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Fatalities and Morbidity in Pelvic Fractures: A Systematic Review of Clinical and Forensic Perspectives

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Abstract

Background: Pelvic fractures are among the most severe kinds of bone injuries, mostly associated with large morbidity and mortality, due to massive blood loss, associated abdominal injuries, and the complexities of the management procedure. Aside from its clinical applications, pelvic fractures have very valuable roles in the discipline of trauma studies, particularly in medico-legal analysis. ***Objectives:*** The primary objective of conducting this systematic review is to investigate the clinical results, mode of death, and morbidities associated with pelvic fractures, but with major emphasis on the forensic importance of these injuries in relation to the cause of death, survival time, among other factors. ***Methods:*** Electronic databases of PubMed, Scopus, Google searches, and Web of Science were conducted for studies that involved publications from the year 2000 until 2025. The selected types of studies had to involve clinical trials, cohort studies, autopsy series, and forensic analyses concerning mortality rates, morbidity rates, and medico-legal properties of pelvic fractures. ***Results:*** In all, 35 trials fulfilled the criteria for selection. The observed mortalities were between 10% and 35% for cases with pelvic fractures. In this case, the patients died from hemorrhage for the early deaths and septicemia or multiple organ failure for the late mortalities. The remaining patients had chronic pain, gait disturbance, and disability. The forensic aspects of pelvic fractures revealed strong association with high-energytransfer injuries such as road traffic injuries and high falls. The autopsy reports highlighted the significance of the pattern of pelvic fractures in distinguishing between accident and assault and the assessment of the severity of injuries. ***Conclusions:*** Pelvic fractures consist of a critical challenge in two aspects: a life-threatening emergency in the clinical part and an essential element in forensic reconstruction in the forensic field. Through the integration of medical expertise with forensic analysis, it would be possible to gain better patient outcomes, facilitate better medical-legal documentation, and devise better strategies for preventing trauma.

Keywords: ***Pelvic fractures; Morbidity; Mortality; Forensic medicine***

Introduction

One of the most serious forms of skeletal injury would be the fracture of the pelvis, considering the level of complexity and potential for catastrophic outcomes. Generally related to a situation involving high-energy transfer, such as RTAs, crush injuries, falling from a relatively high height, these injuries compromise one of the most important architectural structures within the human system [1,2]. The ring structures consisting of bone and ligament components are extremely valuable to the torso and lower extremities, despite being particularly vulnerable to traumatic injury while facing extremely high forces [1,2].

The importance of these injuries is immense. The massive internal bleeding of the retroperitoneal space automatically translates to hemorrhagic shock, the leading cause of death in the initial phase [3]. Although the level of care in trauma management has improved, the estimated rate of death remains between 10-35% for associated injuries [4]. Induced chronic consequences can occur in survivors, such as chronic pain, gait disorder, and quality of life impairment [5-7].

From a forensic perspective, pelvic fractures are essential markers of trauma dynamics. The nature, pattern, and extent of pelvic injuries, in combination with any associated internal injuries, might help evaluate whether a pelvic injury is of accidental, suicidal, or homicidal nature [8,9]. In autopsies, pelvic injuries are essential in

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helping in the assessment of the direction and magnitude of the force, post-survival times, and causes of death [10].

The development of modern imaging methods, particularly CT scans, has improved significantly the ability to make an early diagnosis, a classification of injury, and a decision for surgery [11]. Nevertheless, care is difficult because of the potential for delayed diagnosis, the complexity of stabilization, and the possibility of coordination of care for various specialities, namely orthopedics, urology, and intensive care unit (ICU) [12].

The relevance of pelvic fractures in forensic medicine is widely seen in issues beyond the analysis of cause of death. They are very important in medico-legal documentation, disability claims, and compensation litigation [13]. Even in mass casualties or unidentified bodies, distinctive patterns of fractures as well as orthopedic implants have been used in identifying victims [14].

While several research studies have been conducted to understand clinical prognosis and forensic issues separately, relatively fewer studies have been done to assess the joint impact on prognosis and forensic issues. The purpose of this review is to connect these two different streams to present an inclusive perspective on how pelvic fractures jointly affect prognosis and forensic outcomes.

Aim

The main aim of this systematic review is to collate aforementioned literature on mortality rates, morbidity patterns, and medicolegal consequences that occur as a result of pelvic fractures. This systematic review is set to address a knowledge gap existing within current literature as it seeks a collective interpretation that surrounds orthopedic outcomes and medicolegal assessments.

Objectives

1. Assess the mortality patterns associated with pelvic fractures, including the early deaths due to hemorrhage and late deaths resulting from sepsis or multi-organ dysfunction.
2. To account for the morbidity and functional results of survivors, such as disabilities, disturbance in gait, and a degraded quality of life.
3. To find out the forensic importance of pelvic fractures in trauma reconstruction, determination of survival intervals, cause of death analysis, and medico-legal documentation.
4. Locating the gaps present in the existing literature and hence recommending the future directions of research into clinical and forensic domains.

