preventing ischemic stroke in patients with non-valvular atrial fibrillation, for other cardiovascular disease that increase risk of thromboembolic event and for the treatment and prevention of venous thromboembolism (VTE) [5].

DOACs have broadened the landscape of oral anticoagulant therapy for almost a decade. They were first approved for the prevention of VTE after hip or knee replacement surgery [6]. Since 2011, they have also been indicated for stroke prevention in patients with non-valvular atrial fibrillation as well as for the treatment and secondary prevention of VTE. In 2016, the guidelines issued by the European Society of Cardiology and the American College of Chest Physicians recommended DOACs over vitamin K antagonists (VKAs) in eligible patients [7].

Initially, VKAs were the only feasible oral anticoagulants. There is a substantial downside with the use of VKAs such as increased risk of bleeding, narrow therapeutic index, individualized dosing based on INR, and many more. Direct oral anticoagulants resolved these issues to a remarkable extent. It is at least as effective as traditional anticoagulants and is convenient to administer as it is given as fixed doses without routine coagulation monitoring. It has a predictable and consistent PK-PD profile. Unlike VKAs, DOACs have more predictable PK-PD properties. Due to this appreciable characteristic, DOACs are used at fixed doses without periodic monitoring of coagulation parameters [8].

DOACs act by two different mechanisms. Based on this, it is grouped as direct thrombin inhibitor and direct factor Xa inhibitor. The former category inhibits coagulation by directly binding to thrombin and prevents the formation of fibrin by restricting thrombin from breaking fibrinogen. The latter group inhibits factor Xa, which is trypsin-like serine protease that plays a critical role in the blood coagulation cascade. It has a principal position in linking the intrinsic and extrinsic pathways to the final common coagulation pathway. These agents bind directly to factor Xa and prevent it from cleaving prothrombin to thrombin [9].

Pharmacokinetic profile varies among agents in this family. All DOACs absorbed rapidly following administration. Food intake has a

variable effect on DOACs absorption; Rivaroxaban is more effectively absorbed when taken with food, however, there is no effect of the presence of food in the stomach on absorption of Edoxaban, apixabana and dabigatran. Most of DOACs extensively bound to plasma protein, and as a result, systemic exposure unbound active drug is low. DOACs metabolism is variable; dabigatran metabolized by the glucoronic acid conjunction. Apixaban metabolized by cyp3A4, cyp1A2, cyp2j2, cyp2bC8, cyp2C9 and cyp19. Edoxaban metabolized by Cyp3A4. Rivaroxaban metabolized by cyp2A4 and cyp2j2. Patients with hepatic impairment are at increased risk of bleeding complications and thrombotic events [5].

Most DOACs therapies are eliminated by the kidneys to varying degrees, and alterations in renal clearance must be taken into account when dosing these agents. Recommended dosing regimens are nevertheless based on clinical characteristics (weight, age, renal function) and some co-medications. DOACs are anticoagulation pharmacotherapy used for the prevention of thrombosis in several cardiovascular contexts. DOACs are categorized into two main classes: oral direct factor Xa inhibitors (Rivaroxaban, Apixaban, Edoxaban, and Betrixaban) and direct thrombin inhibitors (Dabigatran) [8].

While DOACs have many beneficial effects, they are usually well-tolerated with few side effects. The main side effect is bleeding, which can range from minor (e.g., slight bruising or occasional bleeding from the gums when bruising teeth) to serious bleeding (e.g., vomiting blood, blood in the stools/urine, or bleeding inside your head) [10].

Our study has been designed to evaluate the prevalence and severity of DOACs-related DDIs, identify common interacting drugs and mechanisms, and assess the associations with comorbidities, age, and polypharmacy; those will impact on the Improving Patient Safety by avoiding harmful drug combinations, reducing the risk of adverse effects and enhancing patient safety. Although, Optimized Treatment Plans by knowing which drugs interact with DOACs, doctors can create more effective treatment plans tailored to individual patients, especially those with comorbidities and on polypharmacy. Moreover, the finding of this study will help in the improvement of informed decision-making, enhanced clinical guidelines, and aid to personalize medicine.

