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Bicompartmental Knee Arthroplasty: Is it a Safe and Effective Technique Nowadays?

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Bicompartmental Knee Arthroplasty

Whether nowadays total knee arthroplasty (TKA) is the gold standard in treating advanced osteoarthritis (OA) affecting all of the three compartments of the knee, it becomes more controversial when OA only involves two of them. In this case several alternative surgical treatments could be proposed such as: high tibial osteotomy, unicompartmental knee arthroplasty (UKA), bicompartmental knee arthroplasty (BKA) or TKA. Concerning TKA it is also crucial the possibility to use of medial pivot knee or cruciate retaining (CR) TKA; these can better reproduce normal knee kinematics that would reduce polyethylene wear, increase stability and even patient satisfaction.

Discussing on BKA, orthopedics surgeons intend use of medial or lateral UKA in addition to a patella femoral joint resurfacing.

BKA has become a more convincing alternative treatment to TKA in the last years, due to improved technique, prosthesis design enhancement and achievement of better clinical results [1-6].

The rationale of performing a segmental resurfacing of the joint originates from the observation of normal age-related cartilage wear in both cadaveric and radiographic studies. Structural changes typically progress from condyles to patellofemoral compartment [7,8]. The Oxford group observed a significant incidence of patellofemoral cartilage erosion in patients undergoing UKA; an overall rate of full thickness cartilage loss was recorded in 13% of the knees, with 9% involving the medial facet and 4% the lateral facet of the patella [9-12]. Ledingham et al. reported a 58% incidence of bicompartmental OA in their population of patients referred to hospital and a relatively small number of tricompartmental OA. Medial and patellofemoral compartment involvement was the dominant pattern that was observed in 50% of the knees, while lateral and patellofemoral was only found in 8% of patients [13]. Besides, Heekin et al. demonstrated that a significant subset of candidates for TKA had intact cruciate ligaments. They subsequently established that a relevant portion of patients (28%) could benefit from cruciate ligaments preservation and bone sparing BKA [14]. The same authors found that women are more likely to be candidate for bicompartmental knee replacement when compared with men of the same age.

This acquisition lead to the idea that a significant percentage of patients could benefit from the implantation of BKA instead of TKA. The main advantages of UKA and BKA are to be found in preservation of ligaments and minimal impact on bone stock: the keys to comprehend the functional advantages related to these procedures [15,16].

Historically there are two kinds of femoral design in BKA. While the former monolithic architecture with a fixed position of tibiofemoral and patellofemoral components leaded to poor results [17,18], the latter modular unlinked design with two split parts placed independently recorded promising results [16,19-24]. Recently the monolithic BKA is hardly used anymore as the high incidence of persistent knee pain and reduced function made the rate of failure and subsequent conversion to TKA unacceptable [25].

On the other hand BKA achieved better results if accurate indication is given; inclusion criteria (OA grade and extension) were established by Kozinn and Scott: minimum of 90° flexion arc and less than 5° of flexion contracture, angular deformity of no more than 10° of varus and 15° of valgus and intact anterior cruciate ligament (ACL) [26]. No limitations of weight and age are recommended, although BKA is especially suitable for young and active patients with body mass index (BMI) <32 and high functional expectations [1,2,4,16,23].

Early results for the less invasive procedure of BKA showed excellent pain relief and knee function, lower complications rate (fat embolism, blood loss, infection and venous thromboembolism), shorter hospital stay, allows faster rehabilitation and return to daily activities, if compared to TKA [4,5,15,16,27].

Revision, if required, is often carried out without difficulties and performed with the utilization of primary implant TKA. Occasionally the employment of augments and stems is required, and the use for revision TKA is generally unnecessary [23,25,28-33].

TKA produces predictable and durable results [31], nevertheless it unavoidably alters knee biomechanics and loads distribution of the joint. The preservation of a more physiological biomechanics as it happens in BKA should theoretically protect the implant and limit the stresses acting on it. The BKA should have at least the same potential survivorship capability of its more invasive alternative, however few long-term studies are yet available. Past studies showed in most cases poor survivorship compared to TKA's reports.

Parratte et al. found a 54% of BKA revisions in a 17-years follow up analysis, radiographic loosening or disease progression [27]; but 15 of the 20 patellofemoral loosenings were uncemented implant, performed before 1989; cemented components produced a significant superior long-term outcome and thus are recommended. The same authors advocate for modular BKA, recognizing that cementless trochlear component fixation, poor instrumentation and polyethylene quality were responsible for aseptic loosening. Other papers reported no surgical revisions after a mean follow up of approximately 12 years [34].

Since BKA is a relatively new procedure, strong mid-term and long-term outcomes still have to be established. Further studies should determine whether long-term durability of the implant is comparable to that of TKA or single compartment arthroplasty for bicompartmental disease. A characterization of the un-resurfaced compartment response to BKA and its disease-free survivorship has yet to be done [35].

