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# **PhD THESIS**

**SUMMARY**

**CEMENTLESS TOTAL KNEE ARTHROPLASTY IN  
YOUNG PATIENTS. ADVANTAGES AND  
BENEFITS**

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## **INTRODUCTION**

Cementless knee implants have recently gained increased attention due to advanced design processes and manufacturing technologies, such as: the implementation of an additional coating layer that improves biological adhesion and consolidation, and the pattern of implant components (1-4). Another reason for increased attention to cementless fixation is the age of patients undergoing TKA. Younger patients (<65 years), with increased activity levels after surgery, as well as longer life expectancies, who require firm, long-term fixation techniques, are increasingly being considered for TKA. Since the cement mantle does not have remodeling properties like biologically osseointegrated parts, it is subjected to increased pressure resulting in a higher incidence of aseptic loosening (5-7).

In the field of orthopedic surgery, TKA is considered to be one of the gold standards. However, there are categories of patients (ie, obese patients, morbidly obese patients, even younger patients, etc.) in whom cemented TKA still has a high failure rate. Moreover, the frequency of use of uncemented TKA is increasing due to the potential benefits of long-term biological fixation, being an innovative field addressing a new generation of orthopedic surgical treatment, more suitable for young patients who have bone quality (from good to very good, as density).

Currently, there is little data to highlight the advantages/disadvantages of cemented/uncemented implant attachment based on individual candidate characteristics. The purpose of this research is to comparatively evaluate the evolution of subjects after TKA with uncemented implant vs. cemented by tracking individual characteristics, how they managed pain, how they gain mobility in daily life and how they improve their daily activities. The contribution of this study to the orthopedic literature is to highlight the benefits of cementless knee arthroplasty in younger patients with good bone preservation.

## **GENERAL PART**

The general part contains two chapters.

The first chapter of the general section illustrates updated data on therapeutic approaches in the management of gonarthrosis, data on the incidence and etiology of the pathology, pharmacological and surgical approaches. The second chapter of the general part describes unsedated TKA, benefits, operative technique, data on post-interventional evolution and prosthesis survival rate by implant type and current approaches in the management of patients undergoing TKA, based on current scientific evidence.

### **SPECIAL PART**

The special part of the work is structured in chapters 3 and 4. Chapter 3 describes the general methodology of the research, the objectives and the experimental part. Chapter 4 is dedicated to the results and includes 3 studies. The first study aims to establish the clinical profile of patients from Bihor County hospitalized with gonarthrosis and includes 1045 patients hospitalized consecutively in the period 2014-2020. The characteristics of the morbidity caused by gonarthrosis in Bihor County are analyzed, following the demographic and anamnestic aspects characteristic of the pathology, the association of risk factors and the pharmacological treatment. The second study in chapter 4 aims to identify the particularities of the clinical profile of the TKA patient and comparatively analyzes the pathology characteristics of 549 patients according to the type of implant. The last study is dedicated to monitoring the postoperative evolution of patients who have undergone TKA and has as its objective the comparative evaluation of the postoperative evolution, depending on the type of implant, in order to identify the benefits brought by the use of the cementless implant in young patients. Immediate, 6-month and 12-month benefits are tracked through clinical consultation and specific standardized instruments.

### **CHAPTER 3. GENERAL RESEARCH METHODOLOGY**

A prospective observational study was conducted that included 1045 patients with a primary or secondary diagnosis of gonarthrosis, consecutively enrolled in the orthopedic department of the Oradea County Emergency Clinical Hospital, Oradea, Romania, in the period 2014-2020. The study protocol of the

enrolled patients consisted of the initial assessment of the entire cohort and reassessment at 1 month, 6 and 12 months after the knee implant in the case of patients who underwent TKA, data centralization, comparative statistical analysis (cemented implant vs. cementless) and the descriptive and analytical interpretation of the results obtained. Demographic description, characteristics of gonarthrosis, clinical manifestations, risk factors, type of intervention, type of implant, immediate benefits and at 6 and 12 months, TKA complications, but also quality of life evaluated with specific instruments were followed.

Knee OA was defined according to the American College of Rheumatology (ACR) criteria (8).

Before TKA, patients completed demographic data surveys, the Western Ontario and McMaster Universities Osteoarthritis Pain Scale (WOMAC), the Disability and Pain Scale (HAQ), and the Knee Society Score (KSS). The re-evaluation at 6 months and at 12 months was carried out by clinical examination, comparing the benefits, complications and quality of life according to the type of implant, by applying specific questionnaires. The X-ray was taken in order to monitor the implant.

