Orthopedic surgery approach with uncemented metallic prosthesis in knee osteoarthritis increases the quality of life of young patients

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Abstract. Osteoarthritis is mainly located in the knee area. It is an important concern related to the population health, determined by the influence on the quality of life of patients. Total knee arthroplasty (TKA) with uncemented fixation is among the most encountered procedures performed in patients of a younger age. The present study investigated the response of patients (quality of life, mobility and pain management) with titanium/hydroxyapatite-coated implants with polyethylene inserts. A total of 57 patients with knee arthroplasty were studied with an average age of 54.1±4.9 years and 57.8% were females. The present study focused on the following aspects: The components of such a prosthesis and the way they contribute to a physiological fixation/recovery; how the implant surgery is performed; the clinical and demographic characteristics of the patients; postoperative pain assessment in different types of movement; the management of the movement capacity 1 year after the surgery; and complications that may occur. One year after the surgery, these patients reported pain release, considerably favorable results in every-day activities, and good mobility (capable of using the car, rising from the bed or standing). Knowledge and accurate observation of the correct steps in performing this surgery and the role of the components of the prosthesis can lead to favorable therapeutic outcomes for patients with knee osteoarthritis.

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Introduction

The most frequent rheumatic pathology is osteoarthritis; the knee joint being the most often affected area. Osteoarthritis at the knee joint level, also known as knee osteoarthritis, determines considerable function disabilities and also handicaps. Considering the influence on the quality of life of patients, knee osteoarthritis is an important issue for the population health, not to mention the increased cost in the social and economic sectors (1,2). Due to population aging, osteoarthritis affects up to 30% of people >65 years of age; 10% of males and 17% of females over the age of 65 are affected (1,2). It is among the 4 main causes of morbidity, being the most frequent cause of knee pain after the age of 50, as an effect of obesity and overweight as well as the ageing of the population (1-3). Due to its incidence and increased prevalence rate, knee osteoarthritis is more significant than other categories of osteoarthritis; mainly affecting obese females of a young age (3,4). As the age group of the population cases decreases, total knee arthroplasty (TKA) is increasingly carried out on subjects of a younger age (5-8). Various authors have indicated that the average age of the patients submitted to TKA is reducing and the ratio of subjects below 65 years is growing (7). For orthopedic surgeons, young subjects represent a difficulty due to the fact that they resume their activities at a quick rate after surgery and also because their lifespan is greater than older patients (6,7). For patients in their 50s, there is a greater probability of enthusiasm compared to patients in their 30s concerning an implant which has a survivability of 5 to 10 years (5). As patients of younger age have a greater rate of activity, increased pressure will be put on the implant, thus correction surgery is a probable outcome (7,8). Therefore, TKA has to ensure a

favorable outcome and durability as well as maintain to the greatest extent possible the bone (8).

Uncemented attachment of the orthopedic implants is properly verified and has effective functioning in various areas. The connection linking the bone and the implant is physiological and it is a vivid interface that reacts to pressure in a physiological way. The knee implant with cemented attachment does not always succeed and in various cases the uncemented attachment has been revealed to be superior to the cemented attachment (5,8). As a result of design and material improvements (9-12), uncemented attachment is becoming the first option for numerous surgeons, due to demographic changes in the population with TKA (7,8). There are several conditions that influence the direct skeletal fixation: The characteristics of the implant surface (13,14); the host bone condition; the set-up of the operation site; loading circumstances; design of the implant (13,15,16); and avoidance of initial and chronic infections. To obtain high quality TKA, polymers with biostability and also several metals and ceramics are used. The material of prosthesis minimizes pressure at all surfaces and optimizes the function of the knee, reproducing the physiological femoral rollback (14,16).

The purpose of the present research was to assess the progress of subjects after uncemented TKA: The way they managed the pain, how they gained their mobility in everyday life, and how they improved daily activities. The present study contributed to the orthopedic literature data by emphasizing the benefits of uncemented knee arthroplasty in younger patients, with favorable bone preservation.

Materials and methods

Characteristics of the implant. The femoral component of the prosthesis (C2F Implants) was cobalt-chromium material. Models of cementless prosthesis that offer initial stability and favor instant osteointegration are provided for right and left knees, in available sizes, twice covered with stratums of high porosity titanium and hydroxyapatite plasma sprayed (13-17). The femoral box open-top permits reverse insertion of an intramedullary nail for patients with supracondylar fracture condition. The weight of the component is reduced with 25-30% when ridges are configured in the lateral condyles. Physiological kinematics replicates natural femoral roll-back and allows deep flexion occurrence. The tibial component is also cobalt-chromium tibial tray 5 sizes available in uncemented version covered twice with stratums of high porosity titanium and hydroxyapatite plasma sprayed (17-19), which offers initial stability and favors instant osteointegration (20). The tibial tray, that is anatomically configured, matches each of the two knees (right and left). Keel conical core (which is hollow) is configured to accommodate the mobile bearing stem (21).

