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SUMMARY OF THE DOCTORAL THESIS
The recovery prognosis in periprosthetic fractures of the hip

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List of articles published on the topic of the thesis

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Niculescu, V.; Nistor Cseppento, D.C.; Tirla, S.; Osser, B.; Aur, C.; Mocuta, D.; Popescu, G.I.; Necula, R.D. A Retrospective Study on the Incidence of Periprosthetic Fractures Related to Total Hip Arthroplasty and Postoperative Complications During Hospitalization. *Clin. Pract*. **2025**, *15*, 42. https://doi.org/10.3390/clinpract15030042	Article	2.2/WoS, Q2 Pubmed
Niculescu, V., Ene R., Dimitriu A.L., Tirla S., Marge C., Pop M.G., and Necula R.D., Assessment of frailty, performance, and functional independence in patients with periprosthetic fractures associated with total hip arthroplasty. Balneo PRM Res. J ***2024***;15(4):758 Full Text DOI 10.12680/balneo.2024.758	Article	1.1/WoS, Q3
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INTRODUCTION

The doctoral thesis "The recovery prognosis in periprosthetic fractures of the hip" represents a scientific approach to evaluating the incidence of periprosthetic fractures (PF) in patients undergoing total hip arthroplasty (THA), along with the complications that occurred in the immediate postoperative period and their impact on patients' quality of life.

Several factors determine the increase in the demand for arthroplasties worldwide: on the one hand, the aging of the population, on the other hand, the sedentary lifestyle and obesity; these factors contribute to the deterioration of the joints, determining the increase in the incidence of degenerative diseases. Technological advances and surgical techniques have made arthroplasties more effective, with faster recovery and a longer lifespan of the prostheses. Also, people have become more aware of the options available for the treatment of joint pain and, in many regions, have better access to surgical interventions [1].

Hip PF is a postoperative complication that occurs after the implantation of a hip prosthesis, or most commonly, as a result of a fall or minor trauma. These fractures are a significant concern in orthopedic surgery, given their impact on the quality of life of patients by affecting physical performance and functional independence, as well as the cost of treatment. Femoral PF associated with ATS, introduced in 1954, has had an increasing incidence due to the expansion of indications and increasing life expectancy, with age representing a significant risk factor, especially due to osteoporosis that is associated with advanced age. The overall incidence of these fractures varies from approximately 4% [2] to 15% (according to some national registries) [3]; they are more common in uncemented ATS and in revision of the prosthesis. Late PF constitutes 6% of revisions, being the third leading cause of surgical intervention, after aseptic loosening and infection. These PFs can be classified into intraoperative and postoperative fractures. The intraoperative ones can be determined by the femoral rod insertion maneuver, especially in the case of non-cemented rods. The study published by H Lindahl (2007) suggested an incidence of PF between 3.6% and 20.9% [4].

The treatment of these fractures is complex; non-operative methods, such as traction, have had poor results, while surgical intervention allows early mobilization and shorter hospital stay, reducing the risks of systemic and local complications [2]. Treatment is correlated with the classification of PF (according to the level of the lesion and the stability of the prosthesis). Historically, PF classifications have been based mainly on anatomical location, implant stability

and surrounding bone quality. 25 classification systems have been developed; two of these, such as the Vancouver System (VCS) and the Unified System (UCS), were most appreciated for their simplicity and effectiveness, but require improvement. The VCS, created in 1995, classifies fractures based on location, implant stability, and bone quality, and is still widely used due to its robustness. In 2014, the UCS extended the VCS to include all PFs, providing universal applicability. However, these systems have limitations, such as incomplete coverage of all types of fractures and inaccurate assessment of stability and bone loss, which may lead to misclassifications and suboptimal treatments [3].

Therapeutic objectives are defined within a multidimensional concept that takes into account physical and psychological discomfort, mobility and functional capacity, reduction of pain and other symptoms, preserving the ability to perform daily activities (ADL - Activities of Daily Life) and to actively participate in family and social life.

