

Comparative Study of Design and PCL-Substituting Systems of Total Knee Prosthesis

R. Adam¹, C. Orban², H. Orban¹

¹Department of Orthopaedics and Traumatology, "Elias" University Emergency Hospital, Bucharest, Romania

²Clinical Institute Fundeni, Bucharest, Romania

Rezumat

Studiu comparativ al designului și al sistemelor de posterostabilizare în artroplastia totală de genunchi

Scopul acestui studiu este de a evalua rezultatele postoperatorii obținute prin utilizarea unor diferite proteze de genunchi. Principalele diferențe dintre tipurile de implant sunt date de designul acestora cât și de sistemele de posterostabilizare folosite. *Material și metodă:* În perioada 04.2004 - 02.2012 am efectuat 506 artroplastii totale de genunchi pe un grup de 460 de pacienți. Alegerea noastră, a fost pentru proteze totale de genunchi cimentate, posterostabilizate. În ceea ce privește sistemele de posterostabilizare a implantului am împărțit grupul principal în trei loturi. În scopul de a evalua rezultatul post-operator am folosit American Knee Society Score (AKSS).

Rezultate și discuții: Toate tipurile de proteze pe care le-am utilizat, au înregistrat valori satisfăcătoare ale AKSS. Studiul nostru a arătat că un grup a realizat valori mai mari ale AKSS, față de celelalte două, dar nu există diferențe statistice semnificative ($p = 0,09$).

Cuvinte cheie: artroplastie genunchi, sistem de postero-stabilizare, design implant, AKSS, funcție articulară

Abstract

The aim of this study is to assess postoperative results obtained by different knee implants. The main implant types differences are given by generally implant design and by PCL substituting systems that are used.

Material and method: Between 04.2004 – 02.2012 we have performed 506 total knee arthroplasties (TKA), on a group of 460 patients. Our choice, was for cemented total knee prostheses, using PCL-substituting systems. Regarding general design and PCL-substituting systems of the implant we had divided the main group in three lots. In order to assess post-operative result we had used the American Knee Society Score (AKSS).

Results and discussions: All prostheses types that we had implanted, had registered satisfactory values of AKSS. Our study showed that one group scored higher values of AKSS, compared the other two, but there are not statistical semnificative differences ($p=0,09$).

Key words: knee arthroplasty, PCL-substituting system, implant design, AKSS, knee function

Corresponding author:

Horia Orban, MD, Professor
Department of Orthopaedics and Traumatology
"Elias" University Emergency Hospital
Bucharest, Romania
E-mail: horiabogdan@live.com

Introduction

Knee arthroplasty represents a laborious surgical procedure, involving a high degree of difficulty, concerning the bony tissue as well as soft tissues. Nevertheless, knee arthroplasty represents a procedure frequently used in orthopaedic clinics around the world, and its incidence keeps increasing (1).

The objectives of this procedure are represented by pain

relief, normal articular space and a normal inferior limb axis, setting up a three compartment stable articulation, with an increased range of motion, providing a normal socio-professional life for the patient. Endurance of the implant and of its objectives represents another important demand for knee arthroplasty (2).

It is indicated in advanced degrees of the degenerative pathology such as primary osteoarthritis or secondary osteoarthritis, and in case of inflammatory pathology (rheumatoid arthritis or ankylopoetic spondylitis). At the same time, there are certain situations in which knee arthroplasty is totally inadvisable – local or distance sepsis or in case of neuropathic arthropathy. Poor general state of the patient or an advanced osteoporosis are relative contraindications for arthroplasty (3,4).

Implant technology has registered a continuous development, in order to improve postoperative results and to cover for every pathological case. Knee compartments can be affected partially or globally, in advanced degrees of the pathological processes that we have mentioned before. In order to respond to these pathological states, unicompartmental, bicompartamental and total knee prostheses were developed (5,6). Bone quality represents an important decision factor regarding the type of implant fixation. If a quality bone is available, an uncemented implant (press fit or porous coated) may be used (6).

Regarding the level of constraint, there are constrained implants (hinge prostheses), semiconstrained and unconstrained implants (7,8).

