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History of Condylar Total Knee Arthroplasty

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1. Introduction

The first attempt of treating patients affected by knee osteoarthritis with arthroplasty go back up to the mid-nineteenth century with the use of either a soft tissue interposed within the joint surface or resection of a different amount of bone of both distal femur and proximal tibia.

However the concept on which total joint replacement is based can be traced only after the 1880 in Berlin with Thermestocles Gluck who gave a series of lectures describing a system of joint replacement by unit made of ivory. The surgeon believed that these unit could be stabilized in bone with cement made of colophony, pumice and plaster of Paris.

The early twentieth saw the return of interposition arthroplasty with the use of autologous tissue or metallic surface and in the 1950s was developed the first surface replacement of the tibia by McKeever (McKeever, 1960). Only during the 1950s and 1960s at last the knee arthroplasty concept diverged into two theories of total joint replacement: the designer focused their effort toward constrained or hinged prosthesis or toward condylar replacement.

Condylar replacement knee prosthesis is defined as one where the femoral and tibial load-bearing surface are replaced with non connected artificial components. Work on the design of an implant that resurfaced the distal femur and proximal tibia without any direct mechanical link between the components began at the end of sixties at the Imperial College in London. The original design known as Freeman-Swanson prosthesis consisted of a metal "roller" placed on the distal femur that articulated with a polyethylene tibial tray and requires resection of both cruciate ligaments.

In other part of the world were developed different experience which carried out to Polycentric, Geomedic, Duocondylar systems (Fig.1).

Even if all of these implants were considered unsatisfactory because of a high percentage of components mobilizations, break of the components and infection the acquired experience permitted the resurfacing prosthesis planning (Insall & Scott, 2001) to occur its successive design phase followed two different ways : the anatomical approach and the functional approach. (Robinson, 2005).

Fig. 1. Duocondylar (courtesy of Prof F. Catani).

2. Anatomical approach

Some designers studied prosthesis that preserve both cruciate ligaments, allowed the femur to roll-back on the tibia.

Yamamoto, from the Okayama University Medical School in Japan, was the first to report on implanting an anatomical femoral component with a minimally constrained single-piece polyethylene tibial component in 1970 (Yamamoto, 1979). The design called the Kodama-Yamamoto knee, consisted of an anatomical femoral mold component, including an anterior femoral flange, made of COP alloy (Co, Cr, Ni, Mo, C, and P). There was a 1-piece, mildly dished polyethylene tibial component that had a central cutout for preservation of both cruciate ligaments.

Others Authors who followed the same approach was Waugh (Waugh et al., 1973) at the University of California UCI, Townley with the cemented Anatomical knee (Townley & Hill, 1974) and Sheedom who designed the Leeds knee. All these prostheses had and horseshoe-shaped tibial component leaving a space behind and centrally for the retention of both anterior and posterior cruciate ligaments.

At the HSS, during the early seventhies, the Duocondylar knee was completely redesigned in an anatomical and symmetrical design: the Duopatellar (Fig.2).

An anterior femoral flange, patellar button, and a more dished tibial surface were added. The tibial component had a fixation peg, identical to the Total Condylar TC, the archetype of the functional approach, and, for the first time, a posterior rectangular cutout—specifically designed for the preserved posterior cruciate ligament.

Although the result of Duopatella were extremely good at the HSS the posterior cruciate–preserving approach would be developed in Boston at the Robert Breck Brigham Hospital (Scott, 1982; Sledge & Ewald, 1979). In Boston the medial tip of the femoral trochlear flange was removed, creating right and left designs based on the asymmetry of the proximal femoral flange.

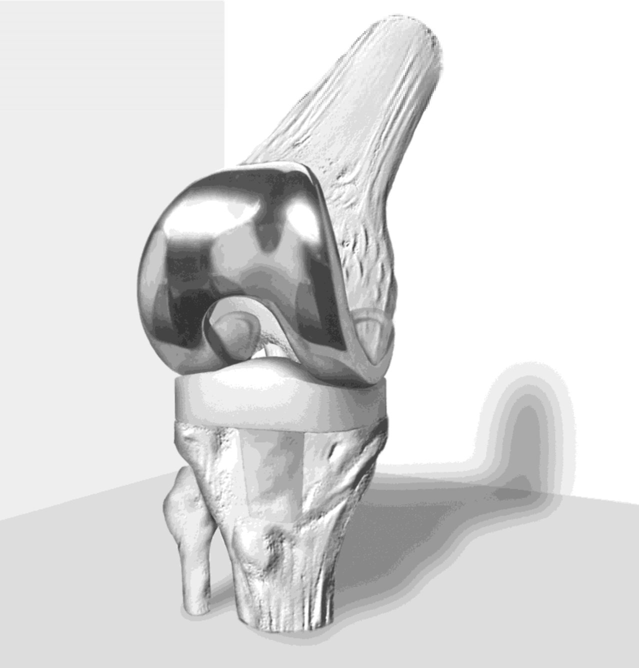

Fig. 2. Duopatellar (courtesy of Prof F. Catani).

This was done to reduce the medial overhang seen in small female rheumatoid patients. The posterior cruciate–sparing version of the Robert Brigham Hospital would later evolved in the PFC knee (Cintor Division of Codman; later, Depuy, Johnson & Johnson). At the same time Peter Walker, Clement Sledge and Fred Ewald, continued the Duopatella concept in the posteriorcruciate–retaining version of the Kinematic knee (Howmedica), which was implanted by Ewald in June 1978. This would evolve into the posteriorcruciate–sparing version of the Kinematic II, Kinemax, and Kinemax Plus systems (Howmedica).