The work is structured as follows:

- The general part, entitled **CURRENT STATE OF KNOWLEDGE** (Chapters I-II), presents data from the specialized literature regarding the current state of knowledge about total hip arthroplasty and types of endoprostheses and the biomechanics of the prosthetic hip. Chapters III – V include the definition, incidence, risk factors, clinical, paraclinical diagnosis and treatment principles of periprosthetic fractures associated with total hip arthroplasty;

- The special part, entitled **PERSONAL CONTRIBUTIONS**, contains the working hypothesis, general research objectives, study design, results of the four studies, conclusions, contributions and originality of the thesis, structured in 6 chapters (chapters VI-XI).

PERSONAL CONTRIBUTIONS

CHAPTER VI. RESEARCH METHODOLOGY

VI.1. Working hypotheses/objectives

The PhD thesis explores two central hypotheses regarding the evolution and impact of health problems related to the occurrence of ATS-associated PF.

- The first hypothesis highlights the fact that the increase in the life expectancy of the population, combined with the increase in the number of patients with degenerative joint diseases, increases the number of arthroplasties in medical practice and, at the same time, the prevention of PF associated with them.
- The second hypothesis focuses on the concept of frailty, a syndrome characterized by the reduction of physical, psychological and social reserves of the individual, which makes him more vulnerable to stresses and adverse events in the historical context of periprosthetic fracture.

The objectives of this PhD thesis were as follows:

1. Evaluation of research trends and directions regarding the prevalence of PF associated with ATS in the context of increasing life expectancy, through a bibliometric analysis of scientific publications at the national and international level, in order to verify the hypothesis that their prevalence increases with the aging of the population.

2. Evaluation of frailty in patients with PF associated with ATS, starting from the hypothesis that the level of frailty and its impact on the patients' quality of life is higher than in patients with primary ATS.

3. Determining the frequency and types of immediate post-surgical complications in ATS-associated PF.

4. Assessment of mortality and risk factors associated with periprosthetic fracture surgery.

5. Retrospective analysis of the incidence of periprosthetic fractures, complications and comorbidities in patients from various medical centers in Romania.

6. Investigation of the relationship between preoperative comorbidities, assessed by the Deyo-Charlson index, and the occurrence of immediate postoperative complications.

These objectives seek a comprehensive understanding of the phenomenon of periprosthetic hip fractures, risk factors and clinical and social consequences, contributing to the improvement of prevention and treatment strategies in this pathology.

VI.2. Research design/patient selection

Study I. To pursue the objectives of the bibliometric analysis study, we used the Web of Science (WoS) database, due to the fact that articles of high scientific value are indexed in this database and, moreover, their citations are quantified. The keywords used were "periprosthetic hip fractures" and "incidence". Data were collected on the authors who published articles on the topics covered, the journal and year of publication, the organizations interested in the topic.

Study II. A retrospective observational study was conducted between January 1, 2021 and December 31, 2023. From a total of 768 patients who underwent hip surgery - primary ATS, total/partial revisions and internal fixation surgeries at the Bihor County Emergency Hospital in Oradea (Group H), we selected cases that involved PF associated with ATS. In order to mitigate selection bias, we took steps to ensure rigorous case selection and complete data collection. In total, we identified 38 cases that required therapeutic management for this diagnosis, referred to as the PF Group.

Study III. Between January and October 2024, a cross-sectional study was conducted in the Ploiești County Hospital to evaluate the incidence of frailty, performance and functional independence in patients with PF associated with total hip arthroplasty. For the comparative evaluation, patients with stage III and IV coxarthrosis (preoperative status), patients with total hip arthroplasty at least 3 months after the prosthesis, patients with a diagnosis of periprosthetic fracture associated with total hip arthroplasty (Vancouver stages A, B, C) at least 3 months after the fracture treatment were recruited.

A total of 125 consecutive patients with the mentioned hip osteo-articular pathology were evaluated for inclusion in the study.