Two main concepts have been enunciated regarding posterior stability in case of unconstrained implants. The first one is based on maintaining an intact PCL in order to provide implant stability (9). ACL and PCL are often affected by osteoarthritis (by intercondylar osteophyte (10), and mainly by rheumatoid arthritis (characterized by severe ligamentous laxity and imbalance (11)). In order to correct that, postero-stabilised prostheses have been developed, with special implant geometry that provides sagittal and frontal stability (12,13).

Study premises

The purpose of this study is to assess postoperative results obtained after total knee arthroplasty practice, using postero-stabilised prostheses, with different implant designs. Knee prosthesis design constantly evolves, new models being considered and promoted by the manufacturing companies as superior to competing models.

The main differences between the implant models used were the overall design of the prosthesis and at the same time the PCL-substituting systems used. We evaluated the performance of these implants, both in terms of immediate postoperative recovery (6 weeks, 3 months) and of their capability to maintain and improve their functionality in a constant manner for a longer period of time (2 years).

Material and Method

Between 04.2004 – 02.2012 we have performed 506 total

knee arthroplasties (TKA), on a group of 460 patients. The mean age was 66.7 years (limits between 43 and 83 years of age). Female were prevalent, 280 patients, equivalent to a rate of 61%.

In our study we have performed knee arthroplasty addressing to a complex pathology, covering both degenerative affections (primary/secondary arthritis. and inflammatory affections (rheumatoid arthritis-RA). Their rate was 456 cases of arthritis to 50 cases of RA. All patients were radiographically assessed preoperatively using standard incidence (AP/ML). In order to establish the degree of articular damage, we used the Albach classification. Over 65% of our cases were classified as stage 4 and 5.

The same surgical team performed all knee arthroplasties, in the same manner. We used an anterior approach, performing a subvastus capsulotomy. Special care was taken to obtain an optimal ligamentous balance, both in extension and in flexion, in order to achieve a stable joint.

Our choice, in all cases included in the study, was for cemented total knee prostheses, using PCL-substituting systems. We performed patellar replacement in all cases. We used bone cement with high viscosity without antibiotic. During the mixing of the cement, we added 80 mg of Gentamicine for each cement pack. Immixing was performed without vacuum. Regarding general design and PCL-substituting systems of the implant we divided the main group in three numerically equal lots – A, B and C.

Lot A – 170 cases, includes total knee prostheses, postero-stabilized by the third condylar system – AGC V2 from Biomet (Fig. 1). This kind of implants were used for primary arthroplasty, and ensures a good frontal and sagittal knee stability.

Lot B – 131 cases, includes total knee prostheses postero-stabilized by cam eminence mechanism – Scorpio from Stryker (Fig. 2). This type of implant provides a higher degree of constriction, leading to an increased frontal, sagittal and rotational articular stability.

We used this kind of prostheses for primary arthroplasty in case of arthritis, but especially of rheumatoid arthritis. This illness is characterized by a sever ligamentous injury, standard ligamentous straining techniques being inefficient. The implant's design also provides a single A/P condylar rotation axis, and at the same time is suitable in both M/L and A/P planes, maximizing contact area and congruence between femoral condyles and tibial articular surface, without enhancement of constraint.

Lot C – 205 cases, includes total knee prostheses also postero-stabilized by cam/spine mechanism – NexGen from Zimmer (Fig. 3). The difference compared to lot B is given by a different design, involving adaptability of the femoral condyle curvature to the tibial articular surface curvature for every component measure, and at the same time, size interchangeability of the femoral component, tibial base plate and tibial articular surface providing maximum contact area, without interfering with kinematic function. Another design characteristic is given by different radii of curvature on the distal and posterior femoral condyle. In the