The rotatory plate is available in 5 sizes and 4 dimensions (9, 11, 13 and 15 mm). The stem is constituted of two sections (lower conical and upper cylindrical) having an overall height of 24.5 mm. The apex of the patella or the patellar tendon is secured against impact by the wide anterior cut-out. The size of the mobile bearing in relation to the tibial tray permits a rotation >20˚, whilst preventing the impact on the soft tissue in the size-to-size design. Unmatching patterns are permitted for the femoral element and the tibial tray. Despite that, the dimension of the mobile bearing has to fit the femoral component dimension. The patella is formed by a sphere portion cut following an oval contour and equipped with 2 markers; the patellar component has to be cemented (21).

The polyethylene insert has a protective role between the two metal components (tibial and femoral, respectively), keeping the joint biomechanics as close as possible to the physiological ones (due to the elasticity of the material) and avoiding the direct contact between the mentioned metal components. Improper implantation of the prosthesis leads to premature attrition of the polyethylene insert. In addition, the wrong selection for the polyethylene insert size has the effect of shortening both the amplitude of joint movements and the life of the prosthesis. As a consequence, one of the most common complications of incorrect implantation is fracture (rupture) of the polyethylene insert.

Study design. A prospective study, including 57 patients admitted with the diagnosis of knee osteoarthritis at the Department of Orthopedics of Clinical County Emergency Hospital of Oradea (Oradea, Romania) from January 2016 to January 2020, was performed. The selection criteria of the patients are presented in Table I. Before TKA, the patients completed surveys of demographic data and the Western Ontario and McMaster Universities Osteoarthritis (WOMAC) (22) pain scale, which represents a frequently used tool to evaluate the pain in case of osteoarthritis of the knee. The WOMAC Index assesses pain during functional activities; it includes 5 items that evaluate pain when the patient walks on flat surface, up and down stairs, when standing upright, lying or sitting and when in bed at night. The results are registered on a five-point Likert scale; a greater score indicates a higher level of pain. The scale has been demonstrated to be accurate and trustworthy in evaluating pain in cases of patients with hip and knee osteoarthritis (8).

The present research was authorized by the Ethics Commission of the Emergency Clinical County Hospital of Oradea (approval no. 176/2015), and conducted respecting the World Medical Association (WMA) Code of Ethics (Declaration of Helsinki 1967) (23). Each patient signed an informed written consent at the moment of hospitalization.

Surgical techniques. There are 3 usable bone references, as follows: i) The trans-epicondylar axis. The line connecting the external epicondyle with the groove right under the internal epicondyle is known as the trans-epicondylar axis (TEA). Various research has revealed difficulties in precisely identifying TEA (4-7). Using this method an error >5˚ was revealed in 56% of cases (14). ii) The antero-posterior axis. The white-side line connects the middle of the intercondylar notch with the lowest point of the femoral trochlea at the site of PCL insertion. Being perpendicular to TEA, the aforementioned line is easily detected. In case of bone deformation, it is modified and determines errors in external rotation, in cases of varus knee osteoarthritis or trochlear dysplasia (16). iii) The posterior condylar axis. The normal knee presents an internal rotation of 3-4˚ of the posterior condylar axis in relation to the TEA, while an external rotation with 3-4˚ in relation to the posterior condyles ensures correct rotational alignment;

Table I. Inclusion/exclusion criteria for selection of patients.

Criteria	
Inclusion	Exclusion
Age ≤65 years old	Neurological problems
Daily active patients	Presence of osteoporosis
Good bone quality	Severe heart diseases in medical history
Uncemented arthroplasty in personal medical history	Severe comorbidities
No severe deformities on radiography evaluation	Another bone joint with arthritis
	Bone not suitable for uncemented arthroplasty

Table II. Demographic and clinical characteristics.

