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A Systematic Review on Long Bone Fractures: Analysis of Clinical Presentation, Management Strategies, and Patient Outcomes

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ABSTRACT

The femur, tibia, and humerus, all of which are long bones, are frequently fractured, especially among elderly people, which leads to a high rate of hospitalizations and an increased risk of mortality. Over 300,000 hospitalizations in the US every year due to femur fractures and with tibia and humeral fractures, the clinical manifestations and the multifactorial etiology should be well understood. The study in question is a comprehensive work that focuses on the clinical presentation of various bones and fractures and reveals the multifactorial etiology and risk factors that cause these injuries. Diagnostic evaluation methods ranging from conventional imaging techniques to more advanced modalities are evaluated in terms of their capacity to correctly assess fractures. Classification systems like AO/OTA and Gustilo-Anderson, as well as conservative and surgical treatments, are evaluated as per the current best practices and ongoing trends. This study identifies long bone fracture complications, such as non-union and post-traumatic arthritis. The patient outcomes, consisting of both challenges and triumphs in attaining the best recovery and quality of life, are put under a microscope. This study emphasises the urgency for a comprehensive management approach to tackle long bone fracture-related healthcare issues. In summary, as this research shows, long bone fractures pose a great healthcare challenge and stress the urgency of the integrated treatment approach. Through the recognition of clinical presentation, the cause, and most effective interventions, healthcare professionals can work toward a better prognosis and quality of life for patients with these fractures.

Keywords: long bones, humerus, tibia, healthcare, locomotion, surgical, lifestyle

INTRODUCTION

In the complex anatomy of the human skeletal system, the femur, tibia, and humerus can be viewed as stalwart pillars [1], which emphasize the strength and resilience of the system. On the one hand, these pillars are crucial for locomotion and daily functioning can be vulnerable to fractures [2-5]. Along with the myriad of cracks in these bones, those involving the hip or femur are associated with devastating outcomes, such as disability and early death, which typically accompany the injured people [6-8]. This situation demonstrates the need for a more profound comprehension of long bone fractures and the importance of well-thought-out management strategies to minimize the effects of these fractures on individual lives and health systems [1].

The magnitude of this problem becomes clear through the fact that more than 300,000 older people are hospitalized every year in the United States only because of femur fractures [8-9]. Furthermore, tibia fractures are quite common. However, the unpredictable nature of the trauma that accompanies these fractures normally leads to prolonged and painful recoveries, sometimes accompanied by complications [5]. The figure of 77,000 hospitalizations for tibia and fibula fractures that take place each year is considerable. Furthermore, the rising rate of humeral fractures among the older population also increases the pressure on the healthcare system, resulting in significant socioeconomic challenges [10].

In treating long bone fractures, current surgical techniques comprise a variety of procedures that include plating, external fixation, and intramedullary nailing [11-12]. Discussion about the most suitable treatment approach for femur, tibia, and humerus fractures is ongoing, and ORIF (open reduction and internal fixation) is the method of choice. ORIF is a process which includes the surgical realignment of the broken bone and the placement of an internal fixation device (e.g., screws, plates, rods, or pins) to stabilize the bone and promote ideal healing [5] [13].

While surgical interventions for long bone fractures are common, there are no clear outcomes and complication rates, which remain unidentified [11]. These consequences depend on a range of factors with fracture type, patient comorbidities, and surgical technique being among the most important.

Therefore, there is a crucial demand for developing a broad knowledge of the use of surgical treatment techniques vis-a-vis fracture anatomy and patient presentation [5]. Such knowledge will not only allow comparing the current patterns of care with the benchmark, but also to inform the stakeholders in the healthcare system, including payers, clinicians, manufacturers,

and above all, patients [11] [13]. This paper summarizes the types of long bone fractures, which include clinical manifestations, treatment strategies, and patient outcomes. The paper assesses the surgical and non-surgical treatments to create a basis for understanding the existing trends and the areas in need of improvement in managing the fractures and the social-economic burdens and preventive measures related to the long bone fractures. Primarily, the outcomes of the research are essential in the effort to create a comprehensive knowledge of long bone fractures, which makes it an indispensable resource for physicians, politicians, and other stakeholders who are involved in the management of fractures and public health issues.