The 80's saw the significant advances in the knee arthroplasty, particularly in the area of surgical technique and instrumentation. Kenna, Hungerford, and Krackow participated in the design of the instruments that were later called the Universal Instruments. Their tools were based on the anatomical concept of measured resection technique rather than the more functional approach of creating equal and parallel flexion and extension gaps which where used until then. The principal aspect of this new conception was that the bone and cartilage removed were to equal the thickness of the prosthetic material replacing them. Up until this time, fixation of the condylar total knee was primarily achieved with cement.

In January 1980 the first Porous-Coated Anatomical Knee (PCA) was inplanted by Hungerford at Johns Hopkins (Hungerford et al., 1982). The implant was anatomical with asymmetric medial and lateral femoral condyles similar to the Leeds and the original Townley designs. However, for the first time, it introduced porous coating in a total condylar knee for a cementless fixation. Each of the 3 components was backed with metal and a 1.5-mm-thick sintered porous coating of cobalt chrome beads.

The Miller-Galante total knee, one of the first knee replacement designed for use with cement or cementless fixation, was first implanted in 1986. The principal innovation of this implant was the choice of a titanium fiber composite for the bony ingrowth surface, because of its well-recognized biocompatibility, and the use of a Titanium Aluminums and Vanadium alloy (Ti6Al4V). The implant is fixed to the tibia with titanium screws and pegs. The uncemented version for patellar resurfacing consists of a metal-backed patella which is

fixed with fiber-mesh pegs. Modularity of tibial polyethylene inserts was incorporate in order to allow better ligamentous tension and possibility of future isolated polyethylene replacement.
“Cruciate retaining” prosthesis developed from the anatomical concept were different: some consisted of a relatively flat surface on the sagittal and transversal plane (Kinemax e PCA) while others maintained a more congruent surface on the sagittal plane. Genesis II (Smith&Nephew), Duracon (Howmedica), Nexgen CR (Zimmer), PFC CR (Depuy) represent some actual examples of this conception.

3. Functional approach

Designers of the functional approach tried to simplify the knee biomechanics by removing both cruciate ligaments.
The first system derived from the functional concept is represented by the Total Condylar prosthesis (TC; Fig.3) developed in 1973 at the Hospital for Special Surgery of New York (Insall et al., 1976).

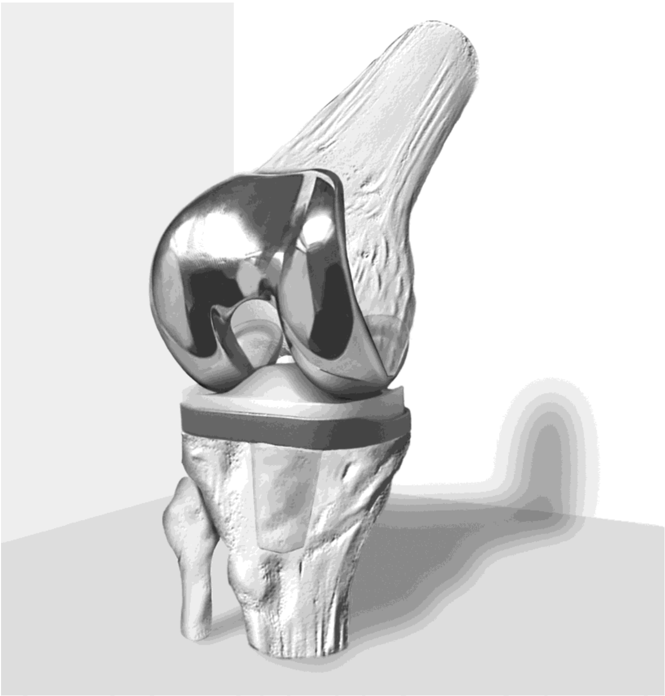

Fig. 3. Total condylar (courtesy of Prof F. Catani).

TC prosthesis consisted of two symmetric condylar surfaces with a posterior decreasing radius of curvature and an articular surface made of polyethylene, perfectly congruent in extension and partially congruent in flexion.
The TC knee would prove to be highly successful, widely used, and would later demonstrate long survival (Vince et al., 1989). Two concerns, however, pointed out the early fases of its clinical use. The femoral component would shift forward, particularly in flexion. In rare cases, this would even result in tibial loosening or anterior dislocation. The second concern was the limited flexion achieved. Average knee flexion with the TC knee was in fact 90° degrees (Robinson, 2005).

In 1978 prosthesis Insall-Burstein was designed to correct these problems by replacing the posterior cruciate ligament with a mechanical lock to reduce posterior translation of the femoral component by using a mechanism of a cam articulated with a post on the tibial component (Fig.4).

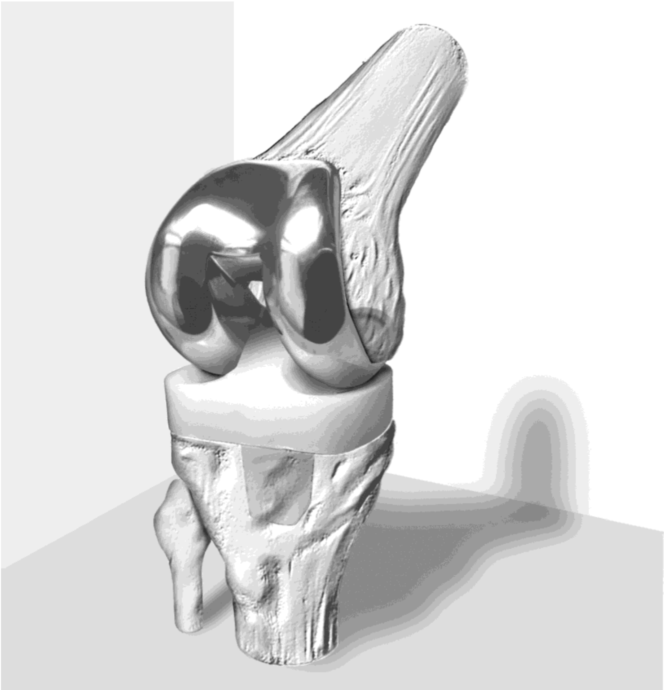

Fig. 4. IB-I allpoly (courtesy of Prof F. Catani).