## **CHAPTER 4. RESULTS**

### **4.1. CONTRIBUTIONS REGARDING THE ESTABLISHMENT OF THE DEMOGRAPHIC AND CLINICAL PROFILE OF PATIENTS HOSPITALIZED WITH GONARTHROSIS**

A number of 1045 patients diagnosed with gonarthrosis, hospitalized consecutively between 2007 and 2020, were included in this study. The average age per cohort was  $50.61 \pm 12.00$  years, the minimum age being 20 years and the maximum 75 years. Most of the patients in the study were female (54.1%), coming especially from rural areas 56.8%. In the years 2018 and 2019, the most cases of gonarthrosis were registered (179 cases -17.1%, respectively 215 cases - 20.6%), significantly more than in the other years.

33.4% of patients were diagnosed with primary gonarthrosis, with a higher incidence of non-traumatic than idiopathic gonarthrosis (24.6 vs. 8.8%).



The frequency of secondary gonarthrosis was 66.6%, the one manifested by cartilage insufficiency upon loading being the most prevalent (36.7%). Synovial hypertrophy was observed in 40.1% of cases. The second most important pathology turned out to be ligament enthesopathies, which affected 267 people (25.6%). Periarticular muscle hypotrophy was registered in 133 patients, and the less frequent pathology was subchondral cysts in only 42 people. Subchondral bone pain was present most frequently, in 352 people (33.7% of the cohort). Joint capsule pain was recorded in 222 cases, and ligament pain was present in a percentage of 16.6%. Pain in the periarticular muscles was recorded in 7.3% of all patients.

Obesity is one of the most important risk factors. The higher the degree of obesity, the greater the overloading of the knee joint and the risk of its damage. A percentage of 25.1% of patients were obese and 42.6% overweight. The presence of knee injuries can be observed in 49.1% of patients. Family antecedents are present in 38.3% of patients, constituting an important degree of risk for gonarthrosis. The assessment of bone density showed the presence of osteoporosis at the local level in 31.8% of the patients, which represents a significant degree of risk for the development of secondary gonarthrosis, respectively in 2.6% of the patients a generalized osteoporosis was observed.

Non-steroidal anti-inflammatory drugs are the most used as allopathic treatment for those with arthrosis. A percentage of 25% of patients received NSAIDs selective for COX2 receptors, but almost 20% of cohort 203 received nonselective NSAIDs. Opioid analgesics were prescribed to 149 patients, antidepressants to 108, aniline derivatives to 72 patients, and anticonvulsants to 17 people. Injectable treatment was applied to 11.2% of patients, most often corticosteroid therapy (3.8%), hyaluronic acid and derivatives (3.1%), but a significant number of patients also received whole blood therapy. Local treatment was also used by a large number of patients (79.3%), mostly with nonsteroidal anti-inflammatory drugs (66.5%).

In 47.5% of all patients, TKA was not necessary, and the following surgical treatments were applied to them: arthroscopic washing and debridement; periarticular knee osteotomies; and unicompartmental joint arthroplasty.

The relatively low average age recorded in this study ( $50.61 \pm 12.00$ ), indicates that knee OA cannot be considered only an inevitable consequence of increasing life expectancy, instead, a major contribution of risk factors is observed modifiable, such as obesity and joint trauma.

#### **4.2. IDENTIFICATION OF PARTICULARITIES IN THE CLINICAL PROFILE OF PATIENTS SUBJECTED TO TKA, DEPENDING ON THE TYPE OF IMPLANT**

549 of the hospitalized patients with a diagnosis of gonarthrosis underwent TKA, of which 319 subjects (30.9%) benefited from a cemented implant, and 230 (22.0%) from a cementless implant. The statistical analysis of the data indicated a uniform distribution in the 2 groups, in terms of gender, and a statistically significant difference ( $p=0.016$ ) in terms of the environment of origin, with rural patients predominating (table 12), and of age ( $p=0.001$ ), significantly younger being the patients in the uncemented implant group. The mean age was under 60 years in both groups, significantly lower in the cementless implant group ( $45.86$ ,  $SD=11.30$  vs.  $58.29$ ,  $SD= 7.61$ ,  $p=0.001$ )..

In the cementless implant group, the youngest patient was 20 years old and the oldest was 60 years old, compared to the cemented implant group where a minimum age of 48 years and a maximum of 75 years was recorded. Regardless of the year of intervention, the number of implants was significantly different ( $p<0.05$ ). A significantly higher incidence of cementless implant is observed in 2014-2015, which reverses in the following years.