Study IV. Between January 1 and December 31, 2024, a retrospective observational study was conducted that evaluated 54 patients with PF hospitalized in three hospitals in Romania: Bihor County Emergency Hospital, Ploiești County Emergency Hospital and Bucharest Clinical Emergency Hospital. Patients were classified according to the hospital to which they were referred, resulting in three groups:

- Group B - patients belonging to the Bucharest Emergency Clinical Hospital;
- Group O - patients who were referred to the Bihor Emergency Clinical Hospital;
- Group P - patients who were treated in the Ploiești County Emergency Hospital.

VI.3. Study instruments

Patients enrolled in study II were assessed using the Edmonton Frail Scale (EFS) questionnaire. The frailty questionnaire, EFS, (translated by an authorized translator) assesses nine dimensions that characterize the quality of life of patients and are associated with frailty (knowledge, general health, functional independence, social support, medication use, nutrition, mood, continence, functional performance) [5]. Each of the assessed domains is scored from 0 to 2 (0 - best performance and 2 - significant impairment). The total score ranges from 0 to 17; values below 5 indicate no frailty, 6-7 express pre-frailty, 8 and 9 indicate mild frailty, 10-11 moderate frailty. A value greater than 12 indicates severe frailty.

The evaluation of patients in studies III and IV focused on the type of prosthesis, surgical technique, risk factors, comorbidities, complications (according to the Clavien-Dindo classification) and postoperative evolution during hospitalization.

The recruited patients received specific medication for associated comorbidities, which included antihypertensives, diuretics, hypoglycemics and anticoagulants (administered postoperatively). They also received antiresorptive drugs, vitamin D and chondroprotective drugs. For neurological conditions, patients were prescribed specific treatments, including antiepileptics (e.g., gabapentin, n = 10), neurotrophic vitamins (vitamins B, n = 10), antiparkinsonian (n = 2) and psychotropic (n = 2) drugs and antidepressants (n = 4). All patients were retired and their daily activities mainly involved self-care and household chores. The Clavien-Dindo classification classifies postoperative complications according to their severity, especially those that may be life-threatening or lead to permanent disability. This classification is divided into five grades, as summarized in Figure 14 [6].

The Charlson Comorbidity Index (CCI) was used to quantify comorbidities. Comorbidities were grouped according to previous clinical decisions to simplify the analysis, including cardiac disease (myocardial infarction, heart failure), peripheral vascular disease, cerebrovascular disease, hemiplegia/paraplegia, moderate to severe renal disease, peptic ulcer, chronic obstructive pulmonary disease, diabetes (with or without impairment), and various types of cancer, as well as other conditions (dementia, liver disease, AIDS). Each item is scored from 0 to 6, depending on the stage and severity of the disease (2 points are added for a localized tumor and 6 points for metastasis). The maximum possible score is 37, and the score is adjusted for age. To determine the CCI score, we used an online calculator [7]. To optimize data quantification, we established three

levels of comorbidity severity: Mild CCI scores between 0 and 3 ($0 \leq$ CCI scores < 3), moderate CCI scores between 3 and 5 ($3 \leq$ CCI scores < 5), and severe CCI scores of 5 or higher (CCI ≥ 5). These classifications help to understand more clearly the severity of comorbidities [8, 9].

VI.4. Ethical approval

The study was conducted in accordance with the guidelines of the Declaration of Helsinki of the World Medical Association and received the approval of the ethics committee (nr. 35964/21/11/2024, nr. 296/15.01.2025, nr. 54150/31.10.2024).

VI.5. Statistical analysis

Microsoft Excel 2019 was used for the fundamental processing of the bibliometric analysis data; the graphs to highlight the collaborations between authors, journals, countries were generated with VoSviewer (version 1.6.20, Leiden University, The Netherlands). The size of the bubble generated by the program is correlated with the number of published articles, which suggests that countries with a higher research output are represented by larger bubbles. International collaboration is illustrated by a curve, the thickness of which indicates the intensity of this collaboration; the thicker the curve, the closer the collaboration between countries. The color of the bubble indicates the cluster to which each country belongs, and the cluster is defined by the countries that publish papers together.

The citation map, along with journal publication year information, was generated using the same program. The color of the bubble reflects the publication year of the papers, and the size of the bubble is proportional to the total number of papers published in the respective journal. The color palette, which ranges from dark blue to yellow, provides a temporal representation of the articles. Darker shades of blue indicate early publications, while lighter shades, including yellow, indicate more recent publications.