The cam of the femoral component connected with the tibial central spine at about 70 degrees of flexion and then the femur could roll-back so to increase flexion.

The first IBPS knee was implanted in 1978 by Insall at the HSS.

The IBPS knee become one of the most successful total condylar knee design (Abdeen et al., 2010). Anterior femoral subluxation was eliminated and average flexion would be 115°. A metal-backed monoblock IBPS tibial component with direct-molded polyethylene was introduced in November 1980: the Insall-Burstein Modular (IBPS II) knee (Stern & Insall, 1992).

The HSS posterior-stabilized knee design would evolve into the Insall-Burstein Modular (IBPS II) knee (Zimmer; Fig.5) in 1988, the Optetrak Posterior-Stabilized knee (Exactech; Fig.6) in 1994, and the Advance Posterior- Stabilized knee (Wright Medical) in 1994.

In the 1980s and 1990s, many variations of these functional designs were introduced by different manufacturers. All of them had the characteristic to produce their motion through a so called guided motion, which mean that some characteristics of the motion, such as rollback, are produced by mechanical interaction between the femoral and tibial components.

In the Kyocera Bi-Surface knee (Kyocera Corp, Kyoto, Japan; Fig.7) (Akagi et al., 2000), for the major part of the flexion range, the knee behaves as a standard condylar replacement with moderately conforming bearing surfaces. Beyond that, the load is transferred to a spherical surface protruding behind from the femoral intercondylar region, contacting within a spherical depression at the posterior of the plastic tibial component.

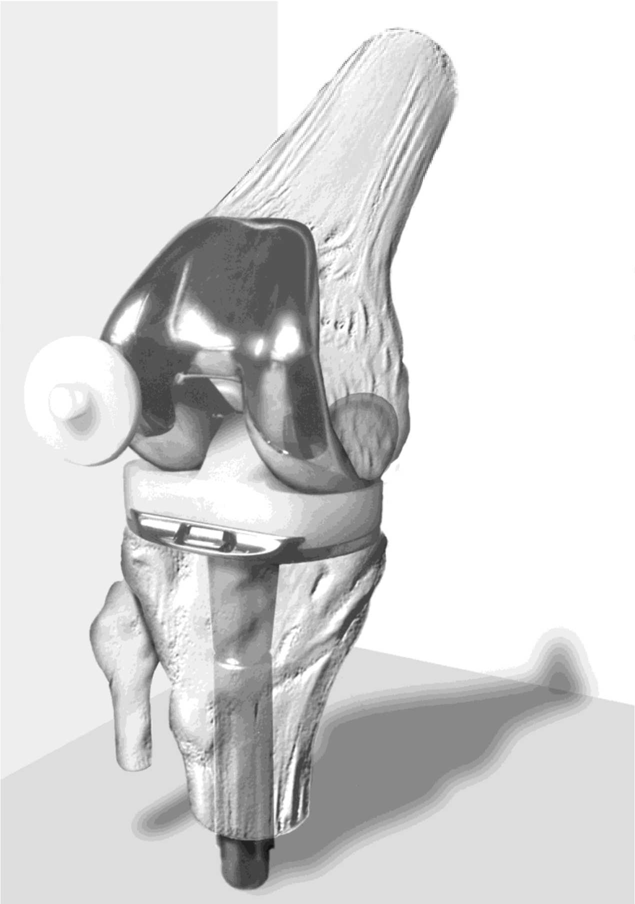

Fig. 5. IB-II PS (courtesy of Prof F. Catani).

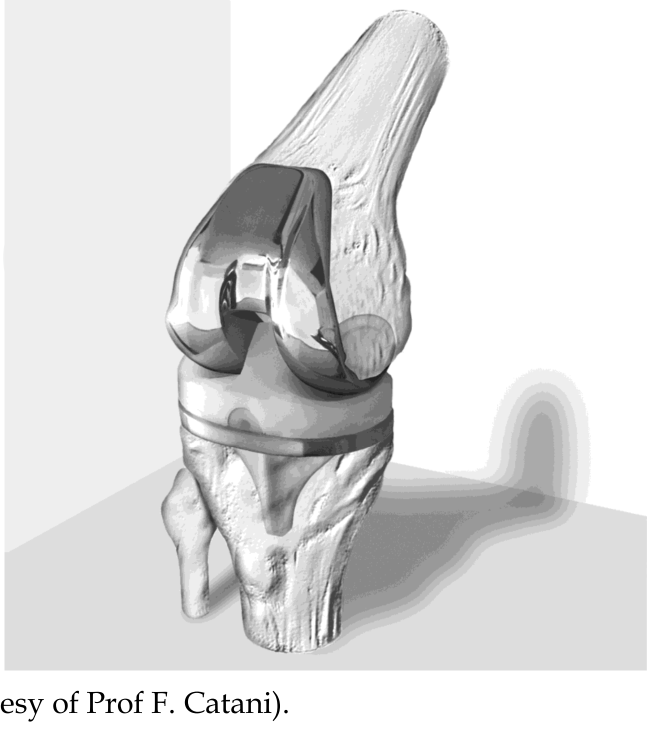

Fig. 6. Optetrak (courtesy of Prof F. Catani).