Primary gonarthrosis had a higher incidence in the group with cemented implant, the most frequently occurring primary non-traumatic gonarthrosis. Patients with secondary gonarthrosis who had modified cartilage with deficiencies, represented 6.2% of the cohort, and the distribution in each year of

the study does not show significant differences during the 7 years considered in the study. In the years 2015, 2017 and 2019, the most cases of various pathologies were observed in patients from the cemented implant group, with significant differences compared to the cementless implant group represented (Figure 1)

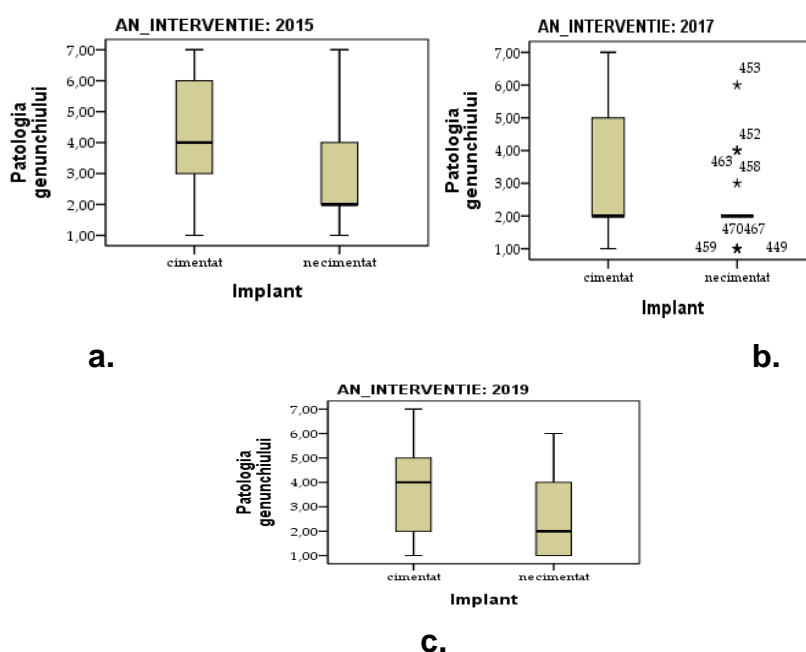


Figure 1. BOXPLOT graphical representation of the significant difference between the two study groups on knee pathology in a. 2015, b. 2017 and c. 2019.

Ligament pain shows an increase from 2014 to 2019, and in 2020 the values are lower. The joint capsule was affected in a percentage of 20.7% of all patients, and showed an increasing trend during the years of the study, the highest frequency being found in 2019. Pain at the level of the synovial membrane affected 18.2% of all patients, without significant differences during the years of the study. Periarticular pain of the subchondral bone shows a high incidence both in those with cemented implant and in those with uncemented implant, but with statistically insignificant differences between the 2 research groups. Subchondral bone pain, occurring in 28.6% of all cases, affected more patients in the cemented implant group (86 people) than those with cementless

implant (71 people). From the point of view of the years of the study, an increasing trend of periarticular pain can be observed, in 2019 being the most subjects registered with subchondral bone pain.

Risk factors for gonarthrosis were identified in 34.6% of the patients in the group with cemented implant and in 22.3% of those with non-cemented implant. 156 patients with obesity of various degrees presented with non-traumatic primary gonarthrosis (28.4%), idiopathic 39 patients (7.1%), a total of 195 people. With secondary gonarthrosis instead, 220 patients (40.0%) of the study group presented with obesity of various degrees. After statistical processing with the Pearson test, a strongly positive relationship was observed. Thus, those with obesity have a higher incidence of secondary gonarthrosis, indicating that obesity is a risk factor in the development of secondary gonarthrosis. A number of 118 patients (21.5%) presented with localized osteoporosis from those with primary gonarthrosis, and 244 patients (44.4%), significantly more, with secondary gonarthrosis presented with localized or generalized osteoporosis. This significant difference indicates that osteoporosis is a risk factor for the development of secondary gonarthrosis (table 24). Checking the relationship between the incidence of trauma in primary and secondary gonarthrosis, no significant relationship was observed. Family history of gonarthrosis showed the most significant correlation with both types of gonarthrosis. They affected the majority of patients (40.1%), most of them were diagnosed with secondary gonarthrosis.

