Osteomyelitis Following Distal Femur Fractures in Adults: A Systematic Review of Reported Incidence.

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Abstract

Background: Distal femur fractures occur in between 3 – 6 % of femur fractures and also account for less than 1% of all fractures. Despite being relatively uncommon, it presents a major challenge especially considering the risk of complications. Osteomyelitis is one of the complications with varied burden across different regions. However, there is paucity of synthesized evidence on the burden of osteomyelitis.

The purpose of this study was to review was the incidence or proportion of osteomyelitis following distal femur fracture treatment.

Methods: This was a systematic review conducted based on the PRISMA guidelines. The studies that were included in the study were published between January 2000 to present through searches in PubMed, Embase and Google scholar. The studies that were included in this review included randomized control trials (RCTs), cohort studies or case series on adult distal femur fractures reporting postoperative osteomyelitis or deep infection rates. Further we also included studies that were written in English-language full text availability. However, case reports, reviews, editorials, pediatric or periprosthetic fractures, and studies without infection data were excluded. A narrative synthesis of the data was performed, and the risk of bias was evaluated.

Results: A total of 99 studies were identified with 11 meeting the study inclusion criteria and thus were included in the study. The incidence rate of osteomyelitis varied significantly from 0.65% to 21% with higher incidence being reported among those with open fractures, male patients as well as those having underlying comorbidities. The studies included in this review were evaluated based on the Newcastle Ottawa Scale (NOS) and they ranged between 4 – 8 showing moderate quality and potential risk to bias mainly due to most of them being retrospective studies and limited follow up periods hence unable to conclusively document risk of osteomyelitis with increasing time after management.

Conclusion: Osteomyelitis incidence rate varies across different regions with literature showing that the incidence is higher among those presenting with open fractures, male and those presenting with comorbidities. However, the varying study designs and follow up period limit the overall focus on the extent of the existing burden. Thus, there is need for standardized definitions with key focus on follow up period of focus to help quantify the burden and develop better targeted interventions.

Background

Distal femur injuries are traumatic and involve a broader region extending from the distal the distal metaphyseal-diaphyseal junction to the articular surface of the femoral condyles (1). They account for between 3 -6 % of the femur fractures and less than 1% of all fractures (2). Diagnosis is mainly made through radiographic approaches mainly Computed Tomography (CT) which is utilized to assess the articular extension. Treatment of distal femur fractures is done mainly operatively with ORIF, intramedullary nail or replacement of the distal femur which is dependent on bone stock, age as well as patient activity needs. The management of distal fractures especially through surgical intervention is associated with increased risk of complication (3,4). One of the complications is osteomyelitis.

Osteomyelitis is defined as an inflammatory process which is characterized by progressive bone destruction. This bone infection is caused by microorganism invasion with staphylococcus being the common bacterial pathogen that is isolated from patients with either posttraumatic and hematogenous osteomyelitis. Osteomyelitis is grouped

into three key types which include posttraumatic osteomyelitis, hematogenous osteomyelitis and vascular insufficiency osteomyelitis (5). Posttraumatic osteomyelitis mainly results from an open traumatic fracture, skeletal surgery as well as during prosthetic joint replacement.

Hematogenous osteomyelitis is common in children as well as the elderly and defined by the spread of bacteria from a lesion to the bone through the bloodstream while osteomyelitis that occurs secondary to vascular insufficiency is more prone in patients with diabetes (6). Another type of osteomyelitis is chronic osteomyelitis which is progressive bone infection that occurs for more than 30 days. This is more common among patients with open fractures and have insertion of implants (7).

The burden of osteomyelitis varies significantly across different regions. The burden in the United States increased from 11.4 cases per 100, 000 people between 1969 and 1979 to approximately 24.4 cases per 100, 000 people between 2000 and 2009 showing an increasing trend (8). In Germany, the burden of osteomyelitis was found to have increased from 15.5 cases per 100,000 in 2008 to 16.7 cases per 100,000 people in 2018 resulting in a 10.4% increase (9). A study done in France showed a high burden of osteomyelitis revealing that 0.2% of all hospitalized patients in France exhibited bone and joint infection resulting in about 54.6 cases per 100, 000 illustrating a high burden of this condition (10).