METHODOLOGY

The literature survey was performed using credible sources such as PubMed, Web of Science and Scopus, and more. The search was implemented by using a variety of keywords, such as long bone fractures, clinical presentation, treatment, and results. The inclusion criteria included articles published in peer-reviewed journals, clinical trials, observational studies and systematic reviews that were related to long bone fractures in adult populations. Exclusion criteria comprised of papers having insufficient methodology, those published in non-English languages, and those entirely focused on pediatric populations. The research strategy was developed to capture a wide range of studies covering the multifaceted issues of long bone fractures to ensure the inclusion of only the best quality literature for analysis and synthesis purpose [figure 1].

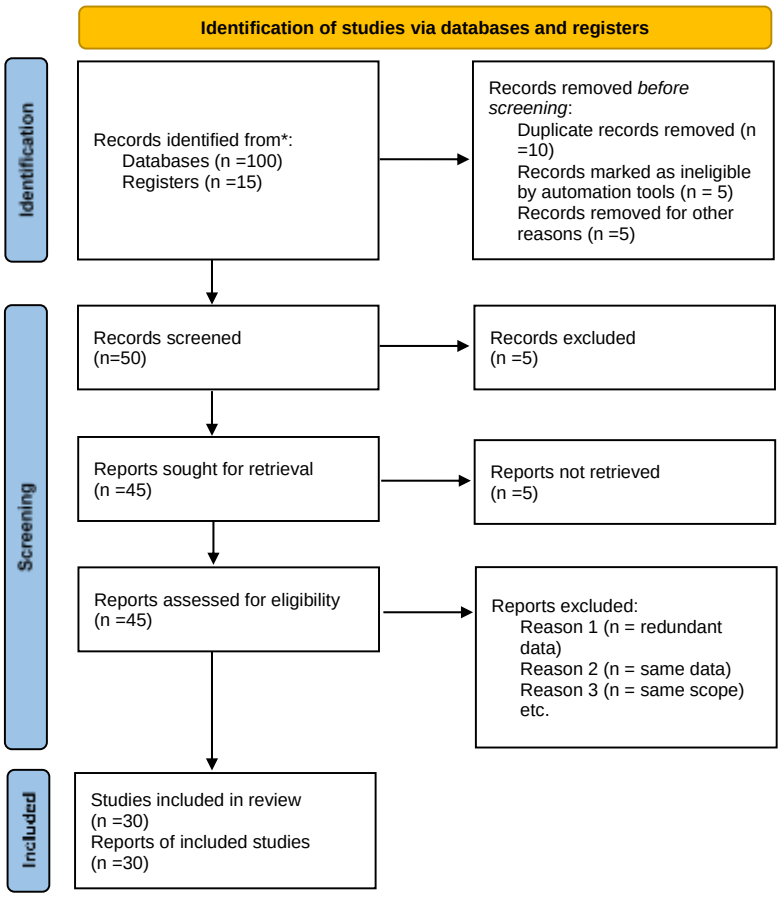

Figure 1: PRISMA flow chart

REVIEW

Femur fractures are a huge issue in a group of long bone fractures that has more than 300,000 hospitalizations annually in the US. This figure, which is quite shattering, shows the terrible impact of femur fracture on a health care system and individual wellness. An extremely notable correlation between age and femur fracture incidence rates has been revealed, showing the sharpest incline among people aged 65 years and older. This is a serious concern as it highlights the susceptibility of the older people to femur fractures that may be due to factors of aging such as low bone density and muscle weakness [1]. Tibia fractures are a major contributor to the overall burden of long bone fractures, which therefore require attention because of their high prevalence and associated morbidity. The incidences of tibia fractures are affected by several factors that are quite complex, including age, sex, and lifestyle [5] [14-26]. The Table 1 shows that just like in cases with femur fractures, tibia fractures tend to increase with age. On the other hand, the female population always has higher incidence rates than the male population in all the age groups as shown in the figure 2.

This shows that the gender-specific prevention and treatment strategies are of vital importance in reducing effects of tibia fractures.