A greater trend of treatment application can be observed in the last years of the study (2018, 2019, 2020). It was also noted that most used COX2-selective NSAIDs (24.2%), including 78 people in the cemented implant group (4.2% more), and only 55 in the cementless one. Regardless of batch, knee OA proved to be a complex pathology that variably involved the cartilage, bone, synovium, and surrounding tissues of the three biomechanically discrete compartments. Thus, the clinical phenotype is highly variable, requiring the consideration of several features for an accurate diagnosis.

### 4.3. COMPARATIVE STUDY ON THE POSTOPERATIVE EVOLUTION OF PATIENTS WITH CEMENTED IMPLANT vs. CEMENTLESS

Following the immediate benefits, one can observe their presence in a higher percentage of patients in the uncemented implant group, without statistically significant differences ( $p>0.05$ ) (table 28). Immediate benefits recorded with greater frequency in the uncemented implant group were: Regaining joint mobility (by 12.48% more); Knee flexion  $>110$  (by 12.13% more); Regaining joint mobility (by 12.48% more); Hyperextension with low deficit (by 10.33% more); Low local sensitivity (by 11.55% more); Lack of rigidity (7.93% more).

The correlations age-benefits indicated a statistically significant direct relationship ( $r=0.215$ ,  $p=0.045$ ) in the case of leg flexion of 110-115 degrees, which associates an increase in the frequency of this benefit with increasing age in the case of the uncemented implant group, and a relationship significant inverse proportional ( $r=0.403$ ,  $p=0.003$ ) in the case of non-deficit hyperextension, associating low age with a higher frequency of this benefit in the cementless implant group (figura 2).

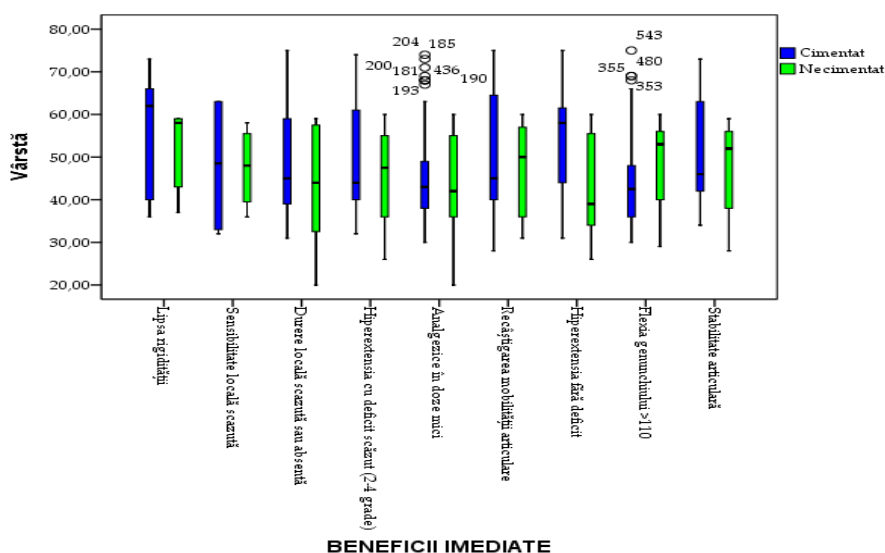


Figure 2. Immediate benefit-age correlations by implant type

At 6 months, a significantly better evolution was registered in the group with uncemented implant, highlighted by the significant differences between the following parameters: • Lack of stiffness/joint mobility (79.56 vs. 74.29,  $p=0.016$ ); Hyperextension without deficit (65.65 vs. 61.44,  $p=0.047$ ); Amplitude of movement  $> 137$  (14.78 vs. 12.56  $p=0.001$ ); • Joint stability (95.65 vs. 4.67,  $p=0.032$ ); Resuming sports activities (75.2 vs. 65.83,  $p=0.001$ ); Return to activities before the intervention (80.00 vs. 74.92  $p=0.001$ ); Low flexion deficit  $< 5$  (87.39 vs. 83.07  $p=0.049$ ) (table 30).

At 12 months, a positive evolution of the benefits identified at 6 months was observed in both groups, with a better evolution in the cementless implant group. Joint mobility improved by 11.30% in patients with cementless implant and by 5.96% in those with cemented implant ( $p=0.003$ ); Hyperextension without deficit improved by 19.56% in patients with uncemented implant and by 14.11% in those with cemented implant ( $p=0.034$ ); The range of motion above 137 improved by 3.05% in patients with cementless implant and by 2.48% in those with cemented implant ( $p=0.187$ ); Flexion deficit below 5 increased by 3.05% in those with cementless implant and remained unchanged in those with cemented implant, while deficit greater than 15 decreased by 1.30% in those with cemented implant and by 0.93% in those with a cemented implant.. Correlation between benefits and age by implant type indicated a statistically significant inversely proportional relationship for local pain, mobility gain, and hyperextension without deficit, as well as a direct relationship for leg flexion.