Impact Statements

This study proclaims that the presence of the interactions of direct oral anticoagulants will result in either increased toxicity, risk of bleeding, and adverse effects that in turn lead to less adherence by the patients to the medications, or decreased effectiveness that results in therapeutic and prevention failure.

Evaluating the prevalence and severity levels of DDIs of direct oral anticoagulants among adults will lead to increased knowledge about DOACs-drug interactions and their severity levels, and how they should be avoided and managed. Our study has been designed to evaluate the prevalence and severity levels of DDIs of direct oral anticoagulants among adults in Sana'a city, Yemen.

Aims and Objectives of the Study

The current study intends to investigate the prevalence and severity of drug interactions

(DDIs) with DOACs among patients aged 18 and over, who have received DOACs therapy from January 2022 to January 2023 in Sana'a city. Specifically, this study aims to:

1.Evaluate the prevalence and severity of DOACs-related DDIs.

2.Identify the common interacting drugs and mechanisms.

3.Assess the associations between DOACs-Drug Interactions and comorbidities, age, and polypharmacy.

Methods

Study Design

This is a retrospective cross-sectional study of all patients who attended the clinic and were diagnosed with cardiovascular diseases or venous thromboembolism. Data were collected through a retrospective review of paper medical records of all of the patients who were managed at the clinic between January 2022 and January 2023.

Study Period and Setting

This study was carried out from January 2022 to January 2023. The sample of this study was selected from the files of the patients discharged from Lebanon Hospital and Cardiac Center-Military Hospital, in Sana’a city.

The Study Sample

The sample of this study was purposively selected from of 1523 patient files that were examined during the study period. The study sample included 146 files of patients aged 18 and over who received DOACs between January 2022 and January 2023.

Inclusion Criteria

Patients' medical records in the hospitals database were filtered by diagnosis and time of discharge. Medical records of patients with cardiovascular disease that increase thromboembolism events who received DOACs therapy and discharged from the hospitals between January 2022 and January 2023 were included .

Exclusion Criteria

Medical records of male and female patients younger than 18 years old and medical records of patients who did not receive DOACs therapy were excluded.

Data Collection

Data were recorded in a predesigned data-collecting format. The data collected included name, age, gender, diagnosis, medications with their dosages and frequencies of dosing. The presence of drug interactions was investigated using Lexicomp online software and recorded in the bottom of the format. Lexicomp is a DDI database for healthcare providers and requires a subscription for access. It has been developed in various platforms, such as mobile applications, online, or desktop software [11]. According to Lexicomp, drug interactions are categorized into five risk rating levels: A (no known interaction), B (no action needed), C (monitor therapy), D (consider therapy modification), and X (avoid combination). These categories indicate the level of urgency and the actions needed to respond to a potential drug interaction.

Principally, paper medical records of adult patients receiving DOACs therapy were used for collecting the required data for the study. The obtained data were written down in a

predesigned data-collecting format. The medications found to be used by the patients including an agent from DOACs drugs were checked for the presence of any drug interaction using the interaction checker Lexicomp and written down in the same format of the patient.

Statistical Analysis

Data were statistically analyzed using the statistical package for social science (SPSS version 21) for categorical data, frequency, and percentage. Statistical differences among groups were evaluated using Pearson's chi-squared test: A p-value <0.05 was considered statistically significant.

Ethical Approval

The study was approved by the Faculty of Clinical Pharmacy at 21 September University for Medical & Applied Sciences and by the ethical committees of the hospitals targeted in this study.

Results

Demographic Data

A total of 1523 patient files were examined. 146 prescriptions were found to include DOACs. Accordingly, 146 patient files were selected for examination in this study. The mean age of the patients was 58 years old (± SD 11 years). In parallel, gender was distributed, as shown in **(Table 1)**, where 111 (76%) were male and 35 (24%) were female.

DOACs Drugs

The results obtained from the identified DOACs disclose that apixaban was prescribed for 111 (76.03%) of the patients while rivaroxaban was prescribed for 36 (24.66%) of the patients.