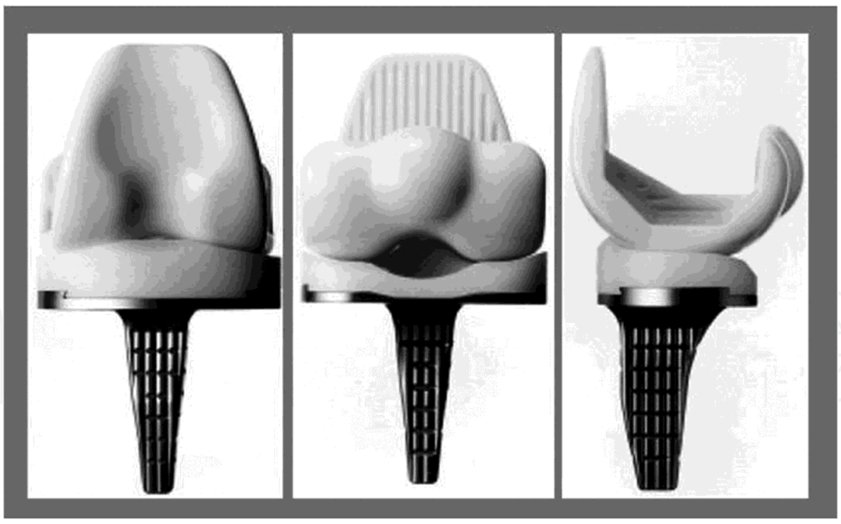

Fig. 7. The Bisurface knee prosthesis (courtesy of Kyocera Corp).

Another example of guided motion knee is represented by The Medial Pivot knee (Wright Mfg Co, Memphis, TN; Fig.8). In that prosthesis the femoral component owns a single radius of femoral curvature and a high level of conformity in the medial compartment where a ball and socket configuration is present. In reason of that configuration the medial side remains in the same position during flexion, but the lateral femoral condyle can displace behind with flexion. The porpoise of the medial pivot design is to reproduce a more physiological kinematics.

Fig. 8. Spherical condylar surface contacting within a spherical depression at the posterior of the polyethylene (courtesy of Wright Medical).

In contrast with this type of solution more recently has been introduce on the market a new design, the 3D Knee, which provides A/P stability similar to ACL deficient valgus knees through a concave lateral compartment. The lateral compartment is fully congruent in extension and allows 15o of axial rotation. As the knee flexes, a greater range of femoral motion is possible, but is controlled by the concave lateral compartment.

The aim of the 3D Knee is then to accommodate and controls the cruciate deficient patterns of motions without constrain in stripe to reproduce the normal kinematic of the knee.

One of the most innovative functional approaches to condylar total knee design evolved from a collaboration between an orthopedic Surgeon at the New Jersey Medical School Frederic Buechel and a professor of mechanical engineering Michael Pappas. Their project to achieve a low polyethylene contact stresses while maintaining knee flexion and avoiding overload of the implant bone interfaces started in 1977 (Buechel & Pappas, 1986) with the introduction of the Low Contact Stress (LCS) knee system (fig.9). It was the first complete systems approach to total knee replacement using meniscal bearing surfaces.

Fig. 9. LCS (courtesy of Depuy J& J).

3.1 Mobile bearing (MB) knee

The principal characteristic of the femoral component was based on the same spherical surface on the mediolateral plane while a decreasing radius of curvature from extension to flexion was present on the lateral side. This shape maintained full area contact on the upper meniscal bearing from the 0 to 45° at which walking loads are encountered, and maintaining at least spherical line at deeper flexion angles. In its origin, the LCS, was proposed as a system inclusive of both cruciate-sparing meniscal bearing and PCL-sacrificing rotating platform variant, with the latter gaining the majority of popular usage over the time.

Afterward the introduction of the LCS system, several types of Mobile bearing knees were produced. They are categorized in according of their conformity: either partially or fully conforming, then a third group is represented by the posterior stabilized MB.

3.2 Partially conforming MB

The LCS other to be the ancestor of all the MB prostheses is also, with its second version featured by a single plastic bearing that freely rotates about its post setaed whitin a hole in the tibial tray, the prototype of the partially conforming one.

Belongs to partially conforming knees the Self Aligning MB (Sulzer) designed by Bourne and Rorabeck in 1987. This prosthesis is characterized by an oval recess in posterior aspect of the polyethylene which allows unlimited rotation and limited AP translation about a tibial tray peg.

The mobile bearing knee produced by the Waldemar Link in Hamburg in 1990, called TACK, is characterized by the presence in the tibial tray of two semicircular guide that engage circular tracks on both sides of the polyethylene platform, permitting wide rotational movement.

The Interax Integrated Secure Asymmetric (Howmedica) prosthesis has nearly fully conformity between femoral condyle and tibial surface in extension and whereas the conformity gradually decrease in flexion. The tibial baseplate has two central posts that engages a curved, t-shaped guide track whitin the meniscal bearing.

In Italy Prof Ghisellini designed the Total Rotating Knee (TRK) (Cremascoli) characterized by a central tibia post projecting from the center of the tibial tray. Two type of plastic bearing were available the R type to allow freedom of rotation was intend to be use incase of PCL excision, whereas the RS allowing 10 mm of AP sliding and freedom of rotation, was indicated when the PCL was retained.

3.3 Fully conforming MB

The progenitor of fully conforming MB knees is certainly the Rotaglide Total knee System (Corin, Cirencester, UK) designed in 1986 by Polyzoides and Tsakonas: the rotaglide femoral component has a constant flexion radius of curvature in the femoro-meniscal articulation, each condyle being part of a sphere of 24 mm radius. This design ensures that congruency is retained throughout the range of flexion. The mobile meniscal bearing has two undercuts which permit up to 5mm of antero-posterior translation and 25° of rotation, 12,5° for each side. The tibial plateau has an anterior bollard that prevents anterior dislocation while restricting the rotation of the platform and another bollard in the middle of the tray that resists posterior dislocation.