CHAPTER VII. BIBLIOMETRIC ANALYSIS ON THE INCIDENCE AND RISK FACTORS OF PERIPROSTHETIC HIP FRACTURES

1. Introduction

The study aimed to evaluate the prevalence of periprosthetic hip fractures, starting from the hypothesis issued by Della Rocca et al. that it will increase with increasing life expectancy [10]. For this purpose, we performed a bibliometric analysis, which has the role of "organizing, classifying and evaluating" scientific publications at different levels (institutions, country, world), thus we will try to verify the hypothesis from which we started.

2. Results

2.1. Publication results and time trend

Between 1991 and 26.09.2024, 3202 publications related to PF were identified (2806 articles and 298 reviews), classified in 74 categories (74.89% orthopedics and 31.49% surgery). After applying the filter regarding the incidence of hip PF, the number of publications was reduced to 513, for the period 1992-26.09.2024. (474 articles and 57 reviews).

Of the 48 contributing countries, the first places are occupied by the USA (36%), the Republic of China (10.6%) and Germany (0.09%). Romania occupies the 28th place in this ranking.

The summary of results is included in Figure 1.

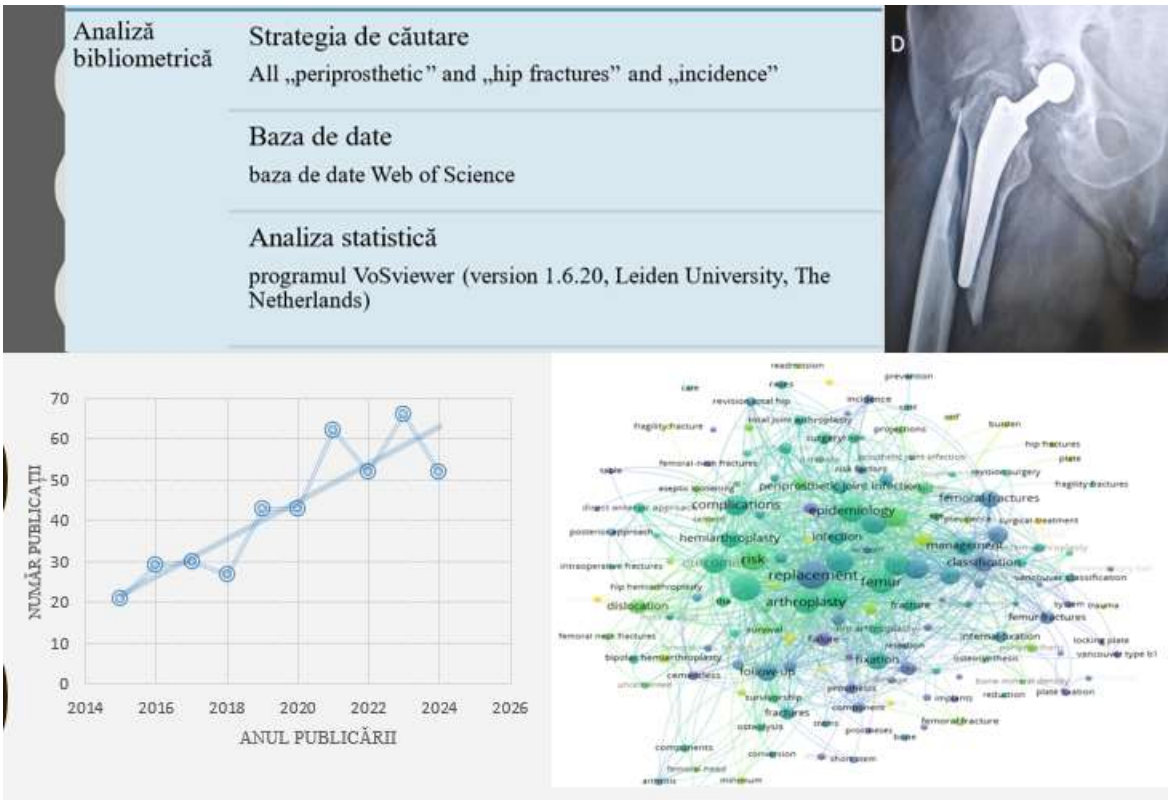

Figure 1. Summary of results.