In Israel, a survey of acute hematogenous osteomyelitis among Jewish individuals 5.2 cases per 100,000 from 2005 which rose to 7.3 cases per 100,000 in 2012 (11). Within the African context, a cross sectional survey done in Uganda revealed that the burden of osteomyelitis was 10% in orthopedic clinics highlighting a considerable gap of this infection among patients with orthopedic injuries hence presenting the need to build a more enhanced focus on osteomyelitis management from low income settings (12). In the Asian context, the annual incidence of osteomyelitis in Korea was 9.1 cases per 100,000 people. the burden of osteomyelitis has remained high with reports in China indicating that management is expensive with an average cost of 5400 euros (13).

Osteomyelitis remains one of the most severe complications resulting from distal femur fractures. This can essentially lead to longer hospitalization, repeated surgical assessment, non-union, implant failure as well as limb amputation in most severe cases. The rate of osteomyelitis has been observed to differ across different regions as well as individual patients due to underlying comorbidities, injury mechanism and available resources. The burden has been relatively low in high income settings which is described by high quality of care limiting severe complications. Middle and low resource settings have been greatly affected by poor health seeking behavior as well as constraint resources which limit access to care. This results into late hospital presentation which in turn has a greater influence on complications.

However, it is worth noting that despite the existing efforts to effectively quantify the burden of osteomyelitis, there exist paucity of data on standardized reporting on both the incidence and major outcomes in distal femur fractures. Few studies have synthesized this literature to provide a more detailed basis within which a proper review can be established and key gaps identified that can form a strong basis for further action in efforts to prevent adverse effects of osteomyelitis as well as its overall occurrence. Without harmonized evidence, clinicians and policymakers struggle to quantify the true incidence of osteomyelitis in distal femur fractures and its impact on union rates, reoperation, and functional recovery. Improving patient outcomes requires evidence-based practice where there is a proper understanding of the extent of the underlying problem. Thus, quantifying the burden of osteomyelitis across different parts of the world is crucial in contextualizing the problem and help define a more robust management plan. Distal femur fractures may at times require surgical management especially open fractures hence increasing the risk osteomyelitis. There is no synthesized literature on the incidence rate of osteomyelitis which is vital in having a global perspective of the problem. This presents the need for a detailed review of literature to help improve existing knowledge as well as gaps.

Methodology

Methodological Approach

The framework that has been adopted in this study aimed to ensure higher rigor, reproducibility and transparency in literature synthesis on the incidence of osteomyelitis and associated outcomes in adult distal femur fractures. This review utilized the PRISMA method to guide in its development.

This study utilized a systematic review approach to characterize the incidence and outcomes of osteomyelitis in distal femur among adults. The adoption of this design was to help provide a more comprehensive understanding on the incidence of osteomyelitis and outcomes to help understand the underlying gaps which would help inform future research across different settings. This review was performed based on the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA guidelines).

Protocol and registration

This review was not registered with PROSPERO.

Eligibility Criteria

This review utilized the PICO approach which was aimed to provide a broader understanding on population and condition of interest. The PICO components that were reviewed included population of interest, intervention, comparator and outcome.

Population

This review included studies involving adult patients (≥18 years) with distal femur fractures managed either conservatively or surgically.

Condition or Domain Being Studied

Osteomyelitis (deep bone infection) following management of distal femur fractures managed surgically or conservatively in adults.

Intervention/Exposure

This involve the different processes that were being investigated in this study. The studies that were included in this study were either of patients managed surgically or conservatively following distal femur fractures.