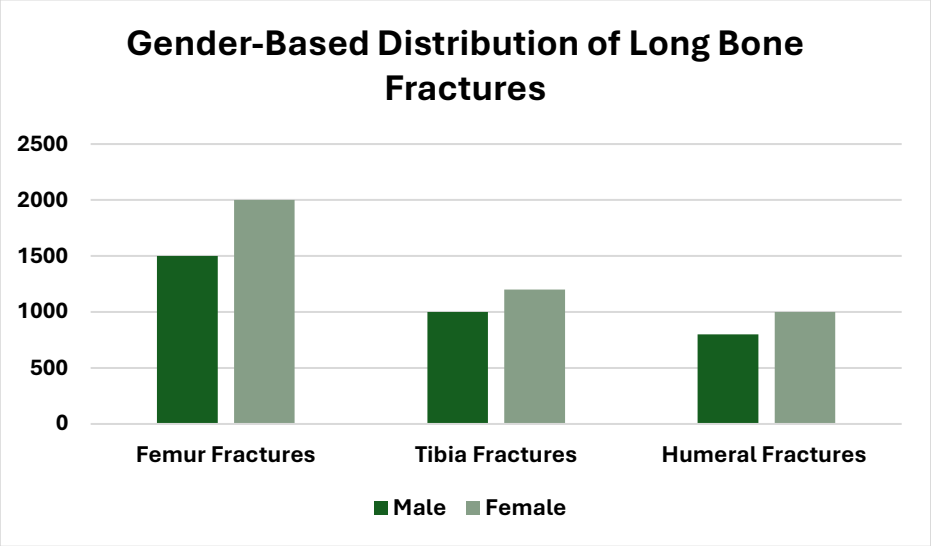

Figure 2: Gender-Based Distribution of Long Bone Fractures

Table 1: Incident Rates of Long Bone Fractures among Different Age Groups [5-12]

Age Group	Femur Fractures (Per 100,000)	Tibia Fractures (Per 100,000)	Humeral Fractures (Per 100,000)
65-74 years	1200	800	600
75-84 years	1800	1100	900
85+ years	2500	1500	1200

Humeral fractures, traditionally perceived as less severe, have witnessed an alarming rise in incidence rates among the aging population. This upward trajectory of humeral fractures adds another layer of complexity to the healthcare landscape, amplifying the socioeconomic burdens associated with these injuries. Analyzing figure 3, it is notable that individuals with a sedentary lifestyle exhibit higher incidence rates of long bone fractures compared to their active counterparts.

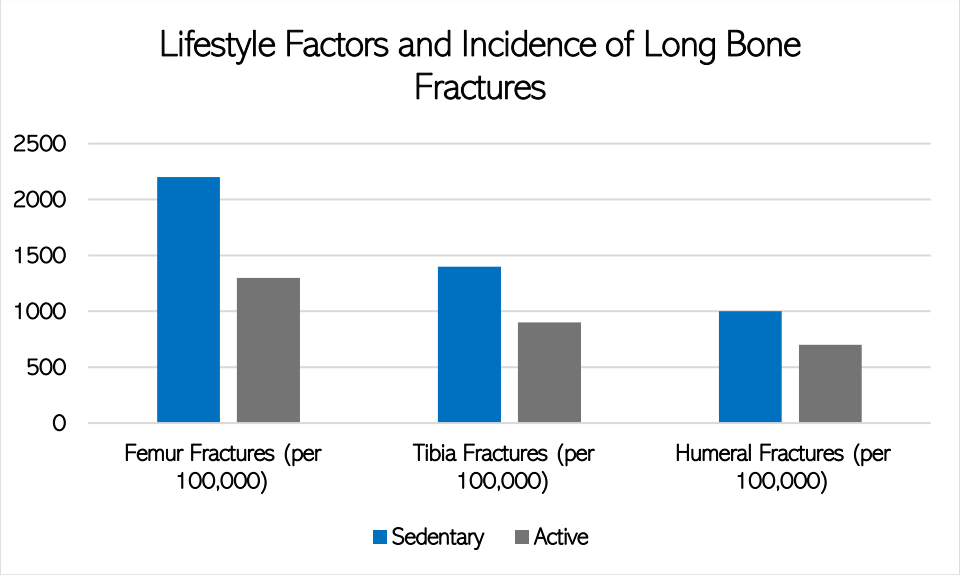

Figure 3: Lifestyle Factors and Incidence of Long Bone Fractures

Signs, Symptoms, and Variations in Presentation

In the clinical presentation of long bone fractures, there is a lot of variability because of a variety of factors including fracture type and grade, the mechanism of injury, and the demographics of patients [1]. The chief grievances are generally pain in the fractured region, swelling, deformity, and joint dysfunction. For instance, femur fractures caused by high-trauma energy may be accompanied by bruising, deformity, and non-weight bearing on the affected limb [27-28]. On the contrary, tibia fractures may be accompanied by pain and tenderness in the lower leg, swelling, and inability to fully extend or flex the knee.