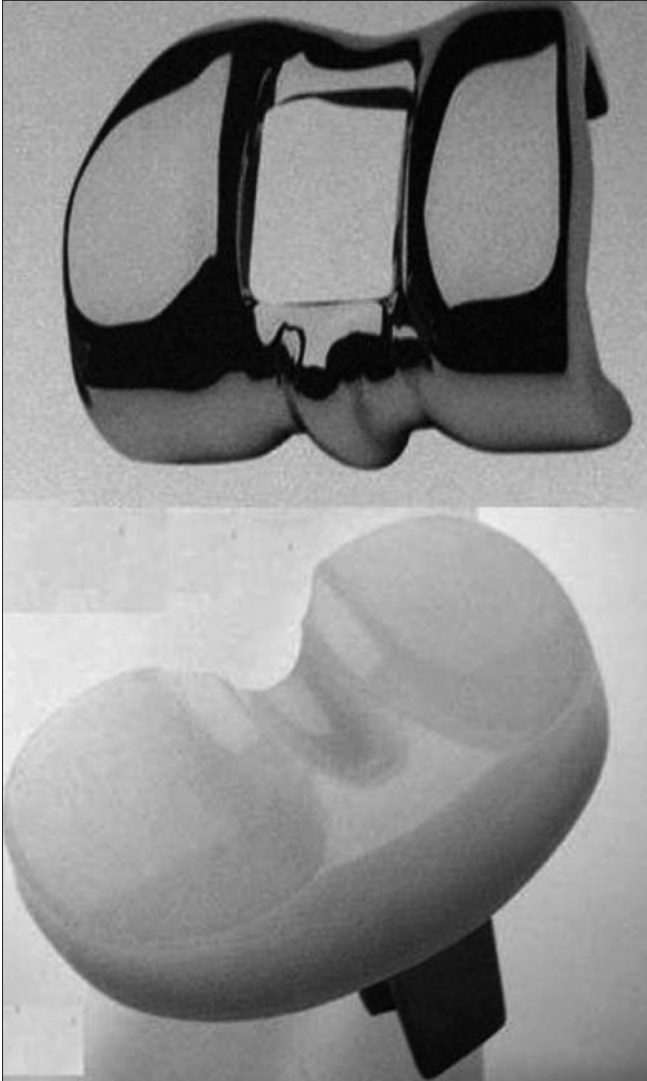


Figure 1. Lot A's type of implant

frontal plane, this type of implant featured dished articulating geometry which provides large contact area on the loaded condyle, without edge loading. At the same time, this implant features symmetrical sagittal geometry – the radii of curvature are the same on both the medial and lateral condyle, in order to allow the cam/spine interaction to provide rollback, while minimizing the tendency of the femoral component to rotate around the spine (14).

In order to be unbiased in our evaluation, we assessed our patients at 6 weeks, 3, 6, 12, 24 months after surgery using the American Knee Society Score. This score is highly objective, being divided in two separate scores: articular and functional score. This allows us to eliminate associated inferior limb affections and patient's subjectivity. We performed statistical analysis of the difference of values at 6 weeks and 3 months, this representing the recovery period, and at 2 years to assess prosthetic function after a longer period of time.

We allowed early bed mobilization, using alternative passive flexion and extension positions, for two hours each,