3. Conclusions

The interest regarding the incidence of periprosthetic hip fractures is not constant; the United States and the Republic of China have proven to be the most prolific countries, as shown by the bibliometric analysis performed. To improve clinical outcomes and decrease the incidence of these complications, it is essential that orthopedic physicians be aware of the risk factors and implement appropriate preventive measures, including rigorous preoperative evaluation and correct surgical techniques. Continued education, research, and collaboration within the orthopedic community are necessary to advance knowledge about these fractures and improve the management of affected patients.

CHAPTER VIII. RETROSPECTIVE STUDY ON THE INCIDENCE OF PERIPROTHETIC FRACTURES ASSOCIATED WITH TOTAL HIP ARTHROPLASTY AND POSTSURGICAL COMPLICATIONS DURING HOSPITALIZATION

1. Introduction

Periprosthetic fractures (PFs) are serious complications that can occur after total hip arthroplasty (THA), particularly in elderly patients who often have multiple comorbidities and low bone density. Surgical treatment of PF usually involves internal fixation or revision arthroplasty, depending on the fracture type as classified by the Vancouver classification. Immediate complications reported in specialized literature include those at the wound level associated or not with infection (superficial or deep), with an incidence below 15%, deep thrombosis (1.3%), pulmonary embolism (0.7%); sciatic paralysis is a neurological complication that can occur in 1.3% of cases. Other reported complications are prosthesis dislocation (6.0%) and refracture (10.0%) [11]. The risk of deep periprosthetic infection is 1%, with serious long-term consequences [12]. The mortality associated with PF, during hospitalization, is below 2.5%; the mortality risk increases percentageally (at 30 days approximately 3.5%, at 90 days 4.8% and at one year 13.4%), according to the data published by J. N. Lamb in 2022 (n=4841); the incidence is higher in the elderly over 85 years old with a low functional reserve. No differences were reported depending on the type of intervention [13].

This study examines the annual incidence of PF and complications occurring during hospitalization, as well as the predictive role of age in the occurrence of these fractures and their associated complications.

2. Results

The average age of 65.77±10.4, belongs to the regression age (transition to old age). Approximately 75% of patients are over 60 years old. Over 50% of patients come from rural areas. The evaluated clinical parameters were hypertension (54.4%), chronic kidney disease (55.72%), lung disease (6.38%), chronic venous disease (16.80%), obesity (45.70%), vitamin D deficiency (13.90%).

Out of the total of 95.30% patients with associated pathology, 35.50% have two associated comorbidities and 40% have more than 3 associated comorbidities. The average number of associated comorbidities in the evaluated cohort is 2.26 ± 1.22.

Primary total hip arthroplasty was performed in approximately 90% of patients (Table 4); the total number of prosthesis revisions was 69 (8.98%), of which total revision was performed in 7.55% of the recruited patients. Of the 768 patients with ATS, 169 (22%) had bilateral prosthesis. A percentage of 70.05% followed treatment with internal fixation and cerclage; modular revision was carried out in one patient (2.63%), respectively total revision was required in 24.69% (9 cases). 7.90% of patients required surgical interventions, without anesthesia (debridements determined by wound infections), 4 patients required treatment for phlebitis; the majority of patients treated for PF required no specific treatment (approximately 74%). Death occurred in a proportion of 7.90% (3 patients), determined by massive digestive hemorrhage, acute liver failure, metabolic acidosis. It is noted that the death of the 3 patients is associated with an average age of 75 years; likewise, grade 3 complications are also associated with advanced age (over 70 years).

Future directions

Contemporary periprosthetic fracture management strategies focus on both preventive measures and advances in implant technology. Innovations in prosthesis design aim to improve load distribution and reduce the risk of bone stress related to osteoporosis,

which can compromise bone integrity and increase fracture susceptibility [14]. The study published by F. Washburn et al. (2023) [15] suggests the importance of coronal valgus alignment. A misalignment of over 3 degrees is a risk factor for PF [15]. These efforts represent significant progress in improving clinical outcomes and decreasing periprosthetic fracture incidence.