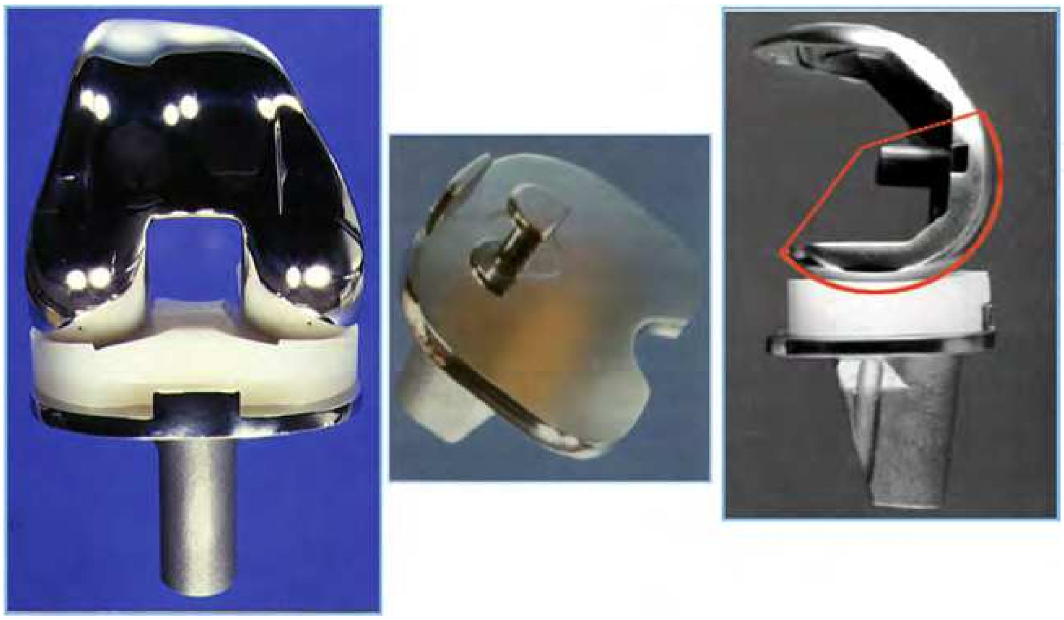

Fig. 10. a) MBK designs (courtesy of Zimmer).

Fig. 10. b) MBK schematic.

The Medially Biased Kinematics Knee (MBK) was developed by J Insall, P Aglietti e P Walker in 1992 (Fig.10a-b). The design concept of this prosthesis is complete conformity between the femoral component and the polyethylene insert at any degree of flexion and during rotation and AP translation of the tibial insert on the tibial tray. The prosthesis design allow a medially biased kinematics guided by the natural knee's stronger medial structures and greater lateral mobility. The polyethylene has approximately 20 degrees of both internal and external rotation on the tibial baseplate about a D-shaped "mushroom" post. The tibial baseplate translates 4,5 mm in an AP direction. An anterior stop prevents the plastic bearing from sliding off the tibial tray.

3.4 Posterior stabilized MB

These design are based on the "cam and post" mechanism on a rotating polyethylene platform. The common feature is the presence of a cam situated between the posterior femoral condyles that engages a post projecting from the mobile polyethylene platform. The "cam and post" mechanism acts as a third weight-bearing condyle to help improve, load transfer and minimize polyethylene stress.

Belongs to this category the Two Radii Area Contact (TRAC, Biomet) which was indroduced in 1997. More recent designs are the P.F.C. Sigma RPF (DePuy) and the LPS mobile Flex (Zimmer).

4. Patellofemoral joint

Symptoms related to the patello-femoral joint have been reported to be a frequent cause of failure following total knee arthroplasty.

During 1980s, up to 30% of patients suffered of complication associated with the patella-femoral joint (Rhoads et al., 1990).

This disappointing feature of what was otherwise a successful procedure led between surgeons to a debate as to whether the articular surface of the patella should be replaced and, in event of the replacement , exactly how this should be performed.

At the some time various authors (Grace & Rand, 1988; Yoshii et al., 1992) pointed out the importance of prosthetic femoral and patella components.

As this problem started off with the improvement of flexion allowed by the second generation of resurfacing condylar knee, so that minimal patellofemoral problems were associate with the TC which permitted at least 90° of flexion, the principal concern of designers was to perform a deeper trochlea which floor could extend behind so as to roof of the intercondylar notch, thereby providing a surface against which the patella can articulate in full extension.

In effort to obtain a suitable designed trochlea Kulkarni and Freeman (Kulkarni et al., 2000) stressed out the importance that the trochlear surface would extended proximally sufficiently to enable even the highest patella to articulate with the femur in full extension. In their philosophy this part of the femoral prosthesis should be provided with a lateral wall and floor to ensure that the patella remains in contact with the floor of the trochlea from 0° to 20° of flexion. Lastly, the Kulkarni and Freeman trochlea surface should have a lateral wall of the trochlear groove sufficiently steep to provide a distinct resistance to lateral subluxation.

According to these criteria most of the design introduced during the nineties have incorporated multiple changes in the geometry of the trochlear groove, which have been shown to have a positive impact on the patellar complication rate (Bindelglass & Dorr, 1998; Kavolus et al., 2008; Mont et al., 1999).

An important contribution to lowering the rate of patello-femoral complication was correlate with greater attention that since that time was given to the rotational alignment of the femoral component (Anouchi et al., 1993; Scuderi et al., 1994).

5. Polyethylene

In spite of the success of designer in solving some the mentioned problems the 90's marked a period of concern regarding the catastrophic failure of the polyethylene.