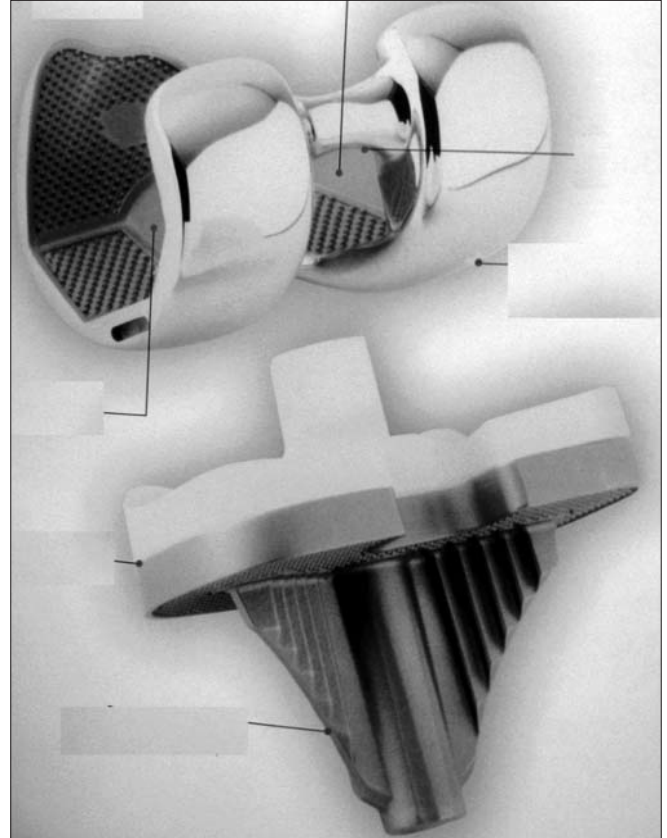


Figure 2. Lot B's type of implant



Figure 3. Lot C's type of implant

without kinetec. At the same time we encouraged patients to have early active extension and flexion movement in order to regain full range of motion. Walking was allowed from the second day after surgery with full weight bearing. All patients required at least two units of blood transfusion. Antibiotic prophylaxis was administered for a period of three days in case of arthritis and for 7 days in case of rheumatoid arthritis. We started thrombosis prophylaxis 12 hours before surgery using low molecular weight heparin and we continued for 35 days after surgery.

Results

The A, B and C lots average values of the knee articular score are listed in the *Table 1*.

The A, B and C lots average values of the knee functional score are listed in the *Table 2*.

The knee articular and functional score dynamic evolution are listed in *Diagrams 1* and *2*.

Statistical analysis: Fisher test.

Functional score: p value at 6 weeks: 0.09; p value at 3 month and 2 years: > 0.1.

Articular score: p value at 6 weeks, 3 month and 2 years: > 0,1.

Usually in case of RA, we are dealing with an advanced articular destruction, intraoperative difficulties and a slow and difficult recovery of the knee function. That's why we performed a parallel assessment of the RA cases, obtaining at 2 years after surgery lower AKSS values compared to arthritis. Knee articular score: 87 points for RA compared to 92 for arthritis. Knee functional score: 76 points for RA compared to 97 for arthritis.

Discussions

- Articular score recorded a sharp increase in the first 6 weeks postoperatively, followed by a moderate but steadily increase up to 2 years. This increase is due to pain relief, improved flexion, and joint stabilization. After 3 months group C had an increase superior to the other two, but not statistically significant.
- Functional score, in the case of lots A and B shows a moderate increase in the first 6 weeks, increased significantly between 6 weeks and 6 months, afterwards



Diagram 1. Knee articular score

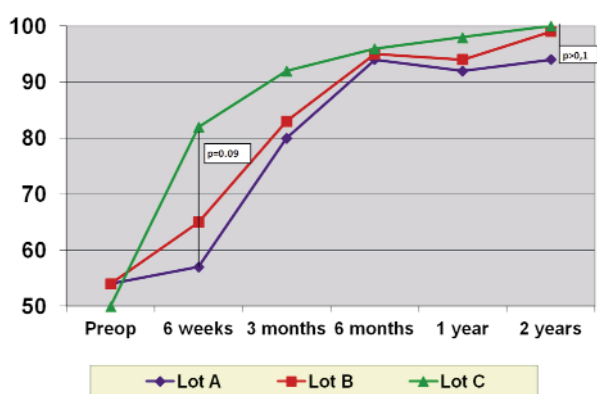


Diagram 2. Knee functional score

remaining constant up to 2 years. In contrast, group C functional score grew faster in the first 6 weeks, followed by a steady and superior increase compared to groups A and B, up to 2 years postoperatively, but in this case as well the difference at 6 weeks and 3 months is not statistically significant.

- All three types of implants included in the study recorded satisfactory AKSS values, expressing a good recovery and functionality of the prostheses studied.
- Although the development of new types of prosthesis stabilization and design is important, the study did

Table 1. Knee articular score

	Preoperative	6 weeks	3 months	6 months	1 year	2 years
Lot A	26	85	86	90	93	90
Lot B	22	84	85	89	88	93
Lot C	32	81	88	90	95	95

Table 2. Knee functional score

	Preoperative	6 weeks	3 months	6 months	1 year	2 years
Lot A	54	57	80	94	92	94
Lot B	54	65	83	95	94	99
Lot C	49	82	92	96	98	100

not show significant differences between the three models. We consider that it is important to maintain the basic principles of prostheses (postero-stabilized, anatomical design) and a surgical technique as high-performing as one can obtain, in order to achieve good results.

Conflicts of interest and source of funding

No funds were received in support of this study. No benefits in any form have been or will be received from a commercial party related directly or indirectly to the subject of this manuscript.

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