The humerus, which is commonly broken during falls or direct blows to the upper arm, is often accompanied by pain, swelling, and a restricted range of motion of the injured arm [29-36].

Figure 4: Clinical Presentation of Long Bone Fractures

Diagnostic Evaluation and Classification Systems

In the case of a long bone fracture, the diagnostic process is a complex procedure that is of great importance for correct diagnosis and appropriate treatment planning. With the help of imaging modalities like X-rays, CT scan, and MRI a health care provider obtains detailed

information about where, how serious and what kind of fracture is involved. Such radiographic studies are invaluable in identifying the fracture alignment, configuration and any soft tissue injuries that then becomes a basis for the recommended treatment [37-49]. The clinical assessment confirms the imaging findings by assessing soft tissue damage and neurological function and ruling out any life-threatening situations like compartment syndrome or vascular compromise. The integration of imaging modalities with clinical assessment as a part of the diagnostic evaluation in healthcare facilitates healthcare providers to make well-informed decisions and to design customized treatment plans that, in the end, improves patients' outcomes and speeds up the process of recovery from long bone fractures.

Diagnosis of long bone fractures is an integrated process that is based on both the clinical assessment and imaging modalities to achieve the most accurate diagnosis and treatment of these injuries. All these imaging modalities are used under different circumstances and are chosen according to the clinical situation and the specific needs of the patient.

X-rays: X-rays are the most used imaging modality in the initial assessment of long bone fractures because they are affordable, easily accessible, and they give detailed information about the anatomy. X-rays have been detected that can give the doctors high quality images of the bones, thus allowing them to find the fractures, the alignment and other associated complications like dislocations or joint involvement [48]. X-rays are of great value as they clearly show bony structures; however, they are less sensitive to soft tissues and may miss the identification of delicate fractures.

Computed Tomography (CT): CT scans are indispensable imaging modalities for the complete evaluation of long bone fractures, especially in complicated or tricky cases. The CT scan provides a precise 3D image of the bone fracture and this helps to have a preoperative plan and guide the surgery. They enable a much more accurate representation of the shape and alignment of the fracture compared to plain x-rays. Nevertheless, the CT scan uses radiation that is the subject of a matter of concern, particularly in children and pregnant women. CT has another advantage of a clear visualization of bone structures, however, the differentiation between soft tissues might be a little bit difficult.

Magnetic Resonance Imaging (MRI): MRI, another advanced imaging method, is also used in evaluating long bone fractures, especially for assessing soft tissue injuries and intra-articular involvement. MRI offers the best soft tissue contrast, which makes it possible to evaluate ligamentous disruptions, cartilage injuries, and soft tissue edema associated with fractures in more complex ways [49]. It is especially useful in the diagnosis of occult fractures or in

detecting ligamentous injuries, or joint effusions among others. Nevertheless, MRIs are not as easy to access as x-rays and CT scans, and they usually have longer scanned time.

The clinical examination is complimentary to the imaging studies and involves a comprehensive physical exam to assess the extent of soft tissue damage, the status of neurovascular structures, and the associated injuries. This entails searching for symptoms of compartment syndrome, vascular compromise, and neurological deficits that may require immediate surgery. In addition, the pathophysiology of injury, patient history and presenting symptoms are thoroughly evaluated to decide on the best management approach.

The classification of long bone fractures is a key component of the system that is responsible for organizing and categorizing fractures based on various parameters, including anatomical location, severity, and mechanism of injury. These systems facilitate the exchange of information, they reach an agreement on treatment plan and predict patient outcomes in a uniform manner.