3. Conclusions

This study indicates that the incidence of these fractures fluctuates over time. Minor complications occur frequently during hospitalization. It is concerning that older women are more likely to suffer both periprosthetic fractures and complications related to their treatment. Furthermore, it is important to recognize that age is a significant predictor of periprosthetic fractures associated with total hip arthroplasty. Given the debate in the existing literature regarding risk factors for PF, we advocate continued efforts to perform quantitative analyzes aimed at optimizing risk factor screening in patients undergoing total hip arthroplasty (THA) to help prevent PF. Such studies could provide valuable information to optimize femoral preparation techniques during surgery, with the ultimate goal of reducing the incidence of fractures in this patient population.

CHAPTER IX. ASSESSMENT OF FRAILTY IN PATIENTS WITH PERIPROSTHETIC FRACTURES ASSOCIATED WITH TOTAL HIP ARTHROPLASTY

1. Introduction

Definitions of frailty vary, but usually include clinical criteria such as decreased muscle strength and mass, fatigue, reduced physical activity, impaired mobility, and poor general health [16]. In most studies, frailty is associated with an increased risk of falls, hospitalizations, functional disability, and mortality. To assess frailty, numerous scores and instruments have been developed, which consider five key dimensions: unintentional weight loss, muscle weakness, fatigue, reduced physical activity, and walking speed. Three of these criteria are sufficient for diagnosis [17]. An accurate assessment of frailty allows the development of personalized interventions that can help improve quality of life and reduce associated risks.

The study aimed to evaluate the frailty of patients with PF associated with ATS.

2. Results

The data analysis suggests that between the three groups (ATS Group, OAH Group, PF Group) there are no significant differences associated with the environment of origin, gender ($p=0.732$). However, it is noted that the mean age in the PF group is higher than the mean of the other two groups. Significant differences were noted regarding the average age of the patients in the three groups, namely between the ATS group and FP ($p= 0.022$) and between the OAH group and PF group ($p=0.011$). The mean EFS total scores fall within the pre-frailty–mild frailty range for the ATS and OAH groups, with no significant differences between them, while the mean score of the PF group falls within the severe frailty range. In the evaluated cohort, the incidence of severe frailty is approximately 11%, of which 72.72% is present in the PF group. Approximately 63.5% of the total recruited patients fall within normal values or have scores belonging to the pre-frailty or mild frailty domains, of which only 9.09% (N=1) belong to the PF group.

Functional performance evaluates the time in which the examined patient rises from the chair, walks a distance of 3 m at a sustained pace, turns and sits down on the chair. A duration between 0-10 sec is scored with 0 points, between 11-20 sec, one point is scored, and a duration over 20 sec or the need for assistance is scored with 2 points. The data analysis shows that approximately 75% of patients in the PF group have a significant impairment of functional performance. Post hoc analysis (ANOVA) performed to identify differences between groups regarding functional performance suggests that there are no

differences between the PF Group and the OAH Group ($p=1.00$), but differences are reported between the PF Group and the ATS Group ($p<0.001$).

Regarding functional independence, the data analysis shows that the average value of the score determined for the PF Group is much higher compared to the other two groups, values determined by the difficulties encountered by the patients for shopping, transport, and housekeeping.

3. Conclusions

PFs associated with ATS are common in the elderly and cause increased frailty. The functional performance of patients with periprosthetic fractures, at a distance of more than 3 months from the fracture, is affected in over 75% of cases. Also, the sharp reduction in functional independence is present in over 90% of patients.

This research can be a starting point for the development/implementation of optimal public health policies regarding the identification of risk factors associated with periprosthetic fractures. Early diagnosis, adequate treatments and preventive measures can significantly reduce the impact of these injuries on the mobility and quality of life of patients.