It was also found that 86 (58.9%) of the patients had two comorbidities, 35 (23.9%) of them had three comorbidities, and 7 (4.8%) of them had four comorbidities. The majority of the patients were diagnosed with IHD.

Table 1. Demographic Characteristics of the Patients Receiving DOACS.

Demographic Data	Number of prescriptions	Percentage%
Age		
<40	8	5.48%
40-49	22	15.07%
50-59	53	36.3%
60-69	48	32.88%
70-79	10	6.85%
≥80	5	3.42%
Gender		
Male	111	76%
Female	35	24%
Diagnosis		
IHD	65	23.99%
Post-PCI	34	12.55%
Diabetes Mellitus	23	8.49%
Atrial Fibrillation	13	4.8%
Deep Vein Thrombosis	3	1.11%
Others	133	49.06%

Concomitant Drugs The concomitant drugs that were prescribed along with DOACs were analyzed as well. Their average number was 6.89 (±SD 2.118). Aspirin, beta-blockers, pantoprazole, statins, and clopidogrel were the most common drugs prescribed with DOACs. All co-administered drugs and their percentages are listed in **Table2.**

Table 2. Concomitant Medications co-Prescribed Medications with DOACs

Concurrently Used Drug			Concurrently Used Drug			Concurrently Used Drug		
Medication	**No.**	**%**	**Medication**	**No.**	**%**	**Medication**	**No.**	**%**
Aspirin	97	66.4%	**Levocarnitine**	6	4.1%	**Salbutamol**	2	1.4%
Bisoprolol	81	55.5%	**Acetylcysteine**	5	3.4%	**Vitamin D3**	2	1.4%
Pantoprazole	67	45.9%	**Sitagliptin**	5	3.4%	**Allopurinol**	1	0.7%
Atorvastatin	66	45.2%	**Ciprofloxacin**	4	2.7%	**Cefepime**	1	0.7%
Clopidogrel	58	39.7%	**Glibenclamide**	4	2.7%	**Cefixime**	1	0.7%
Spironolactone	49	33.6%	**Glimepiride**	4	2.7%	**Cefoperazone**	1	0.7%
Torsemide	46	31.5%	**Paracetamol**	4	2.7%	**Cortisone**	1	0.7%
Linezolid	43	29.5%	**Potassium gluconate**	4	2.7%	**Dexamethasone**	1	0.7%
Rosuvastatin	33	22.6%	**Vitamin B**	4	2.7%	**Diclofenac Na**	1	0.7%
Furosemide	23	15.8%	**Albumin**	3	2.1%	**Dobutamine**	1	0.7%
Carvedilol	22	15.1%	**Amiloride**	3	2.1%	**Domperidone**	1	0.7%
Nitroglycerin	20	13.7%	**Amlodipine**	3	2.1%	**Escitalopram**	1	0.7%
Dapagliflozin	18	12.3%	**Cefuroxime**	3	2.1%	**Fentanyl**	1	0.7%
Metformin	13	8.9%	**Ferrous sulfate**	3	2.1%	**Flupenthixol**	1	0.7%
Enoxaparin	12	8.2%	**Folic acid**	3	2.1%	**Heparin**	1	0.7%
Sacubitril/Valsartan	12	8.2%	**Isosorbide dinitrate**	3	2.1%	**lansoprazole**	1	0.7%
Ramipril	11	7.5%	**Valsartan**	3	2.1%	**Melitracen**	1	0.7%
Digoxin	10	6.8%	**Candesartan**	2	1.4%	**Meloxicam**	1	0.7%
Losartan	10	6.8%	**Diltiazem**	2	1.4%	**Metoprolol**	1	0.7%
Amoxicillin/ clavulanic	9	6.2%	**Gliclazide**	2	1.4%	**Omeprazole**	1	0.7%
Empagliflozin	8	5.5%	**Levothyroxine**	2	1.4%	**Ondansetron**	1	0.7%
Amiodarone	7	4.8%	**Metronidazole**	2	1.4%	**Ranitidine**	1	0.7%
Hydrochlorothiazide	7	4.8%	**Nebivolol**	2	1.4%	**Sacubitril**	1	0.7%
Insulin	7	4.8%	**Phenoxymethylpenicillin**	2	1.4%	**Tramadol**	1	0.7%
Ceftriaxone	**6**	**4.1%**	**Piperacillin**	**2**	**1.4%**	**Warfarin**	1	**0.7%**