The AO/OTA classification system, which is the result of the combined efforts of the AO Foundation and the Orthopaedic Trauma Association (OTA), is one of the most widely used classification systems for long bone fractures. This is a method by which fractures are classified according to their site in the bone (e.g., proximal, diaphyseal, metaphyseal) and the amount of displacement or commitment of the fracture. The AO/OTA system of classification is the systematic way of naming the fractures for a common language of healthcare workers. This ensures consistent communication between them and facilitates treatment planning and optimal patient care. Moreover, this taxonomy system is a powerful tool for studying the fracture patterns and outcomes since it allows the same reporting of fracture patterns across different research projects.

Another popular classification is the Gustilo-Anderson system for open fractures. This system classifies open fractures into 3 categories, I, II, and III, based on the degree of soft tissue injury and contamination, from least to most severe. Through the Gustilo-Anderson classification, which grades the severity of open fractures, clinicians can determine the chances of complications, such as infection, and provide optimal wound management and antibiotic therapy. This categorization system is particularly useful in trauma settings where the timely and accurate evaluation of the open fractures is a vital factor in the process of the patient’s optimal outcome.

Table 2: Classification Systems for Long Bone Fractures [36-49]

Classification System	Description	Utility
AO/OTA	Categorizes fractures based on anatomical location	Standardized communication and treatment
Gustilo-Anderson	Stratifies open fractures based on soft tissue injury	Predicts risk of complications

Non-surgical and surgical approaches

Conservation treatment for stabilized injuries or those with minimal displacement is the primary reason for applying this type of treatment. The main aim of these measures is to ensure that the patient is stable and supported through the provision of supportive care that accelerates natural healing and reduces the risk of complications. The process of bracing a limb that is fractured is done by the application of splints, casts or braces which is meant to stabilize and realign the affected limb. As well as medications, such as analgesic drugs or physical therapy that will help the patient to feel more comfortable and to recover more quickly.

Immobilization has been proven as a non-surgical method whose primary purpose is to fixate the fractured limb by using stabilizers or any other technique to keep it in place so that there is no further displacement and the alignment is promoted. The most frequent method of immobilization of the bone is the use of splints, casts, or brace devices. The classification of the fracture dictates the methods used to reduce it. The prison has a target of relieving the pain, protecting the damaged limb from further injury, and preparing callus, which is the precursor to bone formation.

As opposed to traditional treatment options, supportive treatment strategies are intended to help patients manage their symptoms and create a healing environment instead. Pain management techniques like medication that has analgesic or non-pharmacological therapies like ice therapy and elevation to alleviate pain and decrease inflammation may be used for this. Consequently, the physical therapist may use passive range motion exercises and weight-bearing restriction modalities that aim at preserving joint mobility and preventing muscle wasting during the recovery process.

Functional bracing is the term for the application of a certain kind of orthotic equipment, which aims at providing support and stability to the fractured extremity and at enabling the patient to move partially and to have early mobilization. Unlike regular casts that hold the whole limb together, functional braces can be fine-tuned and allow for some limited motions

at the fracture site. The use of this method would be of great value for the prompt recovery and the eventual return to the normal state due to the lack of complications that arise from long bed rest periods.

Alternatively, if the fracture is minimally displaced or stable, an approach could be adopted, which would involve the patient being closely monitored for any indication of progression or any other complications. This means management is conservative enough, which is, it only recommends surgical intervention when rehabilitation is not possible without surgery. Follow-up appointments and imaging studies are scheduled on a regular basis and the recovery process of the patient is monitored and the best possible result is achieved.

If non-operative methods are insufficient or undesirable to deal with long bone fractures, then surgical treatment is required to restore anatomic alignment, stability, and to promote the best healing possible. Surgical methods are adapted to the general structure and intensity of the fractures, which are often achieved by means of open reduction and internal fixation (ORIF), external fixation, and intramedullary nailing [50-52].

Open Reduction and Internal Fixation (ORIF): ORIF (open reduction and internal fixation) is a type of osteosynthesis used to treat long-bone fractures that often occur in conjunction with large displacement and/or comminution. By means of the procedure, the exposed bone is cut open via the surgical incision (open reduction), and the pieces are put together in their anatomical right places. Following that, some fixation devices like plates, screws, or rods are applied to protect and to maintain the alignment of the fracture during the healing process. ORIF is a good method for visualization and manipulation of the fracture site to achieve accurate alignment and strong fixation [52]. What we are left with is an accelerated healing rate and complete function restoration. However, this technique provides a wide invasion of the site of fractures and higher rates of infections and nonunion.