Comparator

In this review, there were no comparative groups although as part of the secondary objective of the study, we sought to compare the incidence between open and closed fractures and among different fixation methods. Thus, the comparative groups that were integrated in this review were the incidence rate of either open and closed. This will be done where the data available allows. This is essential because it helps understand the distribution of the osteomyelitis burden based on the type of injury.

Main Outcome

The main outcome of this review was the incidence or proportion of osteomyelitis following distal femur fracture treatment.

Inclusion Criteria

The studies that were included in this review included randomized control trials (RCTs), cohort studies or case series on adult distal femur fractures reporting postoperative osteomyelitis or deep infection rates. Further we also included studies that were written in English-language full text availability.

Exclusion Criteria

Case reports, reviews, editorials, pediatric or periprosthetic fractures, and studies without infection data were excluded.

Information Sources

The study will primarily abstract literature from PubMed, Embase, Scopus, Web of Science and Google Scholar. The reference lists will be hand searched and integrated into Zotero for synthesis and referencing. The primary database that was considered in this study was PubMed which served to ensure reproducible core although other databases were also included which ensured completeness of information being sort.

Identify MeSH Terms and Keywords

These are key terms that guided the search strategy to ensure that relevant data is included in the study.

Inclusion

Distal femur fractures

MeSH: "Femoral Fractures"[Mesh]

Keywords: distal femur, supracondylar femur, AO/OTA 33, periprosthetic distal femur

Osteomyelitis / infection:

MeSH: "Osteomyelitis"[Mesh], "Surgical Wound Infection"[Mesh]

Keywords: osteomyelitis, fracture-related infection, FRI, deep surgical site infection, bone infection

Population (Adults):

MeSH: "Adult"[Mesh], "Aged"[Mesh]

Keywords: adult, adults, elderly

Exclusions

Pediatric population and adolescents were excluded from this study.

MeSH: "Pediatrics"[Mesh], "Child"[Mesh], "Adolescent"[Mesh]

Keywords: pediatric, child, children, adolescent

Search strategy in PubMed

The following query was used in PubMed to extract relevant literature.

(("Femoral Fractures"[Mesh] OR "Femur"[Mesh] OR femur[tiab] OR femoral[tiab]) AND (distal[tiab] OR supracondylar[tiab] OR "distal femur"[tiab] OR "supracondylar femur"[tiab] OR "AO/OTA 33"[tiab] OR "periprosthetic distal femur"[tiab])) AND ("Osteomyelitis"[Mesh] OR osteomyelitis[tiab] OR "fracture-related infection"[tiab] OR FRI[tiab] OR "deep surgical site infection"[tiab] OR "bone infection"[tiab]) AND (adult[MeSH] OR adult[tiab] OR adults[tiab] OR "aged"[MeSH] OR elderly[tiab]) NOT (pediatric[tiab] OR child[tiab] OR children[tiab] OR adolescent[tiab] OR "Pediatrics"[MeSH]) AND ("2000/01/01"[Date - Publication] : "2025/12/31"[Date - Publication])

Time Frame and Language

The studies that were included in this review were from January 2000 to present. This was aimed to ensure a larger basis within which more key studies could be included in review and ensure a more comprehensive understanding of the burden of osteomyelitis among adult patients with distal femur fractures. Studies included were primarily English studies with available full text.

Study Selection

To ensure that studies included in the review meet the predefined criteria, a detailed screening process was instituted helping ensure detailed findings. The screening was done in two main stages with other stage being documentation of the findings. Stage 1 included review of the study titles and abstracts to ensure that it conformed to the set eligibility criteria which was incidence, prevalence or rate of osteomyelitis among distal femur fractures. The stage 2 in this review entailed extraction of full text which helped in ensuring the compliance with the underlying objective.

Data Extraction

This review used an extraction form which had a list of key indicators being assessed in this review. These indicators included authors names, year of publication, country of study, the study design, sample size, and study follow up duration. These components were essential in ensuring that quality data that meets the criteria is extracted.