	TKA patients (n=57)	
Characteristics	No.	%
Sex		
Females	33	57.8
Males	24	32.2
Age		
<50 years	7	12.28
50-60 years	35	61.40
>60 years	15	26.31
Average	62.91±6.13	
Previous surgery		
CVI	16	28.07
Gall bladder stone surgery	6	10.52
Cardiovascular surgery	2	3.50
Bariatric surgery	3	5.26
Patient status		
Normal	21	36.84
Overweight	22	38.59
Obesity	12	21.05
Morbid obesity	2	3.50
Etiology		
Primary osteoarthritis	35	61.40
Secondary osteoarthritis	22	39.60
Surgical approach		
Medial approach	57	100
HKA angle pre-operator		
Varus	22	38.6
Valgus	35	61.4
Charnley classification		
A unilateral knee arthritis	35	61.4
B1 Unilateral TKA	13	22.8
B2 Bilateral TKA	7	12.3
C3 Unilateral or bilateral TKA or THA	2	3.5

TKA, total knee arthroplasty; CVI, chronic venous insufficiency; HKA, hip-knee-ankle; THA, total hip arthroplasty.

Table III. WOMAC score evolution 1-year after TKA.

	Pre-operative patients		Post-operative (1 year) patients	
WOMAC pain score	No.	%	No.	%
Using stairs	18	31.5	6	10.5
Weight bearing	13	22.8	5	8.7
Standing	11	19.3	2	3.5
Bathing	4	7	0	0
Using the toilet	2	3.5	1	1.75
Shopping	15	26.3	5	8.7
Using the car	3	5.2	1	1.75
Rising from bed	6	10.5	1	1.75

TKA, total knee arthroplasty; WOMAC, Western Ontario and McMaster Universities Osteoarthritis.

mistaken external condyle hypoplasia may appear in valgus knee osteoarthritis while in varus knee cases, the anterior cruciate ligament deficiency produces erosion of the medial femoral condyle rear part (14-16).

Results

The average age of the subjects was 54.1±.4.9 years. In addition, 36 patients were overweight, 14 of them were obese. The clinical characteristics of the patients, hip knee arthroplasty angle pre-operator (varus or valgus), etiology, and surgical approach are summarized in Table II.

Hydroxyapatite coating (10,14,16-18) acts by providing anchorage between the implant and the bony surface. The ability of the bone to adapt and connect to the hydroxyapatite layer of knee implants favors reliable osteointegration and the long-term survival of the implant. The surface of the implant has an important role in the direct skeletal fixation, porous implants being highly efficient for skeletal fixation. Radiographic assessment suggested excellent femoral component fixation. The pain scale 1 year after TKA is presented in Table III. Postoperatively, most of the patients had high movement ranges, compared with preoperative status, with a

Table IV. Pre-/post-operative range of motion.

	Pre-operative patients		Post-operative (1 year) patients	
Characteristics	No.	%	No.	%
Range of motion				
>137	9	15.7	7	12.28
129/136	6	10.52	9	15.7
121/128	7	12.28	8	14
113/120	10	17.54	6	10.52
105/112	6	10.52	6	10.52
97/104	2	3.50	4	7
<97	7	12.28	11	19.29
Flexum deformity				
>15	4	7	2	3.5
11-15	11	19.29	1	1.75
5-10	22	38.59	4	7
<5	20	35	50	87.71

Table V. Complications of TKA.

	Uncemented patients	
Complications	No.	%
ROM <90˚ (3 months after treatment, under anesthesia by manipulation)	2	3.50
Patellar clunk syndrome (treated by arthroscopic synovectomy)	1	1.75
Stiffness (treated by arthroscopic arthrolysis)	1	1.75
Loosening (treated by revision)	2	3.50
Periprosthetic fracture (treated by internal fixation)	2	3.5
Periprosthetic infection	1	1.75

TKA, total knee arthroplasty; ROM, range of motion.

high level of mobility (Table IV). After 2 years surveillance, complication in TKA developed in 8 patients with minor influences, as revealed in Table V.