External Fixation: External fixation is concerned with the application of appliances, called external fixators that are placed outside the body and hold the broken bone in proper position. These instruments are called the fixators, which are made of either metallic pins or wires that are inserted into the bone, above and below the fracture site. These are then linked to the frame that is external. External fixation is applied to provide stability and immobilization of the fracture and consequently allows the soft tissues to resolve from the swelling and the secondary healing to occur [50-52]. This will be very beneficial in the event of a trauma with severe tissue injury where either surgery cannot be done or it is not the best option.

Intramedullary Nailing: This technique is called intramedullary nailing, and it is the most common surgery to treat fractures that involve the bone shaft. The rod or nail that is made of

metal gets inserted into the fractured bone's medullary canal which provides the bone with the internal support and stability that it requires. The nail can be stabilized by locking screws at the ends of the fracture site from both sides to prevent both rotational and angular displacement. Intermediate nailing is a way to share the load between the bone and the implant [50-52]. Thus, it allows early mobilization and physiological weight-bearing that helps in the quick healing of bone fractures and stimulates the functional improvement of the patient.

The goal of surgery for long bone fractures strives for structural integrity of the fractured bone at the best healing possible and thus keeping the risk of complications like malunion or nonunion at a low level. The determination of surgical approach depends on the type of injury, the location of the fracture, the age and the general state of the patient, and the surgeon's preferences, ultimately to grant good outcomes and a quick recovery.

Complications and Rehabilitation

Fractures of long bones are among the most widespread musculoskeletal injuries, frequently necessitating diverse treatment approaches to prevent complications and facilitate the optimal healing process. In the next part of the chapter, we will address the postoperative complications of long bone fractures, such as delayed union, nonunion, and post-traumatic arthritis, as well as the rehabilitation protocols to restore function and mobility.

The complications of long bone fractures are very heterogeneous and can lead to malunion and disability. Some of the complications, like delayed union, which is a period of delayed healing beyond of the normal expected time is also another difficulty. Non-union means that the bone is not healing according to the expected phases, and pain and impaired function persist with the delayed recovery and a longer time to get back to a normal life. There are a few factors that can lead to the delayed union, namely, incorrect immobilization of the fracture, low blood flow to the injured area, presence of infections or patient-related factors such as smoking or bad feeding.

The worst-case scenarios may result into non-union situation, where the fractured bone does not heal properly. Laboratory work-up is as much of a problem as it is surgical intervention that is aimed to promote bone healing and stabilize the joint. Non-union is a complication that can happen for a variety of reasons, including severe soft tissue injury, infection, anatomical mispositioning, or patient-specific factors such as improper postoperative management. The management of non-union typically involves bone grafting followed by bone stimulation techniques or growth factors, all of which attempt to improve biological conditions at the fracture site and facilitate bone growth.

This type of fracture can be followed by post-traumatic arthritis owing to joint injury or misalignment. The path of post-traumatic arthritis encompasses a deterioration process of the joint tissues, which includes cartilage loss, osteophyte formation, and narrowing of the joint space [40]. This simple modification is often the reason for joint pain, stiffness and movement limitation, which when prolonged may affect the quality of life and ability to function. The prevention of post-traumatic arthritis involves prompt and proper diagnosis and treatment of joint injuries, correction of the joint alignment, and implementation of rehabilitation programs to restore functioning and movement.

Functional training is an integral component of the rehab process, which focuses on the activities of daily living and professional activities [47]. The activities include walking practice, step up and step down, and upper extremity strengthening exercises, which are customized to the unique requirements and goals of each individual. As a result of this task-focused training, patients are motivated to practice motor recovery skills in the functional tasks, providing an opportunity for them to transfer the tasks learned in the rehabilitation setting to real-life situations and enabling them to achieve independence and autonomy in their lives [33].