Data analysis indicated insignificant differences between the 2 groups in terms of complications occurring in the first year after surgery. During the evaluation period, complications were present in 19.12% of patients in the uncemented implant group and in 23.16% of patients in the cemented implant group. A higher incidence of periprosthetic fractures was observed in the cementless implant group, without significant differences (4.78% vs. 1.88%,  $p=0.677$ ), while all other recorded complications had a lower incidence in the group with cementless implant, without significant differences ( $p>0.05$ ).

The comparative analysis of the WOMAC score showed a significantly greater decrease at 6 months, in the group with cementless implant vs. cemented, as well as insignificant differences at 12 months. The evolution of the HAQ score showed a significantly greater growth at both 6 months and 12 months in the cementless implant group vs. cemented. The KSS score showed significantly greater growth at 6 months in the cementless implant group vs. cemented and non-significant differences at 12 months (figure 3).

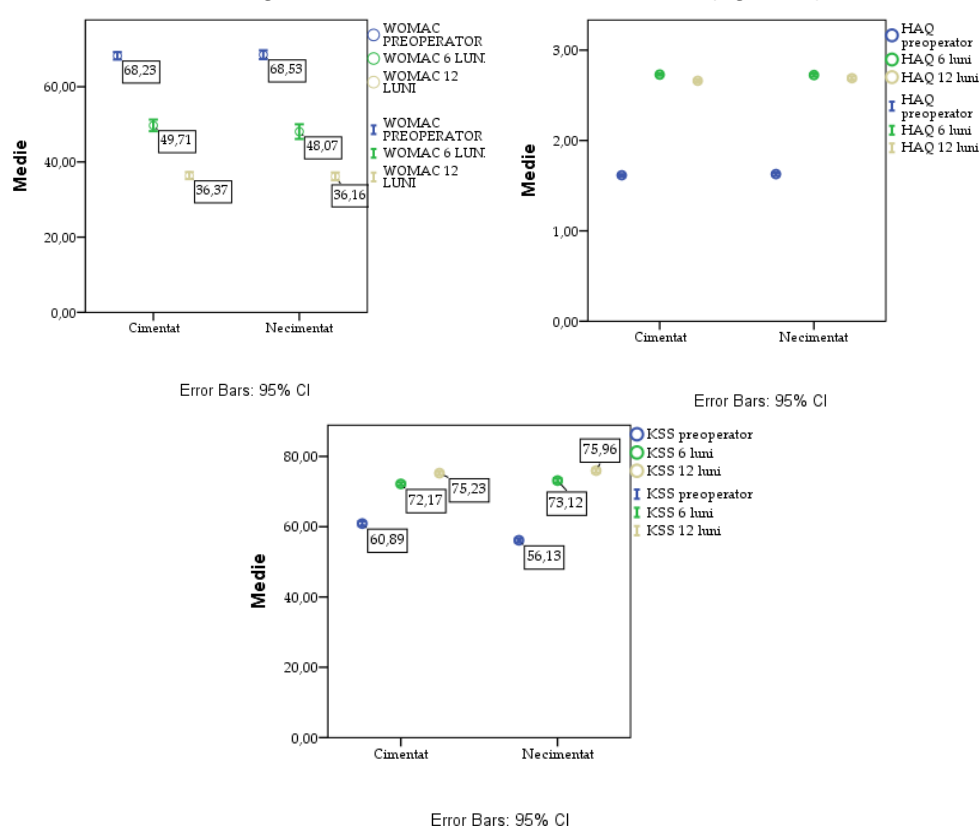


Figure 3. Graphic presentation of mean values of WOMAC, HAQ and KSS scales according to implant type.

## CONCLUSIONS AND PERSONAL CONTRIBUTIONS

The studies carried out in this research have brought further arguments regarding the importance of using cementless knee prosthesis in young patients, which favors biological adhesion to the bone and offers a number of benefits and a good survival rate of the prosthesis, advocating for an individual approach to

for each patient, depending on demographic criteria, pathology characteristics and specific risk factors.

The results of the undertaken research allow the opening of new perspectives in the clinical management and surgical approach of patients with gonarthrosis, highlighting the importance of analyzing the individual characteristics of the patient correlated with the benefits/risks of each type of implant available

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