Quality Control

Quality control was considered in this review. Several factors were considered to ensure quality review. These measures included dual extraction while cross checking to remove any duplicates.

Risk of Bias and Reporting Quality

STROBE Assessment

Observational studies were assessed using the STROBE checklist, covering:

- Clarity of objectives

- Study setting and participants
- Variable definitions
- Bias and confounding control
- Study size and statistical methods
- Descriptive and outcome data
- Key results and limitations

Bias Domains

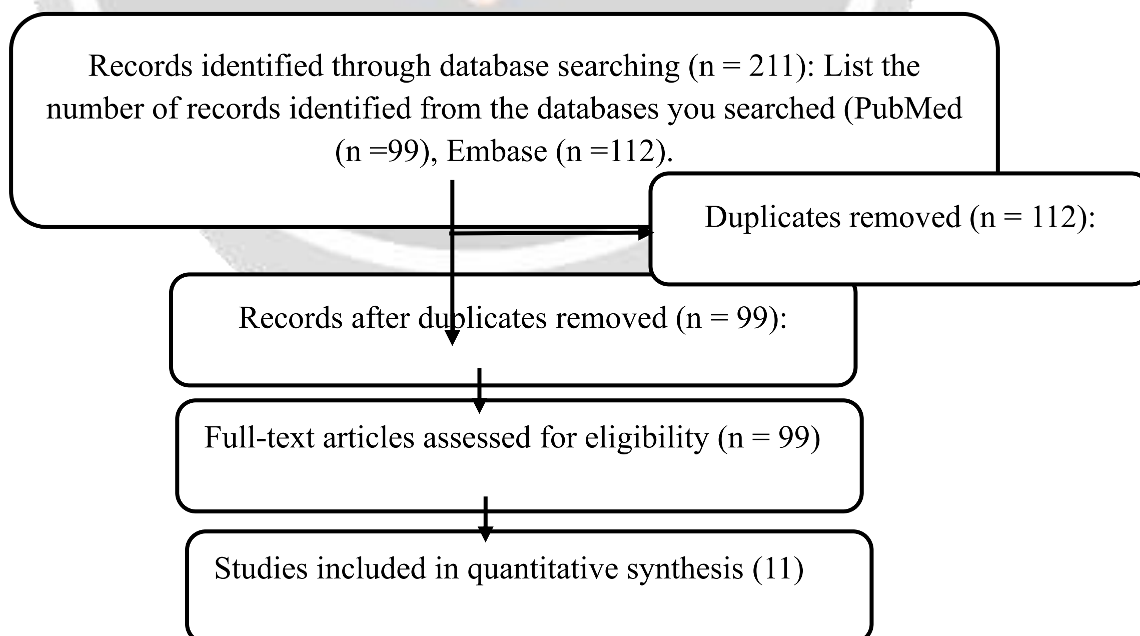
Risk of bias forms a key part of systematic review since it is vital to assess the level of evidence of the included studies. The Newcastle Ottawa scale was used to assess the risk of bias as well as quality of the study.

Data Synthesis and Statistical Analysis

To synthesize data in this review, a structured narrative synthesis was performed. The underlying study characteristics were summarized using descriptive tables which included author, year, country, design, sample size, fracture type, infection definition and follow up duration. The reported burden of osteomyelitis was extracted from the studies and presented as ranges. To ensure that the review incorporates quality studies, the NOS tool was used to rate the studies and help identify the existing limitations and strengths. The NOS tool has a maximum score of nine where higher score shows higher accuracy. Visual summaries were done using tables. Study characteristics were documented; incidence of osteomyelitis and the quality assessment tables were developed to help synthesize literature and understand the study objectives.