The outcome and quality of life of a patient with a long bone fracture may be greatly influenced by the level of severity, treatment modalities, and individual patient factors such as comorbidities. This is the part where we look at the recovery trajectories, long-term consequences, and the influence of the long bone fracture on the quality of life and getting back into activities.

The pattern of bone long fracture recovery can be highly variable and depends on many factors such as the fracture type, the presence of other injuries and the quality of treatment administration. Usually, the initial recovery phase is about acute pain, swelling and inflammation management, and then the weight-bearing and functional activities follow step by step tolerating. This stage that is essential for it includes rehabilitation which aims to bring back the range of motion, muscle strength, and joint stability, hence, to speed up the healing process and to enhance functional recovery.

The ways of dealing with fractures both by means of surgeries and rehabilitation can be improved but a long bone fracture still may have long-term effects that might negatively influence the patients' outcomes and quality of life. In addition to the common lasting consequences such as pain and stiffness that limit the range of motion, joint function may also continue to be impaired even after the healing of the fracture [34]. The factors that cause to take place for long-term sequelae are as follows: the initial injury severity, the presence of

other injuries like nerve and vascular damage and the development of complications such as non-union and post-traumatic arthritis.

Resuming activity after a long bone fracture may differ from one to another based on treatment outcomes, fracture severity and the patient's personal preferences and objectives. The situation may be different for various patients. Some of them may have a full recovery and be able to continue their pre-injury activities without any restrictions, while others may have permanent impairments or disabilities that require constant management and adjustments [39]. The time and scope of return to activities should be determined by a thoughtful evaluation of the functionality, the patient's goals and the possibility of reinjury or worsening of the existing symptoms.

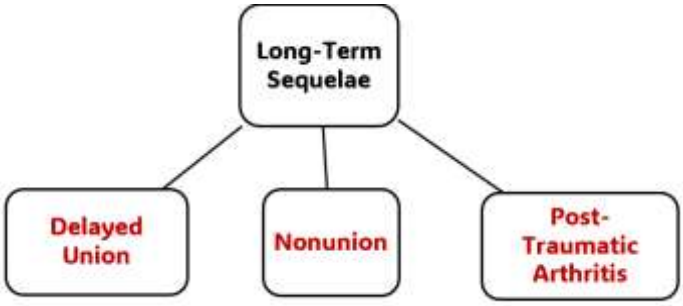

Figure 5: Long-term consequences of long bone fractures.

In essence, bone fractures of long bones can have a significant impact on the patients' outcomes and quality of their life, as the recovery pathways are influenced by a number of factors. Being cognizant of the physical, psychological, and social dimensions of rehabilitation is necessary to improve the quality of patient outcomes and to help them return to normal activities. Through the application of a multidisciplinary approach that is tailored to meet the specific needs and goals of each patient, healthcare professionals can help patients to overcome the challenges of recovery after fractures and achieve best long-term results.

The treatment of long bone fractures comprises many healthcare expenses, including hospitalization, surgeries, rehabilitation, and follow-up care. In addition to the direct medical expenses associated with long bone fractures are the costs for emergency room visits, hospitalization, doctor's consultations, diagnostic imaging, and surgeries. This cost can be further increased due to the need for prosthesis, physiotherapy and aftercare for complications such as infections or delayed union. In addition, the indirect cost associated with the long bone fracture includes the loss of productivity as well as the reduced earning capacity [30-40].

This is particularly true for long bone fractures which create a huge societal burden by increasing the medical costs, decreasing productivity, and, thus, contributing to health disparity [47]. These endeavors are doomed to failure if stakeholders do not come together to enhance access to healthcare, eradicate disparities, and to improve the quality and the efficiency of fracture treatment. Through employment of a comprehensive approach, manage fractures, healthcare systems can lessen the societal and financial burden associated with long bone fractures as well as improve the patients and communities' outcomes [23].

DISCUSSION

An in-depth analysis of long bone fractures involves various facets of fractured epidemiology, complex clinical management, and social and economic implications. Femur, tibia, and humerus fractures are the ones that have the most significant impact on the healthcare system and adult population. In particular, the data on femur fractures shows a strong age-related tendency where the number of cases doubled between individuals older than 65 years and those younger. The high incidence of fractures among the elderly underlines the necessity of focused prophylactic actions and specialized care for the elderly to reduce the occurrence of fractures and improve the health outcomes. Furthermore, the gender-specific disparities in fracture incidence (for instance, the tibia fractures where females always exhibit higher rates across all age groups) underscore the need for gender-tailored prevention and treatment [5] [7]. The mastering of the epidemiological particulars of long bone fractures is vital for the development of competent public health plans aimed at curbing the overall burden of these injuries and improving the quality of life of those who have undergone them.