DOACs-Drug Interactions, according to Lexicomp

The Prevalence of Potential DOACS-Drug Interactions

Broadly, there were 140 (95.9%) patients out of 146 patients who had a total of 733 clinically significant drug-drug interactions. Category C represented 513 (70%), category D represented 204 (27.8%), and category X represented 16 (2.2%) of those drug-drug interactions.

Specifically, given that only categories C, D, and X are clinically significant, the result show that out of 146 patients, there were 113 (77.4%) individuals who had a total of 184 (25.1%) clinically significant DOACs-drug interactions, as shown in **Table 3.**

Table 3. The Prevalence of Clinically Significant and DOACs-Drug Interactions

Interactions	No. of patients	Percent of patients	No. of DDIs
General DDIs	140	95.9%	733
DOACs-Drug DDIs	113	77.4%	184

Remarkably, the study found that the age group between 50-59 is associated with the most DOACs-drug interactions **(Figure 1).**

As displayed in Table 4, apixaban was prescribed for 111 (76%) of the patients and rivaroxaban was prescribed for 36 (24.66%) of the patients. Besides, out of 184 DOACs-drug interactions, apixaban accounted for 126 (68.5%) of the patients whereas rivaroxaban accounted for 58 (31.5%) of them.

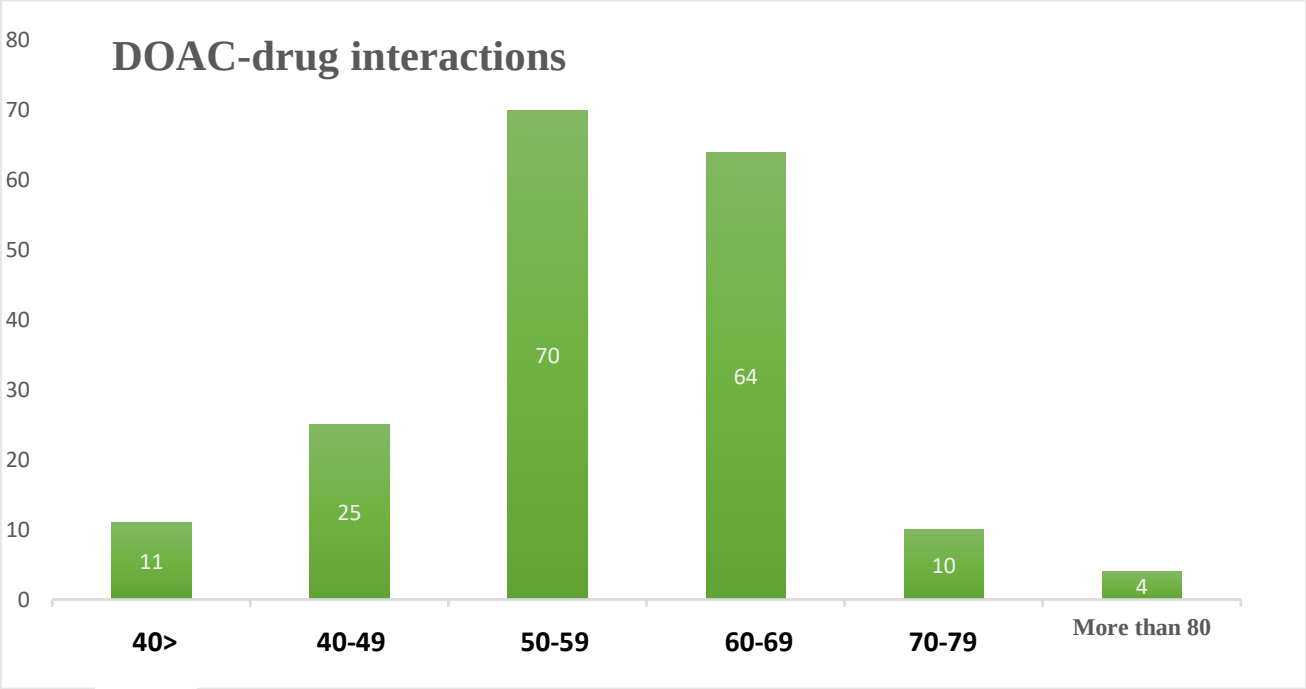

Figure 1. Association of DOACS-Drug Interactions with the Age Group

Table 4. Distribution of DOACs Agents Among Patients

DOACs agents	No. of Prescriptions	No. of Interactions
Apixaban	111 (76%)	126 (68.5%)
Rivaroxaban	36 (24.66%)	58 (31.5%)

Factors that might Affect the Occurrence of DOACs-Drug Interactions

When examining the factors that might affect the occurrence of DOACs-drug interactions, it was found that the number of comorbidities was associated with more concomitant drugs (0.308, p-value < 0.0001). Consequently, the number of concomitant drugs was shown to be strongly associated with more DOACS-drug interactions (0.386 p-value < 0.0001). By the same token, the increased number of comorbidities is directly associated with an increased number of DOACS-drug interactions (0.194, p-value < 0.05). **Table 5** illustrates the degree of correlation between the factors that were found to affect the occurrence of DOACs-drug interactions.