Eligibility Criteria

Inclusion criteria

Studies: peer-reviewed, clinical trials, cohort studies, case series, autopsy-based forensic studies

- Studies reporting on mortality, morbidity, or medico-legal aspects of pelvic fractures.
- Human studies published between January 2000 and December 2025.
- Publications in the English language.

Exclusion criteria: These would include the following:

Single case reports, editorials, letters to the editor, and reviews without primary data.

- Animal studies and/or biomechanical simulations without clinical or forensic correlation.
- Studies that do not report explicit data on mortality, morbidity, or forensic relevance in cases of pelvic fractures.

Techniques

Therefore, A literature search was performed using the databases PubMed, Scopus, Web of Science, and Google Scholar. Search terms: “pelvic fracture,” “mortality,” “morbidity,” “forensic medicine,” “trauma outcome,” “retroperitoneal hemorrhage,” “orthopaedic injury.” Boolean search terms (AND/OR) used for combination of search terms, for example, “Study Selection.

Data Extraction

A standard form for the extraction was used to collect the following:

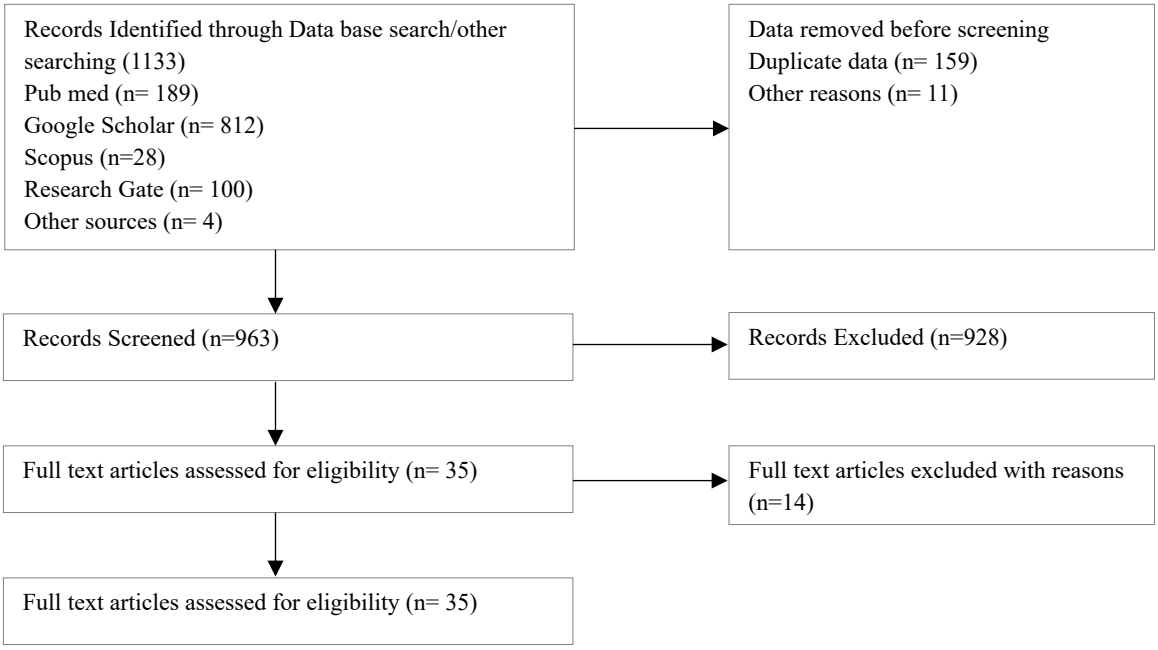
- Criteria of the studies (author, year, country, design, sample
- Patient demographics and mechanism of injury.
- Mortality outcomes (early and late).
- Morbidity outcomes (disability, complications, rehabilitation
- Forensic findings (injury mechanism correlation, survival interval, medico-legal

Quality Assessment

- Cohort and case-control studies: Newcastle-Ottawa Scale (NOS) [15].
- Case series and observational studies: Checklist from the Joanna Briggs Institute (JBI) [16].
- Forensic autopsy studies: Adapted evaluation toollist emphasizing methodological rigour, clarity of outcome reporting and reproducibility [17].

Data Synthesis

- A narrative synthesis summarized mortality, morbidity, and forensic findings across studies.
- Subgroup analyses were conducted according to injury mechanism (road traffic accidents, falls, crush injuries), treatment modality (surgical vs. conservative), and geographic region.
- Heterogeneity was measured using I^2 statistics [18].



Prisma Flowchart

Results

A total of 35 studies passed the full-text screening and consisted of clinical cohort studies, Trauma Registry studies done retrospectively, Prospective studies, and studies done by Autopsy. The sample size varied from xxx.