Polyethylene (UHMW) has been chosen to create articular insert used for knee prosthesis. It's a low friction polymer, very resistant while articulating with metallic and extremely smooth surfaces of prosthesis.

Knee Prosthesis survival curve after 15 years arrives over 94% using this material (Insall & Scott, 2001).

Despite of these characteristics material usury it's a problem especially considering young active patients.

Damage mechanism of polyethylene are: delamination, usury caused by adhesive and abrasive wear mechanism.

Many factors can affect negatively the mechanical properties of polyethylene; some of them are due to type of prosthesis and material, others depend by clinical conditions (post-operatory alignment, weight, age of patient, ecc).

Polyethylene properties can be modified by sterilization by radiation and by exposition to oxidative environment; the effects are increase in density and elasticity of the materials itself.

Since 1995 all the industries virtually modified polyethylene sterilization procedures, by getting rid of gamma ray sterilization.

Sterilization in inert environment, gas plasma, ethylene oxide, represent at the moment the most common sterilization methods. On the same time , packaging and conserving systems has been modified.

Radiation damage on polyethylene underlined cross-link techniques advantages on usury effects.

Cross-linked polyethylene is widely used in hip prosthesis but it didn’t reach the same application in knee prosthesis.

In fact a recent study performed on untimely mobilized components of prosthesis do not underlined significant differences concerning usury between conventional polyethylene and cross-linked polyethylene (Muratoglu et al., 2003).

6. High flexion knee and new materials

Some important issues have characterized the beginning of the new millennium as the effort to improve movement and the research for new materials. Both these issues are direct for better-performing prostheses for younger more active patients who wish to run, play tennis, and downhill ski.

Range of motion (ROM) after total knee arthroplasty is an important issue in determining clinical outcome and a better satisfaction from the patient. In association to expanding the indication of total knee arthroplasty to more young and active patients, their demands and expectations have increased including secondary goals other than pain relief, such as restoration of “normal-like” joint function, especially weight bearing range of motion, to suit their desired lifestyle (Noble et al., 2006).

Apart from being influenced by the condition of the patient and surgical technique, the final outcome, at least in part, depends on the implant design. Therefore, more recently, implant manufacturers have attempted to design TKAs that better accommodate knee mechanics in high flexion up to 155°.

Since it has been shown that in general posterior cruciate ligament retaining designs have erratic motion with potential for paradoxical roll forward, most of them belong to the posterior cruciate substituting prostheses (Dennis et al., 1998).

These new high-flexion designs are not radically different from their traditional (non high-flexion designs) counterparts but incorporate subtle changes in the geometry of the components to allow improved contact mechanics in the high-flexion ranges compared to traditional designs.

Regarding the sagittal geometry of the femoral component a reduction of the femoral condyles radii in the mid- and high-flexion ranges has been showed some advantage when compared with the traditional implants. In order to eliminate edge loading on the femoral component, on the posterior tibial articular surface, was necessary to extend the posterior femoral condyles. In addition an extended posterior femoral condyle help to restore the posterior condylar offset which has been previously emphasized (Bellemans et al., 2002) as an important factor in achieving high flexion. In that study the Authors observed that for every 2 mm decrease in posterior condylar offset, the maximal obtainable flexion was reduced by a mean of 12.2°.

Some designers prefer mobile bearings for the assumption that for achieving deep knee flexion is the need for large internal rotation of the tibia, which occurs with extreme

posterior shift of the lateral femoral condyle over the posterior tibial plateau increased tibial rotation with deep flexion and the theoretical advantage of improved contact area (Kurosaka et al., 2002; Nakagawa et al., 2000).
These changes are associated to a modified cam/post mechanism which allow a more jump distance and avoids dislocation at deep flexion angles (Fig. 11a-b).

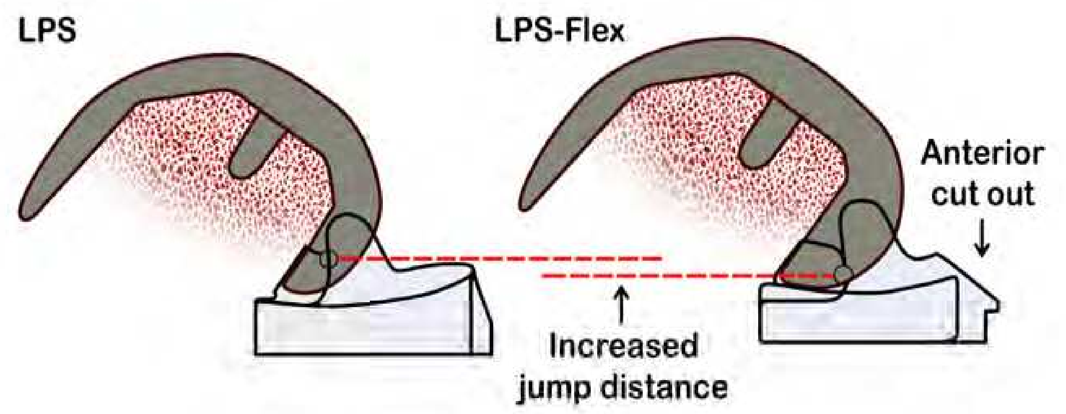

Fig. 11. a) Difference in height distance of the post/cam mechanism between LPS and LPS-Flex designs.

Fig. 11. b) LPS-Flex designs (courtesy of Zimmer).