RESULTS

PRISMA flow diagram



Study characteristics

Table 1 as shown present a detailed review of the studies included in this review with a summary including author names, year of publication, country, study design applied, sample size and the follow up duration which are key characteristics that helps us to synthesize the literature on the subject matter. The designs varied from

retrospective cohort designs to observational studies and follow up timelines which ranged from 30 days post management to nine years which show a broad basis within which the incidence rate of osteomyelitis was being assessed. The studies obtained were from United States, Europe such as Kazakhstan and Germany, Asia such as China and Africa such as South Africa and Uganda.

Table 1: Study characteristics

Author	Year	County	Design	Sample size	Follow up duration
Venter et al. (14)	2021	Cape town, South Africa	A retrospective record review	80 patients	January 2016 and December 2018.
Tung et al.(15)	2025	Boston, United States	Retrospectively identified all patients (aged 18–50)	86 patients	Between 2006 and 2023 with ≥ 3-month clinical follow-up
Stanley et al.(12)	2010	Uganda	A prospective observational study	9354 operations conducted during a one-year period at the same five hospitals.	12 months
Lubega et al.(16)	2017	Uganda	A prospective cohort study	114 patients	Followed up for a maximum period of 30 days postoperatively between September 2014 and January 2015
Alazani et al. (17)	2025	United States	A multicentre retrospective study	A total of 93 324 adult patients were identified.	ICD-10 codes recorded between 1 January 2016 and 31 December 2023
Syliamova et al.(18)	2022	Kazakhstan	A matched case–control design was used	245 patients admitted to the National Scientific Centre of Traumatology and Orthopedics	From 2018 to 2020.

Lu et al.(19)	2019	China	A multi-center retrospective study	724 of patients who underwent ORIF for distal femoral fracture	From January 2013 to December 2017
Broke et al. (20)	2023	United States	A Multicenter retrospective cohort study	Patients with OTA/AO 33A or C distal femur fractures (n = 1107).	
Parkkinen et al., (21)	2016	United States	A retrospective observational study	A total of 655 proximal tibial fractures were treated with open reduction and plate fixation included in the study	Between 2004 and 2013.
Hanselmann et al., (22)	2021	Germany	A retrospective cohort study.	Patients with OTA/AO 41 B or C tibial plateau fractures (n = 2106).	
Spitler et al., (23)	2020	United States	Retrospective, case-control study.	150 patients with 43C Pilon fractures	A 5-year period with follow-up to bony union.

The incidence of osteomyelitis

Table 2 provide a detailed summary of the incidence rate of osteomyelitis as reported across various studies. The incidence was found to vary from 0.65% observed in a study done in Kazakhstan to 21% as reported in a study done in South Africa. Studies done in Low- and middle-income countries reported higher osteomyelitis burden compared to those done in developed countries. Further analysis revealed that the burden was higher among patients who had open fractures.

Common factors included open fractures, older age, male gender, and certain underlying medical conditions such as diabetes. These findings emphasize on the need to understand other patient characteristics which help predict the likelihood of developing complications following distal femur fractures.

Table 2: The incidence of osteomyelitis

Author	Year	County	Age	Gender	Type of fracture	Burden of osteomyelitis
Venter et al. (14)	2021	Cape town, South Africa	Mean age of 36.25 years (SD 13.39,	The final cohort consisted of		21% developed chronic osteomyelitis