Table 5. Correlation between the Most Important Factors that Might Affect the Occurrence of DOACs-Drug Interactions.

		No. of comorbidities	No. of DOACs-DDIs	No. of drugs
No. of comorbidities	Pearson Correlation	1	0.194*	0.308**
	Sig. (2-tailed)		0.019	0.000
	N	146	146	146
No. of DOACs-DDIs	Pearson Correlation	0.194*	1	0.386**
	Sig. (2-tailed)	0.019		0.000
	N	146	146	146
No. of drugs	Pearson Correlation	0.308**	0.386**	1
	Sig. (2-tailed)	0.000	0.000	
	N	146	146	146

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Potentially Interacting Drugs with DOACs

When analyzing the drugs that were involved in the identified DOACs-drug interactions, aspirin, clopidogrel, enoxaparin and diltiazem were found to be responsible for most DOACs-drug interactions.

Table 6. Percent of each Potentially Interacting Drug with DOACs According to Lexicomp

Interacting drug	Number of prescriptions	Percent%	The Severity
Aspirin	100	54.35%	D
Clopidogrel	61	33.15%	D
Enoxaparin	11	5.98 %	X
Apixaban with Rivaroxaban	2	1.09 %	X
Diltiazem	2	1.09%	C
Heparin	1	0.54%	X
Diclofenac Na	1	0.54%	D
Meloxicam	1	0.54%	D
Escitalopram	1	0.54%	C
Fluoxetine	1	0.54%	C
Indomethacin	1	0.54%	D
Warfarin	1	0.54%	C
Ibuprofen	1	0.54%	D
Total	184	100.0%	

The Severity of the Potential DOACs-Drug Interactions

Equally important, the severity of the potential DOACS-drug interactions was analyzed, revealing that out of 184 DOACS-drug interactions, 5 (2.7%) were of category C, 165 (89.7%) were of category D, and 14 (7.6 %) were of category X interactions. This distribution is shown in **Table 7.**

Table 7. Percentage of the Severity Levels of DOACS-Drug Interactions

Severity	Number of Prescriptions	Percent%
C (Monitor Therapy)	5	2.7%
D (Consider Therapy Modification)	165	89.7%
X (Avoid Combination)	14	7.6%

Mechanism of the Potential DOACs-Drug Interactions

Lastly, the potential mechanism by which the DOACs interacted with other medications has a pharmacokinetic basis in 3 (1.6%) of the interactions and most DOACS-drug interaction has a pharmacodynamic basis in 181 (98.4%) of them. **Table 8** illustrates the mechanism of DOACS-drug interactions.