Clinical manifestations and diagnostic investigations are the cornerstones of fracture treatment, determining the course of action and the patient's outcome. The presence of many signs, symptoms, and the complexity of classification system of the fractures demand for a cohesive approach that combines radiological modalities and clinical examination. AO/OTA classification, which is widely recognized for its systematized categorization of fractures by means of anatomical features and severity, enables the standardized communication among all the healthcare professionals and optimizing the treatment plan [5] [33-35]. On the other hand, the evolution of diagnostic techniques, for example, computer-assisted surgery, is the one that may bring the surgeons to the point where the surgical precision would be increased and the risk of malalignment, as well as implant-related complications, would be reduced.

Surgical and non-surgical approaches for the treatment are two sides of the same coin that highlights the significance of personalized care that matches the unique qualities of each fracture [12]. Consequently, surgical procedures such as open reduction and internal fixation (ORIF), external fixation, and intramedullary nailing have been proven as a safe and effective approach for restoring anatomical alignment and stability; nevertheless, minimally invasive techniques like percutaneous fracture reduction and minimally invasive plate osteosynthesis (MIPO) could be the next step in the evolution of surgical [48].

Nevertheless, various treatment development strategies have been introduced, but still there are many problems to be solved such as delayed union, nonunion, and post-traumatic arthritis that bring difficulties to rehabilitation and long-term outcomes [3-6]. The economic ramifications of fractures (these are diseases characterized by escalating healthcare costs, productivity loss, and disparities in access to care) are a reminder that interventions that target both clinical and social aspects of fracture management are needed. Thus, this discourse deciphers the complex interplay between epidemiological trends, clinical management approaches, and the social and economic implications of long bone fractures [4] [49]. The main task for key players is to develop a multidisciplinary approach that will incorporate clinical care, research, public health programs, and policy to effectively reduce the burden of fractures, improve patient outcomes, and minimize the risk of fractures in diverse populations**.**

CONCLUSION

Traumatic bone injury of the long bones, such as the femur, tibia, and humerus, are crucial public health problems, particularly in the elderly population. Work has been comprehensive research of the different segments of a long bone fracture, including clinical presentation, management approaches, patient results, and social economic consequences. The fact that femur fractures, which are usually associated with severe hospitalizations and high mortality rates, are becoming more and more common among the elderly is undeniably one of the factors that put the healthcare systems around the world under extreme pressure. Diagnostic evaluation tools including conventional X-rays and advanced imaging methods such as CT or MRI are essential for accurate diagnoses and determining appropriate treatment options. The AO/OTA and Gustilo-Anderson systems, as a classificatory framework, are useful classifications of fractures by anatomical features and soft tissue involvement, which eventually promote communication standardization and treatment planning. Surgical techniques i.e. open reduction and internal fixation (ORIF), external fixation, and intramedullary nailing are the mainstay of treatment of complex fractures that help in

anatomical alignment and stability. The novel approach and minimal invasive techniques promise the better results and fewer complications, so research and innovation in the sphere of orthopaedic practice are necessary steps. Complications like delayed union, nonunion, and post-traumatic arthritis are the ones that make it necessary to have the complex rehabilitation protocols to help the patients improve functional outcomes and quality of life.

Socioeconomic barriers to orthopaedic care and the extremely high medical bills that follow from long bone fractures underline the importance of prevention and public health programs. Finally, the injury prevention programs, educational campaigns, policy measures, and community actions must be implemented so that the risks of fractures can be reduced, bone health can be improved, and there will be a well-being in the society. Whereas healthcare problems related to long bone fractures, require the integration of clinical care, research, public health, and legislative interventions. By the application of evidence-based approaches, the engagement of all sectors and implementation of preventive measures, we will be able to target the impact of long bone fractures and enhance the recovery of those who suffer from them.

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