CHAPTER X. A MULTICENTRIC STUDY OF COMORBIDITIES IN PATIENTS WITH PERIPROSTHETIC FRACTURES AFTER TOTAL HIP ARTHROPLASTY AND THEIR ASSOCIATION WITH IMMEDIATE POSTOPERATIVE COMPLICATIONS

1. Introduction

The study aims to perform a radiography of the incidence of PF associated with ATS, immediate postoperative complications and comorbidities in PF patients from three emergency hospitals in different areas of Romania. Another aim of the study is to identify the relationship between preoperative comorbidities, assessed by the Deyo-Charlson index, considered a valid measure for the assessment of comorbidities, and immediate postoperative complications [18].

2. Results

The average age at the cohort level is 74.74 ± 9.52. From the analysis of the data in Table 20, it follows that most compared variables do not show statistically significant differences between the three groups, except for the environment of origin. Falling injuries

from the same level account for approximately 90% of the causes leading to PF. The incidence of PF at the right coxofemoral joint is 63%. The results suggest the prevalence of these fractures in females is above 60% at the cohort level, with no significant differences between groups. The average interval of occurrence of PF from ATS is 9.33±5.48, approximately 50% occur in the interval 3-10 years, 33.33% occur after 10 years from the primary surgical intervention.

The most frequent cemented ATS were present in group B (n=23) vs. 15 in group P and 1 in group O. Regarding the approach, the predominance of the lateral approach is observed in all groups. In group B, the posterior approach was used in approximately 10% (n=38). Of the total 54 cases included in the study, 1 case of periprosthetic fracture was associated with a cemented primary prosthesis.

Data analysis suggests a higher prevalence of PF Vancouver B (over 90%). The prevalence of PF in patients with cemented hip prostheses is less than 10%/center and approximately 5% at the cohort level.

According to the data obtained, the most frequent intervention is internal fixation, representing more than 50% of cases both at the cohort level and among the evaluated centers. Conservative treatment was applied to 24.13% of all patients with PF, with a higher frequency in groups B and P. Group O reported a higher frequency of prosthesis revision (21.42%). The p-value of 0.455 indicates that there are no significant differences in therapeutic approaches between centers.

There were no significant differences regarding complications and discharge status among patients from the three centers.

3. Conclusions

The data analysis indicates that the main cause of PF associated with THA is falls, highlighting the importance of fall prevention among elderly patients. In addition, most fractures occur 3 to 10 years after prosthetic surgery, and the incidence is higher in women. There was a higher incidence of death among elderly patients with comorbidities such as diabetes and heart disease, emphasizing the need for increased care in managing cases with comorbidities. However, no significant differences were observed between the evaluated centers in terms of therapeutic approaches or postoperative complications. These findings indicate an urgent need to update treatment and prevention protocols, especially given the anticipated increase in periprosthetic fractures in the future. In this context, it is essential to develop effective strategies for the management of patients with total hip arthroplasty, aimed at minimizing risks and improving long-term outcomes.

The summary of the study is contained in Figure 2.

Figure 2. Summary of the association of comorbidities with immediate postoperative complications.

CHAPTER XI. FINAL CONCLUSIONS AND PERSONAL CONTRIBUTIONS

The research conducted in this thesis led to the following conclusions:

1. There is a significant variation in the global interest in the incidence of periprosthetic fractures, with the United States and the Republic of China leading the field, according to the bibliometric analysis.

2. Temporal analysis of the data shows a fluctuation in the incidence of these fractures, with an increased vulnerability in older women, who experience significant complications following treatment.

3. Periprosthetic hip fractures are frequently encountered in elderly and frail individuals. The study shows that, more than 3 months after the fracture, over 75% of patients experience impaired functional performance, and more than 90% experience a significant decrease in functional independence.

4. Minor complications are frequently encountered during hospitalization, and older women are more exposed to both fractures and postoperative complications.

5. Analysis of data from the latest study reveals that the main causes of PF associated with ATS are falls, which emphasizes the need to implement preventive strategies among elderly patients.

6. Most fractures occur 3-10 years after surgery, with a higher incidence in women.

7. Also, elderly patients with comorbidities, such as diabetes and complicated heart conditions, have an increased rate of death, emphasizing the need for careful management of these cases.