Table 8. Mechanism of DOACS-Drug Interactions

	No. of DDIs	Percent%
Pharmacodynamic	181	98.4%
Pharmacokinetic	3	1.6%

Discussion

It was found that out of 146 patients, 86 (58.9%) had two comorbidities while 35 (23.9%) had three comorbidities, and the vast majority of the patients were diagnosed with IHD.

It was also found that the mean number of concomitant prescribed medications along with DOACs was 6.89 (± SD 2.118).

Besides, most commonly co-prescribed medications included aspirin, beta blockers, pantoprazole, statins and clopidogrel.

Our findings revealed that 77.4% of patients experienced clinically significant DOACs-drug interactions; a total of 184 DDI with DOACs were found in 140 prescriptions out of 146 prescriptions. This aligns with previous studies such as Badreldin et al. (2020) and Forbes and Polasek (2017), which reported interaction rates between 37% and 78%. [12,13] The high prevalence in our study may be attributed to the widespread use of polypharmacy in cardiovascular patients.

PD-DDIs were more frequent in patients of this study compared to PK-DDIs (98.4% versus 1.6%, respectively). However, the percentage 98.4% found in our study was higher than of other studies, which could be attributed to the increased use of antiplatelet therapy in our population compared to the other studies. This could be explained by the fact that IHD and PCI were more prevalent in population of this study which may necessitate the use of an antiplatelet for primary and secondary propose.

This study also revealed that as the number of comorbidities increase, the potential DDIs with DOACs increase as well (0.194, p-value < 0.05). The strong correlation between polypharmacy and DOACs interactions ($r = 0.386$, $p < 0.0001$) is expected, as older patients with cardiovascular diseases often require multiple medications.

Most DOACS interactions were classified as category D (89.7%), meaning that the patient should be considered for therapy modification. Additionally, the patient has a substantial chance of an adverse drug reactions, which increase the likelihood of hospitalization and category X (7.6%), indicating that the medications should be avoided. Only (2.7%) of the interactions were classified as category C, meaning that the patient's medications should be monitored. The severity of the interactions not mentioned in other studies such as Badreldin (2020) and Forbes and Polasek (2017) [12,13], by which our study fills this gap. Only Ersoy's (2021) study mentioned the severity of interactions, which in accordance with our study claimed that the majority of significant DDI with DOACs is category D. [14]

It was also found that the most frequently reported DDIs of DOACS were with antiplatelet and NSAID, such as Aspirin, Clopidogrel, Enoxaparin and Diltiazem. These findings are also consistent with the findings of the study made by Ersoy (2021). [14]

Another study was conducted in Saudi Arabia by Badreldin (2020), reporting that NSAIDs and Antiplatelet were the most frequent interacting class of medications with DOACs. [12]
Concurrent use of DOACs and other medications may increase or decrease the effectiveness of some medications. It may also increase the risk of bleeding and gastrointestinal symptoms.
In this study, DOACs were prescribed with aspirin in 100 (54.35%) and clopidogrel in 61 (33.15%) of 140 prescriptions. The use of DOACs in conjunction with antiplatelet therapy (aspirin and/or clopidogrel) showed increase in the risk of major bleeding. The postulated mechanism for this potential interaction was that both agents affect the

pharmacological effect of the DOACs by agonizing its effect. This study showed that DDI of DOACs were mostly observed among the patients whose age was 50 and 59. This is because nearly at this age, a patient usually has several chronic diseases, especially CVD, which require anticoagulation therapy to prevent further consequences.

The majority of DOACs medication interactions may be avoided by adhering to best practices in clinical care and clinical pharmacology, such as avoiding complicated treatment regimens, utilizing a single pharmacy for all prescriptions, and recognizing patient risk factors.

Strengths and Limitations

The present study was the first study to investigate potential DDIs with DOACs in adult patients in Yemen. The results needed to be interpreted with caution because the present study have several limitations. Firstly, the current study was retrospective observational in nature. Secondary, we examined drug interactions of DOACs, but we did not know co-medications' interactions with each other. Moreover, the study examined drug interactions only from one online application. It could be argued that other drug interaction software like Micromedex, In Facts, Medscape, and others online applications of drugs interactions checkers could have different results. However, several reports have shown that Lexicomp was the most accurate and comprehensive software among the drug interactions software.