The need to perform a BKA (generally considered a more complicated procedure than TKA) is founded on the theoretically advantages of the procedure. BKA can provide the same advantages as UKA over TKA. Preservation of the cruciate ligaments, restoration of normal kinematic and gait, preservation of bone stock, maintenance of the rotational axis, maintenance of normal leg morphology, normal patella level and tracking and conservation of proprioception are the fundamental characteristics supporting partial resurfacing procedures [36-41]. UKA patients showed better functional outcomes and increased likelihood of returning to normal functional activity and to low impact sports [37]. The importance of ACL and posterior cruciate ligament (PCL) retaining in knee arthroplasty has both biological and biomechanical explanation. After a correct implantation, the deriving enhanced stability of the joint is given by the less altered tibiofemoral kinematics and the preservation of proprioception. As the native biomechanics are maintained the stresses acting on prosthetic components are reduced and the shear forces between implant and bone minimized. ACL action on the resurfaced knee may be different from the native knee. Some clinical findings support it, although no in vitro data are available to biomechanically evaluate the ability of the ACL to maintain knee joint kinematics after bicruciate retaining BKA [15,27,34]. Some authors simulated weight bearing knee flexion to investigate the role of cruciate ligaments in BKA and TKA with posterior cruciate retaining. They tested BKA with both ligaments preserved, ACL-resected BKA and the previously mentioned TKA for translational and rotational joint kinematics. They found that the translational and rotational knee joint kinematics resemble that of the native knee in bi-cruciate retaining BKA; the PCL-retaining TKA reached similar translational characteristics but resulted in loss of rotation [20]. If both ligaments are conserved femoral rollback and tibial internal rotation with flexion are maintained [28,42,43]. Ultimately, though, the sparing of cruciate ligaments in BKA may be advantageous in terms of implant survivorship, stair-climb ability, joint kinematics and patient satisfaction [16,30,42-47].

The small amount of studies concerning articulation after BKA implantation generally reported a satisfactory range of motion (ROM) recovery. Most of the patients reached a complete flexion greater than 120° with no pain and complete extension [5,21].

Common complications of BKA are in line with data of literature. Deep venous thromboembolism and deep infections are rare [48].

Paratte et al. found that after at least two years, contemporary unlinked BKA was associated with greater comfort during everyday activities (forgotten knee) and better functional outcomes, compared to TKA. These short-term results require validation in randomized trials with longer follow-ups [49].

Other authors found that BKA lead to a greater knee extension in the early post-operative period. However it seems that such advantages over TKA do not persist over the first year after surgery; when adjusted for age, sex, BMI and baseline status, the early advantages offered by BKA appear to vanish. Nonetheless they highlighted a significant difference in the early post-operative period when patients experience a more rapid and drastic reduction in stiffness in favor of BKA [18].

Engh registered that two years postoperatively the BKA and TKA groups achieved equivalent results in clinical scores and functional testing [50].

Yeo et al. underlined how unlinked modular BKA scores equivalent clinical and functional results as TKA for medial and patellofemoral arthritis in the mid-term. Intra-operative blood loss was significantly lower in the BKA group compared to the TKA group. Thus BKA is a viable option for a select group of young and active patients with the advantage of reduced intra-operative blood loss and equivalent functional outcomes as TKA [51].

Other groups found general clinical and functional better outcomes for BKA compared with TKA but no statistical significance was produced. In terms of KSS-function, KOOS stiffness and ADL scores, the BKA group was consistently better than TKA. The better function in the BKA group may be the result of bone and ligaments preserving nature. Postoperative knee ROM and its improvement were again higher in the bicompartmental group [52].

The knee muscles strength recovery seems to be equivalent between BKA and TKA. The less-invasive procedure however gives better results in isokinetic quadriceps strength, which is related to better performance during strenuous activities such as jogging or stair climbing [53].

In our surgical experience we performed patellar replacement in TKA for sintomatic tricompartimental knee OA, if patella is thick enough and in all female patients; we chose a bicompartmental knee arthroplasty option in selected cases with bicompartmental OA either medial unicompartmental and patellofemoral or lateral unicompartmental and patellofemoral OA; a modular unlinked implant is what we prefer after literature analysis.

We perform this surgical technique for active people over 55 years old with bicompartmental knee OA and clinical records such as medial o lateral joint line pain associated with important patello-femoral symptoms; patients have to be without very high functional requests like contact sports and as mountain climbing. Young patients have elevated functional demand and can benefit by the implant of UKA, patellofemoral arthroplasty (PFA) or the combination of the two (BKA). These are considered an effective solution for localized osteoarthritis, but as a pitfall there is higher risk of potential revision.

Our surgical results confirm great patients satisfaction in short and medium term with no complications and need to revision (with a follow up of five years maximum)

In conclusion both BKA and TKA effectively reduce pain and improve physical function compared to pre-operative scores. Advantages can be ascribed to the less invasive BKA, limiting intra-operative blood loss, minimizing tissue damage and sparing bone. BKA shows undoubtedly other important advantages such as bone-stock and ligaments sparing that help reproducing a more physiological knee kinematic. Patients showed better functional outcomes and increased likelihood of returning to normal functional activity and to low impact sports.

Overall results of this surgery are at least comparable to that of TKA, the gold standard treatment for diffused knee OA. Studies regarding BKA are less powerful to assess clear benefits of this surgery over the worldwide spread TKA, although bicompartmental

resurfacing concept is actually much more comparable to UKA than to TKA.

For its features of less-invasive surgery, BKA find its ideal indication in young patients affected by medial or lateral tibiofemoral OA, plus patellofemoral compartment involvement.

Although encouraging results are emerging from recent studies, further prospective, randomized, long-term analysis comparing BKA and TKA have to be performed before definitive treatment recommendation could be determined; analysis of outcomes of PFA replacement in a not definitive indication in patella management in TKA is today mandatory.

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