			range 12 to 67)	80 patients, comprising 59 men (74%) and 21 (26%) women with a		following haematogenous spread
Tung et al.(15)	2025	Boston, United States	The median age was 34 years,	71% were male	42% had an open fracture	3.5%
Stanley et al.(12)	2010	Uganda				3.5% had osteomyelitis.
Lubega et al.(16)	2017	Uganda	The median age of the cohort was 26 years with an IQR of 29 years and range of 2 months to 88 years.	82 (74.5%) were males and 28 (25.5%) were females.		5.9%
Alazani et al. (17)	2025	United States	21% aged between 40 – 49 years; 21% aged between 50 -59 years and 24% aged between 60 – 69 years	59.9% were male		COM incidence rate over time (0.44–0.72 per 1000 patients recorded in the TriNetX database), with some indication of lower rates between 2020 and 2022
Syliamova et al.(18)	2022	Kazakhstan	Average age was 43.2 ± 14.5 years	56 (22.9%) female and 189 (77.1%) male patients who received surgical procedure as a treatment for fracture	Open 34 (13.9%) Closed 211 (86.1%)	The incidence of osteomyelitis was 0.65%
Lu et al.(19)	2019	China	46±16 years with 50% being aged 18 – 45 years, 36% being aged	56.1% were male	Open fractures (9%) and closed (91%)	The overall incidence of SSI was 4.0% (29/724), with deep SSIs being 1.5%.

			45 – 59 years			
Broke et al. (20)	2023	United States				There was a 7% rate (79/1107) of deep surgical site infection.
Parkkinen et al., (21)	2016	United States	The mean age of affected patients was 55 years (range, 16 to 84 years),	65% were male and 35% of patients were female.		The prevalence of deep surgical site infection was 5.2%
Hanselmann et al., (22)	2021	Germany				The rate of deep SSI was 4.5%
Spitler et al., (23)	2020	United States				The overall rate of deep infection was 16.7%.

Quality of Studies

The quality of the literature included in this study was assessed using the Newcastle Ottawa scale (NOS). The findings showed that most of the studies had moderate quality with scores of between 4 and 8 mainly due to design approach and sample size concerns, Retrospective nature of these studies and smaller sample sizes limit the overall quality of the studies. A study by Stanley et al achieved a higher rating of 8/9 which was attributed to its prospective study design, a large sample size of 9354 patients and a follow up period of 12 months. Studies such as Venter et al. (2021) and Tung et al. (2025) had lower scores due to smaller sample sizes and limited follow-up periods.

Table 3: Newcastle Ottawa rating of the study literature

Author	**Sample size**	**Follow up duration**	**NOS**	
Venter et al. (14)	80 patients	January 2016 and December 2018.	4/9	Uses a small sample size limiting the representativeness
Tung et al.(15)	86 patients	Between 2006 and 2023 with ≥ 3-month clinical follow-up	5/9	This study utilizes a small sample size which limits the representativeness and generalizability of its findings. However, it utilized a reasonable follow-up (≥3 months

Stanley et al.(12)	9354 operations conducted during a one-year period at the same five hospitals.	12 months	8/9	Large, multicenter, prospective design; strong representativeness; outcome assessment robust; 12-month follow-up excellent
Lubega et al.(16)	114 patients	Followed up for a maximum period of 30 days postoperatively between September 2014 and January 2015	6/9	Prospective design strengthens selection; outcome assessment clear; follow-up limited to 30 days (short for SSI outcomes); small sample size reduces external validity.
Alazani et al. (17)	A total of 93 324 adult patients were identified.	ICD-10 codes recorded between 1 January 2016 and 31 December 202	7/9	Very large sample, multicentre improves representativeness; retrospective limits exposure ascertainment; ICD-10 coding reliable but may miss clinical nuance; comparability not fully addressed.
Syliamova et al.(18)	245 patients admitted to the National Scientific Centre of Traumatology and Orthopaedics	From 2018 to 2020.	7/9	Case–control design with matching improves comparability; exposure ascertainment adequate; moderate sample size; follow-up period defined (2018–2020)
Lu et al.(19)	724 of patients who underwent ORIF for distal femoral fracture	From January 2013 to December 2017	6/9	Large sample, multicentre improves representativeness; retrospective limits exposure ascertainment; follow-up adequate (4 years); confounder adjustment not clearly described.
Broke et al. (20)	Patients with OTA/AO 33A or C distal femur fractures (n = 1107).		6/9	Large sample, multicentre; retrospective limits exposure ascertainment; outcome assessment adequate; unclear confounder control.
Parkkinen et al., (21)	A total of 655 proximal tibial fractures were treated with open reduction and plate fixation included in the study	Between 2004 and 2013.	5/9	Moderate sample size; retrospective limits exposure ascertainment; long follow-up (9 years window) but unclear patient-level tracking; comparability not addressed.
Hanselmann et al., (22)	Patients with OTA/AO 41 B or C tibial plateau fractures (n = 2106).		6/9	Large sample and outcome assessment adequate; comparability not well addressed.
Spitler et al., (23)	150 patients with 43C Pilon fractures	A 5-year period with follow-up to bony union.	5/9	Case–control design improves comparability; small sample size; follow-up to union adequate but narrow scope.