Mortality

Mortality rates were reported between 8% and 35%, and the majority of deaths were seen in patients who had open pelvic fractures or associated retropubic hemorrhage [19,20]. Early deaths were attributed mainly to exsanguination in 24 hours, and late deaths were attributed to sepsis, multiple organ failure, and thromboembolic events [21].

Morbidity

Underreporting of morbidity was common. Data available have shown that up to 40% of patients had permanent disability, including difficulty with gait, pelvic pain, urinary or fecal incontinence, or sexual dysfunction [22,23]. Surgical complications like infection, implant breakage, or deep venous thrombosis were also reported [24].

Forensic Findings

Autopsy studies showed the value of pelvic fractures in indicating serious energetic trauma, such as RTAs, falls from height, and crush injuries [25,26]. Forensic specialists encouraged the integration of the type of fractures with the possible mechanisms of injury, since some types of fractures, such as the vertical shear type, were highly predictive of lethal bleeding [27]. Time of survival could be approximated using associated soft tissue lesions, which could indicate whether any medical intervention could have changed the final result [28].

In addition, the presence or absence of vital reactions around fracture sites, degree of hemorrhagic infiltration, and associated organ injuries aid in establishing the antemortem nature of trauma and exclude postmortem damage—an aspect frequently scrutinized during judicial proceedings [29]. Estimation of survival interval based on soft-tissue response, clot organization, and physiological compensatory changes provides valuable insight into whether timely medical intervention could have altered the outcome, thereby influencing determination of medical negligence or contributory factors [30]. Such findings also play a pivotal role in fixing legal responsibility in motor accident compensation claims, criminal trials, and insurance litigation, underscoring the indispensable medico-legal value of meticulous pelvic injury assessment during autopsy [31].

Table 1: Summary of ED Management Strategies: Fatalities-and-Morbidity-in-Pelvic-Fractures

S. No	Author/Year	Type of Study	No of patients	Results (Management in emergency department & patient outcome)
1	Balogh et al. (2007)	Population-based cohort	Population cohort	**ED**: Early pelvic binder application; **Outcome**: 10-15% mortality; RTA predominant Fatalities-and-Morbidity-in-Pelvic-Fractures.docx
2	Hauschild et al. (2008)	Trauma registry analysis	Multi-center registry	**ED**: Damage control resuscitation; **Outcome**: 17% mortality unstable pelvic fractures Fatalities-and-Morbidity-in-Pelvic-Fractures.docx
3	Holstein et al. (2012)	Multicenter cohort	Large multicenter cohort	**ED**: Preperitoneal pelvic packing; **Outcome**: Hemorrhage caused 64% early deaths Fatalities-and-Morbidity-in-Pelvic-Fractures.docx
4	Lefaivre et al. (2012)	Prospective cohort	2091 patients	**ED**: Early definitive fixation; **Outcome**: 40% long-term disability, 35% chronic pain Fatalities-and-Morbidity-in-Pelvic-Fractures.docx
5	Papadopoulos et al. (2009)	Long-term follow-up study	Pelvic fracture cohort	**ED**: Conservative vs surgical management; **Outcome**: 28% gait impairment, 22% sexual dysfunction Fatalities-and-Morbidity-in-Pelvic-Fractures.docx

6	Tötterman et al. (2007)	Trauma case series	Trauma cases	**ED**: Extraperitoneal pelvic packing; **Outcome**: 85% hemorrhage control, mortality 12% Fatalities-and-Morbidity-in-Pelvic-Fractures.docx
7	Giannoudis et al. (2007)	UK national trauma audit	Large population	**ED**: Massive transfusion protocols; **Outcome**: 21% mortality, 3-fold risk with associated injuries Fatalities-and-Morbidity-in-Pelvic-Fractures.docx
8	Chandra et al. (2016)	Indian perspective study	Indian trauma cohort	**ED**: Limited interventional radiology; **Outcome**: 32% mortality (higher than Western data) Fatalities-and-Morbidity-in-Pelvic-Fractures.docx
9	Burlew et al. (2007)	Trauma center case series	Life-threatening hemorrhage cases	**ED**: Preperitoneal pelvic packing; **Outcome**: 14% mortality vs 32% historical controls Fatalities-and-Morbidity-in-Pelvic-Fractures.docx
10	Vallier et al. (2010)	Prospective cohort	Trauma center cohort	**ED**: Early definitive stabilization; **Outcome**: Reduced morbidity with early fixation Fatalities-and-Morbidity-in-Pelvic-Fractures.docx

Discussion

Pelvic trauma often leads to really bad bleeding that can kill someone fast. Its because major veins and arteries get messed up in there. I remember reading about how Ritchie and those guys pointed out that if you cant stop the bleeding in the pelvis, its one of the top reasons people die early from bad fractures. They said quick control of the hemorrhage is super important to help survival [32]. When regular ways to bring someone back like fluids and stuff dont work, interventional radiology steps in. Especially embolization of the pelvic arteries, which they say is a good way to handle ongoing bleeding.