8. Data analysis does not suggest significant differences between the evaluated centers in terms of therapeutic methods or postoperative complications.

The multidisciplinary approach to the pathology studied and the diversity of methods used in the research allowed achieving the established objectives, showing that:

- Patients with PF frequently face a decrease in physical condition and physical performance, exposing the person to the risk of developing frailty, more pronounced than the general population;
- The routine use of health questionnaires can provide data for identifying the weaknesses highlighted by patients and implementing a patient-centered treatment.

The present research provided additional arguments for the importance of identifying risk factors, comorbidities and their appropriate management, in order to reduce the rate of complications, especially those that are life-threatening.

The findings of these studies open up new, underexplored and incompletely understood research directions regarding the management of PF associated with ATS. Contemporary strategies for the management of periprosthetic fractures focus on both preventive measures and advances in implant technology. Innovations in prosthesis design aim to improve load distribution and reduce the risk of osteoporosis-related bone stress, which can compromise bone integrity and increase fracture susceptibility. Studies on the importance of malalignment are ongoing. A malalignment of more than 3 degrees is a risk factor for PF. These efforts represent significant progress in improving clinical outcomes and decreasing the incidence of periprosthetic fractures. Given the controversies in the literature regarding risk factors, it is essential to continue quantitative analyses that identify and optimize the detection of these risks in patients undergoing arthroplasty. This research could improve preoperative preparation techniques, thus contributing to reducing the incidence of fractures among elderly patients, while highlighting the urgent need to review and update treatment and prevention protocols, given the anticipated increase in periprosthetic fractures in the future. In this regard, the development of effective strategies

for the management of patients with total hip arthroplasty is crucial, intending to minimize risks and improve long-term outcomes.

ORIGINALITY OF THE THESIS

The multilateral approach through the 4 studies represents original fractions that contribute, in addition to completing and updating the state of knowledge, to identifying the risk factors associated with PF. The entire concept and design of the thesis completes the data set, addressing and providing the necessary information for complete studies on the recovery prognosis of PF associated with ATS, the incidence of risk factors, and their association with the frequency of PF in patients with ATS.

The originality of the work is highlighted by several key aspects derived from the research conclusions:

- Global Perspective: The study provides a comprehensive view of the global interest in periprosthetic fracture incidence, highlighting the central role of the United States and the Republic of China. This bibliometric approach not only identifies leaders in this field, but also outlines an international research landscape around this health issue.
- Temporal and demographic analysis: The research highlights fluctuations in periprosthetic fracture incidence, particularly among older women. This makes a significant contribution to understanding the specific vulnerability of this demographic group, which may influence intervention and treatment strategies.
- Functional impact and quality of life: The study emphasizes the severe long-term effects of periprosthetic fractures on functional performance and independence in the elderly. This patient-centered approach makes a significant contribution to the literature, highlighting the need for early intervention and postoperative support.
- Identification of causes and complications: Detailed analysis of complications and risk factors, such as falls, age, sex, and comorbidities, provides a solid basis for the development of preventive strategies. This not only improves understanding of the problem, but also proposes viable solutions to reduce risks.
- Uniformity in treatments: The observation that there are no significant differences between the centers evaluated in terms of therapeutic methods or

postoperative complications suggests uniformity in medical practices, which may be a starting point for standardizing treatment approaches and protocols.

These aspects underline not only the originality of the research but also its practical relevance in the field of health care for the elderly, proposing a basis for more effective public health policies and clinical strategies. In addition, continued education, research, and collaboration within the orthopedic community are critical to furthering knowledge of these fractures and optimizing the management of affected patients. Thus, the proactive approach in identifying and managing risk factors is crucial for the prevention of periprosthetic fractures, having the potential to improve clinical outcomes in this vulnerable population. This research represents an essential starting point for formulating public health policies aimed at identifying risk factors associated with FP. The implementation of preventive measures can significantly contribute to reducing the impact of these injuries on patients' mobility and quality of life. Thus, a proactive approach in the management of these fractures is crucial for improving the health of the elderly population.

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