Other characteristics of high flex design include the patellofemoral joint which should be designed to accommodate high angles of knee flexion. The femoral trochlear articulation should be deep enough to reduce the contact stresses on the patella and the patella should glide smoothly through a full range of motion. These kinds of prostheses in fact, in order to reduce extensor mechanism impingement during deep flexion, the anterior margin of the tibial articular component has been recessed.
In Japan with the aim to accommodate the oriental lifestyle where people sit more often on the floor than on a chair in 1989 was developed a new design originally called KU knee

(Kyoto University knee). The most outstanding feature of this model is that it has an auxiliary joint of a ball and socket at the center of the posterior part not only to facilitate a rollback movement but also to add a rotational function. During a gait under the load, the femorotibial articulation surface in a conventional design works as for standard design, but when the flexion becomes more, the auxiliary joint takes a part as a rotation center in the flexion motion. This auxiliary joint represents a certain type of posterior-stabilized knee and works to achieve a rollback, and when in flexion, rotation of tibia can be also achieved. Because this knee was unique in its biphasic surface structure for the different purposes, weight bearing, and flexion movement, it was later called bisurface knee (BS knee). Another characteristic of this prosthesis is the presence of zirconia ceramics (ZrO2) for femoral component.

Others companies modified design incorporating a lateral compartment which is fully congruent in extension, but relatively lax in flexion (Fig.12) (Mikashima et al., 2010).

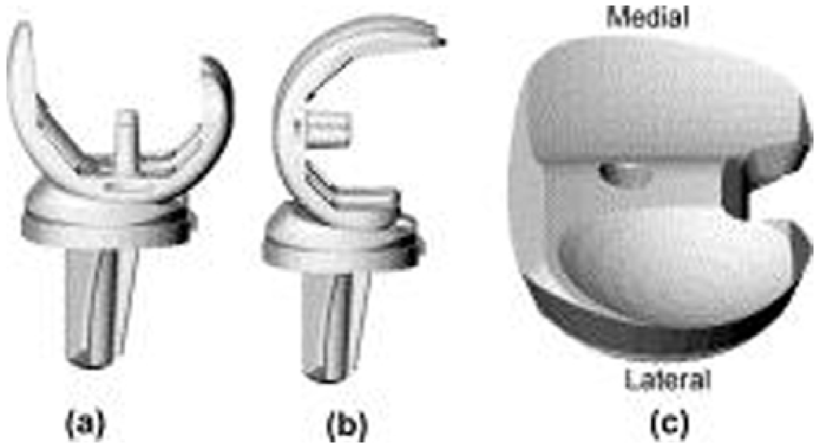

Fig. 12. From Mikashima: the lateral tibiofemoral joint is completely conforming in extension (a), but less conforming at 90 degrees of flexion (b); the tibial insert has an AP curved medial surface and a spherically recessed lateral surface (c).

This lateral congruency constrains the lateral condyle to a central antero-posterior (AP) position in extension, but allows posterior translation in flexion. This articular geometry provides antero-posterior stability and acts through the lateral femoral condyle, thus there is rough analogy with the location and stabilizing role of the anterior cruciate ligament (ACL). In addition, the modified design has a more posterior tibial sulcus (Banks & Hodge, 2004) and the maximum femoral posterior condylar offset occurs later in the flexion arc (Bellemans et al., 2002).

TKA is an effective, well-established treatment for severe arthrythis of the knee. However, further improvement in the longevity in the longevity of the arthroplasty can be achieved with more durable bearing materials.

Due to the non-conforming shape of the bearing surface, hard-on-hard bearing are unlikely to have a role in TKA and polyethylene (PE) still remain an important bearing surface material.

Despite the improvement in manufacturing and elimination of gamma-irradiation in air have already resulted in fewer wear-related problems, concerns remain about adhesive and abrasive wear caused by the hard counterface of the femoral component.

Previous studies have shown that roughening of the cobalt-chromiun (CoCr) alloy can potentiate wear of the PE (Fisher et al., 2004; White et al., 1994).

This wear can then lead to osteolysis, instability, and loosening of the implants from the underlying bone.

Designers are now concentrated on the research of different alloys for femoral components, alternative to the classic CoCrMo one (Stellite), both for complete ceramic or for ceramic surfaces.

A longer lasting of prosthesis with ceramic femoral components should be useful for younger patients with higher functional demands.

Moreover ceramic is useful when dealing with patients affected by allergies to metallic iones (Stellite) (Spector et al., 2001).

The advantages of ceramic bearing surfaces in terms of superior lubrication, friction, and wear properties compared to cobalt-chrome alloy (CoCr) surfaces in total joint arthroplasty are well recognized (Greenwald et al., 2001; Jacobs et al., 1994).

Laboratory and clinical data have demonstrated that ceramic bearings are associated with fewer wear particles that incite a less intense inflammatory host immune response than the metal-on-polyethylene articulations that are the accepted standard in total hip arthroplasty and total knee arthroplasty (Mont et al., 2003; Spector et al., 2001). The brittle nature of ceramics and the inability of ceramic materials to withstand high-impact tensile forces is of concern in clinical applications.

However, more than 10 years' long-term follow-up of cemented different ceramic knees, were performed in Japan and showed satisfactory results with low rate fractures of ceramic component (Akagi et al., 2000; Koshino et al., 2002).

An important improvement has been recently introduced in Europe by CeramTec (AG, Polchingen, Germany) with the BIOLOX Delta a composite matrix material containing 82% vol. alumina (Al_2O_3) and 17% vol. zirconia (ZrO_2) providing good mechanical characteristics in terms of strength and resistance (Dalla Pria, 2007).

Using this material it was possible to develop a femoral component with a tensile strength that meets the demands for application in TKR (Kluess et al., 2009).