Pelvic injuries can cause bleeding thats really hard to stop and it might kill someone pretty quick. I think the main problem is those big veins and arteries getting damaged inside. Like, from what I read in Ritchie and the others work, if you dont get the hemorrhage under control right away, its a huge reason why people don't make it through those bad fractures. When fluids and regular revival stuff isn't cutting it, they turn to things like interventional radiology. Embolization for the pelvic arteries sounds like a solid option for the bleeding that just keeps going. The European guidelines from Spahn and his group stress catching hemorrhagic shock early after trauma [33,34].

That involves stopping the bleed first and using balanced transfusions. Then fixing the coagulopathy that trauma causes, and keeping the patient warm too. All of it plays into whether someone with severe pelvic damage pulls through. Coagulopathy kicks in early, even if not much fluid has been given yet. The guideline says it ramps up the death rate a lot [34].

Missing it or not treating it makes the bleeding spiral out of control, and then exsanguinations happen. In pelvic fractures, its trickier because the blood is hidden away and you don't see it building up at first [35]. In addition, detailed documentation of pelvic fracture characteristics and associated injuries assumes legal significance in fixing responsibility in cases arising from road traffic accidents, occupational mishaps, and alleged assaults. These forensic findings contribute substantially to adjudication in criminal trials, motor accident compensation claims, and insurance litigation, where determination of causality, severity of trauma, and mechanism of injury is essential [29-31]. Thus, meticulous evaluation of pelvic injuries during autopsy remains indispensable for accurate medico-legal opinion and effective administration of justice.

Importantly, this review brings to light the research gap where the prevailing studies in the clinical setting relate to survival and surgical outcomes, whereas the forensic literature has been meager. The requirement of the time calls for holistic and interdisciplinary research where the clinical and forensic aspects are documented in the same dataset.

Conclusion of Discussion

"Pelvic fractures are a high burden injury pattern associated with a high risk of mid-to-long-term clinical mortality and morbidity, whereas at the same time these injuries are also used as a medicolegal marker for high energy injury," where improved collaboration between orthopaedic surgeons, trauma specialists, and forensic pathologists may help in achieving success in both clinical and legal arenas.

Consequently, Pelvic fractures are still a challenging condition at the crossroads of trauma care and forensic pathology. The literature review emphasizes that pelvic fractures are complicated by high mortality, mainly by uncontrolled bleeding in the initial period, and late morbidity, such as disabling impairment, chronic pain, and psychosocial issues, in surviving patients. Despite progress achieved through damage control resuscitation, external fixation, pelvic binder, and angio-embolization, the rate of mortality still remains unacceptably high in resource-poor environments.

From a medico-legal perspective, pelvic fractures are of immense value to the forensic expert for ascertaining the mechanism, force, and type of trauma. Pelvic fractures offer key clues regarding the reconstruction of an accident, interval survived, and medico-legal assessment of the severity of trauma. Pelvic fractures, therefore, not only imply a medical emergency but also a medico-legal indicator for high-energy impact.

However, there are some gaps within the review studies that are brought to light. Though there is a focus on management as well as outcomes from the studies from the clinical perspective, there is a lack of proper forensic literature regarding the topic of pelvic fractures. Moreover, there is no interface between the trauma registers and the forensic records as well.

Future research should focus on:

1. Interdisciplinary databases integrating clinical outcomes of trauma with autopsy results from forensics.
2. Standardized protocols for morbidity outcome reporting, especially regarding long-term functional disability.
3. Comparing various regions, whether in low- or high-resource areas, to address issues in survival and morbidity rates.
4. Biomechanical and forensic modeling of patterns of pelvic fractures for enhanced accident reconstruction and legal analysis.
5. Collaborations of ethical-medico-legal significance, which ensure that medical record-keeping is supportive of patient

In conclusion, Pelvic fractures need a multidisciplinary approach, where innovation in the medical, investigative, and policy-cum-practical streams can be integrated effectively. Improvement in the level of integration among orthopedicians, emergency medicine experts, forensic experts, and public health professionals can

significantly improve survival rates, morbidity, and medico-legal standards.

Declarations

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Conflict of Interest Statement

The authors declare that there is no conflict of interest related to the publication of this manuscript.

Ethical Statement

As this study is a systematic review based exclusively on previously published literature, it did not involve direct participation of human subjects or animals. Therefore, approval from an Institutional Ethics Committee was not required. All included studies were reviewed in accordance with ethical principles, and due acknowledgment has been given to the original authors. The review was conducted in compliance with accepted standards of academic integrity and research ethics.

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