Discussion

The findings from this review have showed that the burden of osteomyelitis varies with some areas having a higher complication rate from distal femur fractures. This was evident from the results which showed a rate of between 0.65% to 21% which highlights the underlying challenges in management of distal femur fractures. Difference in management is evidenced by findings from different geographical regions. Studies done in advanced settings such as the United States and Kazakhstan reported lower incidence rates with 3.5% and 0.65% respectively. These findings illustrate that even though in some areas the risk is low, the burden is still noticeably high requiring proper and targeted management. Settings with advanced care ensure high quality management. However, in low- and middle-income settings, literature has showed alarmingly high risk of osteomyelitis which present the need for proper distal femur fractures management to control the risk of osteomyelitis.

The results have also showed that the variation of incidence has been associated with other factors such as type of fracture, patient clinical characteristics and gender. Open fractures had higher risk of osteomyelitis compared to closed. This is consistent with literature which highlights that open fractures are prone to infections and increased risk of complications hence should be accurately managed which is a challenge in low resource settings. However, synthesized literature has also showed higher burden of osteomyelitis among patients in United States with Broke et al. (20) reporting a 7% incidence with most of these fractures being open. Open fractures are at increased risk of osteomyelitis regardless of the study setting.

The present analysis also revealed that treatment modality plays a fundamental role in determining the risk of infections. Surgical fixation methods, such as open reduction and internal fixation (ORIF), are commonly used to treat distal femur fractures, but they carry an inherent risk of infection due to the need for hardware implantation. This is reflected in the higher rates of deep surgical site infections (SSI) observed in studies with operative treatment (e.g., Lu et al., 2019). In contrast, conservative treatment may carry a lower risk of infection but may not be suitable for all patients, especially those with displaced fractures or significant soft-tissue damage.

Further, underlying comorbidities, such as diabetes and immunosuppression, are known to increase the risk of osteomyelitis. This finding is consistent with the broader literature on osteomyelitis, where patients with diabetes have been shown to be at higher risk of developing bone infections following fractures. The study by Venter et al. (2021) emphasizes the importance of considering these comorbidities in the management of patients with distal femur fractures, as they can influence both the risk of infection and the healing process.

Limitations and Future Research Directions

This review presents a detailed and valuable insight into the incidence of osteomyelitis occurring in patients with distal femur fractures. However, it is worth noting the existing limitations which presents the need for a more advanced synthesis and research to help counter these issues to help define the underlying problem. Most of the studies were done retrospectively making it difficult to replicate and difficult to ascertain the definition used to assess the occurrence of osteomyelitis. This limits the generalizability of findings. Thus, future research should consider large multi-center studies with a clear follow up period to clearly document the incidence of osteomyelitis.

Conclusion

Studies included in this review have showed that osteomyelitis is a significant complication among patients with distal femur fractures which needs to be effectively assessed to help develop clear targeted control measures. Open fractures have been shown to significantly increase the risk of osteomyelitis in patients as well as underlying comorbidities. While the overall incidence appears to be relatively low in most studies, the consequences of osteomyelitis, including prolonged hospitalization, reoperations, and long-term disability, highlight the need for continued efforts to prevent and manage this complication.

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Conflict of Interest

There was no conflict of interest to address

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