Discussion

The most common articular disorder worldwide is osteoarthritis, whose prevalence is increasing. It is also one of the most common causes of disability, pain and loss of function in adults in Western populations. Regarding the risk of knee osteoarthritis during life, it is approximately 47% in women and 40% in men (2). Detailed physical examination, as well as extensive knowledge of the history of a patient, adequate radiological investigations are relevant for patient management. In terms of treatment, a gradual algorithmic approach is possible due to the fact that the disease has a relatively slow evolution. The non-surgical therapies include lifestyle adjustments, using orthotic devises and patient education. These may be obtained within the community. Arthroscopy, joint sparing procedures, joint replacement procedures and osteotomy are the surgical alternatives for this condition. The interventions for replacing the joint may be total as in knee arthroplasty or addressing a single area, as in patellofemoral arthroplasty or single-area knee replacement. In order to obtain optimal long-term results, a good surgical technique, proper selection of the patients and also postoperative counseling are essential (20,22). The uncemented implants have been demonstrated to be efficient in young patients (7,8), in those with rheumatic disease (24), in obese/diabetic patients, despite the increased risk for postoperative complications. Preoperative evaluation and/or control of associated complications of diabetes may improve the clinical outcome of TKA in these patients. The findings of the present research were in accordance with the replacement of the posterior cruciate ligament and the use of mobile inserts. Radiostereometric analysis (RSA) revealed 1 mm migration of the tibial part of the non-cemented prosthesis during the first three months from the implant, which stabilized at approximately a year from the implant. Being related to bone density, the migration has a higher rate in case of patients with osteoporosis (19,25).

Various data have revealed increased hemorrhage following the uncemented implants, the cement acting as bone hemostatic (18,19). However, other studies have confirmed that the non-cemented prosthesis permits releasing of the tourniquet before the implantation, with more precise hemostasis, given improved visibility on the posterior capsule (26). The uncemented technique requires increased precision and accuracy in preparing the bone and balancing the soft tissue; this type of procedure proving to be beneficial for bone conservation and efficient for the operation (7). A major recommendation in case of uncemented TKA refers to the bone quality and its metabolic activity to provide biological fixation (27). The uncemented TKA procedure is fast, it reduces the duration of pneumatic ischemia and allows an easier control in case of malfunction. Prostheses of new generation provide improved osteointegration favoring biological connection of the bone with the prosthetic component that generates better results in time (7). Hydroxyapatite coatings, trabecular and porous metal are the most reliable materials used for these prostheses (17-19). Young patients are a major challenge for orthopedic surgeons, because their life expectancy is higher than elderly patients, and they also have a higher activity level (6-8). Due to the higher activity level of the younger patients, the implant is subjected to greater stress and a probable consequence is revision surgery. The results of the present study indicated accelerated postoperative recovery, with significant improvement in mobility and pain after TKA surgery. One-year post surgery, patients who underwent TKA surgery with an uncemented implant, exhibited alleviation of the pain with markedly favorable results in daily activity, and lack of pain when using the car, rising from bed or standing. After 1-year follow-up, most of them asserted the lack of the presence of the pain, they had, at the examination period, good range of motion of the knee with individually free range off-motion included.

Similar to other medical interventions, TKA could be accompanied by some complications (e.g., periprosthetic infection). The risk of microbial contamination and infection at the operative site is lowest in the knee prosthesis surgery. The incidence ranges between 6.1% (28) and <1% (29). Despite the intravenous followed by oral antimicrobial therapy, in the present study, a single case was complicated with methicillin-resistant *Staphylococcus aureus* periprosthetic infection. The management of these infections could be improved in order to reduce the incidence and avoid the development of antimicrobial resistance (30,31). The components of uncemented TKA (in terms of materials) allows a biological healing on the bone/prothesis interface, that also is in the favor of the patient because of the short period of recovery (27,32,33). In future, as a result of continuous advances in the fields of auxiliary materials, material science and system designing, the uncemented fixation in TKA will be considered as the first option for knee arthritis (34).

In conclusion, for patients under the age of 65 who require TKA, a desirable solution is knee prosthesis with uncemented fixation, where biological adherence to the bone is favored, unlike the case of a cemented implant, where the cement can be fragmented, and further revisions could be necessary. Considering all these advantages, orthopedic surgeons must be prepared to use the optimum implant technique for uncemented prostheses, considering the indications, limitations and possible complications of this type of intervention.

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Availability of data and materials

All data are registered at the Clinical County Emergency Hospital of Oradea, Bihor, Romania.

Authors' contributions

BU, TAM, OM, CP and DCZ performed the surgical interventions and collected, analyzed and interpreted the patient data regarding pre- and post-surgery progress. DMT, SB, TB and JMP made substantial contributions to the conception of the work and interpretation of data and in addition, they drafted the manuscript and were major contributors in writing the manuscript. All authors read and approved the final manuscript to be published. All the authors agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Ethics approval and consent to participate

This research was authorized by the Ethics Commission of the Emergency Clinical County Hospital of Oradea (approval no. 176/2015), Oradea, Romania, and conducted respecting the World Medical Association (WMA) Code of Ethics (Declaration of Helsinki 1967). Each patient signed and provided an informed written consent at the moment of hospitalization.

Patient consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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