Conclusion and Recommendations

This study found that 77.4% of patients receiving DOACs experienced clinically significant drug-drug interactions, primarily in category D (89.7%) and category X (7.6%). Most interactions were pharmacodynamic in nature. The key risk factors for DOACs-drug interactions included advanced age, polypharmacy, and multiple comorbidities.According to the results obtained in this study, we recommend:

1.Adhering to best practices in clinical care and pharmacotherapy such as avoiding complicated treatment regimens and recognizing patient risk factors.

2.Patients' co-medications should be checked regularly in order to support the risk assessment for excessive bleeding or thrombotic events due to DDIs.

3.Close monitoring for excessive bleeding or thrombotic events when DOACs used in combination.

4.Health care professionals should use drug-drug interaction checkers such as Lexicomp, Medscape, and Micromedex.

References

1. Turpie, Alexander G.; Esmon, Charles, "Venous and atrial thrombosis - pathogenesis and the rationale for anticoagulation," pp. 586-596, 2011.

2. Gebretsadik, Z;, "Assessment of Drug-Drug Interaction in Ayder Comprehensive Specialized Hospital, Mekelle, Northern Ethiopia," *A Retrospective Study*, p. 6, 8, 2017.

3. Tannenbaum C, Sheehan NL. Understanding and preventing drug-drug and drug-gene

interactions. Expert Rev Clin Pharmacol. 7(4):533-44, 2014.

4. Bjerrum, Lars & López-Valcárcel, Beatriz & Petersen, Gert. Risk factors for potential drug interactions in general practice. The European journal of general practice. 14. 23-9., 2008.

5. Ferri, N; Colombo, E; Tenconi, M; Baldessin, L; Corsini, A;, "Drug-drug interactions of direct oral anticoagulants (DOACs): from pharmacological to clinical practice," *Pharmaceutics*, vol. 1120, pp. 6-14, 2022.

6. Barder, S; Graff, J;, "Noval oral anticoagulants : clinical pharmacology, indications and practical concentrations," *Eur J Clin Pharmacol*, vol. 69, pp. 1617-33, 2013.

7. Kirchhoff, P; Benussi, S; Kotecha, D, "ESG guidelines for the management of atrial fibrillation developed in collaboration with EACTS," *Eurpace* , vol. 18, pp. 1609-78, 2016.

8. Sennesael AL, Larock AS, Devalet B, Mathieux V, Verschuren F, Muschart X, Dalleur O, Dogné JM, Spinewine A. Preventability of serious thromboembolic and bleeding events related to the use of oral anticoagulants: a prospective study. Br J Clin Pharmacol. 2018, 84(7):1544-1556. doi: 10.1111/bcp.13580.

9. Cuker, A; Burnett, A; Triller, D; Crowther, M; Ansell, J; Van Cott, E.M; Wirth, D; Kaatz, S;, "Reversal of direct oral anticoagulants," Guidance from the anticoagulants forum. Am. J. Hematol, pp. 697-709, 2019.

10. Lane, D A; Wood, K;, "Cardiology patient page. Patient guide for taking the non-vitamin K antagonist oral anticoagulants for atrial fibrillation," Circulation, vol. 131, no. 16, pp. 412-5, 2015.

11. Lexicomp: Evidence-Based Drug Referential Content. [Feb; 2023]. 2023.

12. Badreldin, Hisham A., et al., "Real-world analysis of potential pharmacokinetic and pharmacodynamic drug interactions with apixaban in patient with non-valvular atrial vibrillation," *International journal of general medicine*, pp. 419-427, 2020.

13. Polasek, h. L. Forbes and t. M.;, "potential drug-drug interactions with direct oral anticoagulants in elderly hospitalized patients," therapeutic advances in drug safety, pp. 319-328, 2017.

14. Ersoy İ. Novel Drug Interaction index and Risk of Mortality in Older Patients With Atrial Fibrillation Receiving Non Vitamin K Oral Anticoagulants (NOEL Drug). Clin Appl Thromb Hemost. 2021 Jan-DOACs;27:10760296211038685.

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