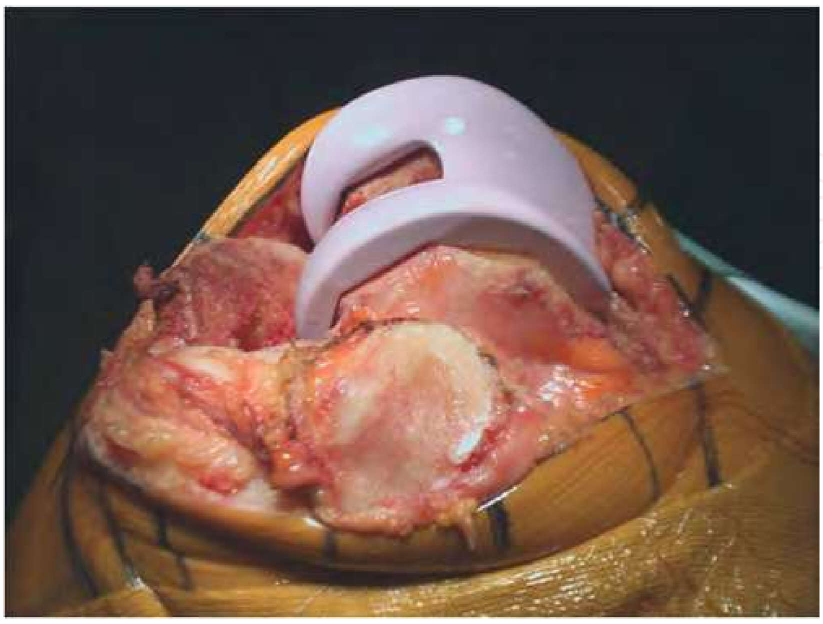

Fig. 13. a) Intraoperative photo of Biolox Delta ceramic femoral component.

A prospective international multicentre study started in 2008 with the aim to evaluate the clinical and radiological outcomes of the unconstrained Multigen Plus total knee system (Lima-Lto) with the new BIOLOX Delta ceramic femoral component (Fig.12a-b).

Fig. 13. b) Post-operative x-Ray of Multigen Plus total knee system (sagittal view).

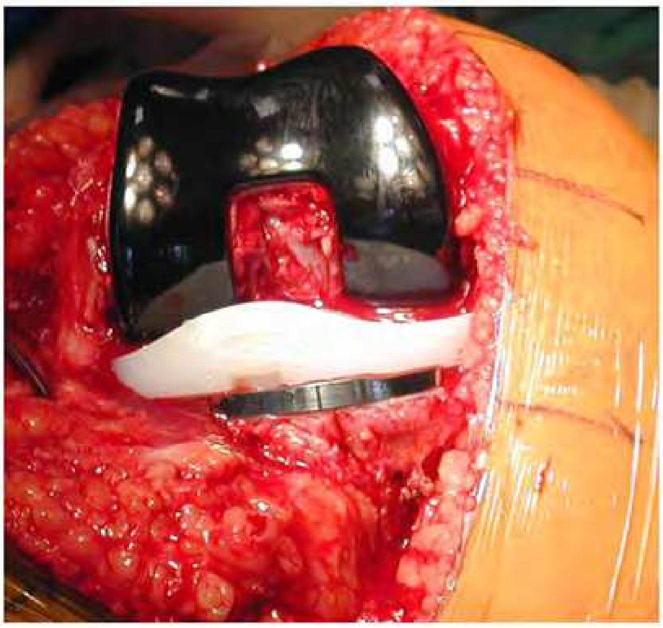

Fig. 14. Intraoperative photo of Genesis II: Oxinium femoral component.

In USA an alternative strategy has been followed to decrease PE wear in THA and TKA, which consists in the surface transformation of metal to oxidized zirconium. A wrought zirconium alloy (Zr-2.5% Niobium) is oxidized by thermal diffusion to create a 5-mm oxidized zirconium layer (Oxinium, Smith & Nephew, Memphis, TN; Fig.14) (Laskin, 2003).

Although existing data are encouraging, with both strategies (Innocenti et al., 2010), further studies are needed to define the precise indications and outcomes of ceramic surfaces in TKA.

7. Conclusions and future perspective

Technological developments in the field of knee replacement continues to increase the range of solutions for the recovery of joint mobility of the painful knee arthritis.

Particularly research and development efforts are focusing on designing effective prosthesis, allowing the movement ever closer to physiological ones, which are well tolerated and long lasting, and are implanted with less invasive interventions.

Explains the considerable attention, first, the morphological aspects of prosthetic components, and second, the quality of materials, with the aim of ensuring greater wear resistance and improved biocompatibility. This is a necessary condition for stability of the prosthetic implant and for the success of the intervention.

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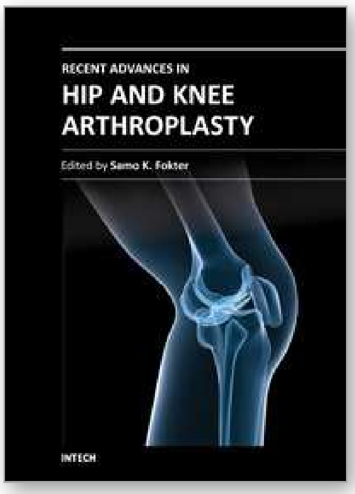

Recent Advances in Hip and Knee Arthroplasty

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The purpose of this book is to offer an exhaustive overview of the recent insights into the state-of-the-art in most performed arthroplasties of large joints of lower extremities. The treatment options in degenerative joint disease have evolved very quickly. Many surgical procedures are quite different today than they were only five years ago. In an effort to be comprehensive, this book addresses hip arthroplasty with special emphasis on evolving minimally invasive surgical techniques. Some challenging topics in hip arthroplasty are covered in an additional section. Particular attention is given to different designs of knee endoprostheses and soft tissue balance. Special situations in knee arthroplasty are covered in a special section. Recent advances in computer technology created the possibility for the routine use of navigation in knee arthroplasty and this remarkable success is covered in depth as well. Each chapter includes current philosophies, techniques, and an extensive review of the literature.

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