4 Unicompartmental Knee Arthroplasty in Medial Osteoarthritis: The Basics

G. Deschamps, C. Dodd, P. Hernigou, A. Franz, S. Parratte, J.M. Aubaniac, Jean-Noël Argenson, and M. Ollivier

Contents

G. Deschamps
C. Dodd
P. Hernigou
A. Franz
S. Parratte
J.M. Aubaniac

J.-N. Argenson (✉)
Hòpital Sainte Marguerite, Service de Chirurgie Orthopédique, 270 BD Sainte Marguerite, FR-13009, Marseille, France
e-mail: jean-noel.argenson@ap-hm.fr

M. Ollivier

4.1 Modern Indications of Unicompartmental Knee Arthroplasty (UKA)

G. Deschamps

Unicompartmental knee arthroplasty (UKA) is designed for patients presenting isolated degenerative unicompartmental medial or lateral femorotibial wear or wear related to aseptic osteonecrosis of the femoral condyle, most frequently medial.

J. Menetrey et al. (eds.), *ESSKA Instructional Course Lecture Book*,
DOI 10.1007/978-3-642-29446-4_4, © ESSKA 2012

Fig. 4.1 An ideal case for UKA with isolated medial wear without excessive bone deformity. Absence of anterior tibial translation on the lateral weight-bearing x-ray predicting a healthy ACL

The indication is based on strict criteria (Argenson et al. 2002) [1, 2] (Deschamps and Chol 1997):

- Wear must stem from degenerative osteoarthritis (Fig. 4.1) or be secondary to aseptic necrosis of the medial condyle (inflammatory rheumatism is a contraindication). The symptoms associated with this feature, and particularly pain, must be localized on the index compartment and recognized by the patient as its own and usual pain.
- Age and activity level should be compatible with an indication for arthroplasty.
- The body mass index should be less than 30 kg/m^2.
- The ligament system must be intact, particularly both cruciate ligaments.
- Any preexisting axis deformity should be moderate and the residual axis deformity, after correction of wear with a UKA acting as a spacer, should not exceed 7–10° varus or valgus.

These highly restrictive conditions result in the ideal indications for UKA suitable for no more than 15–20% of knee arthroplasty candidates for most surgeons experienced in this procedure (Stern et al. 1995).

Although the results of certain early series worried potential users [3], today it can be asserted that recent series whose indications and technique correspond to modern use criteria have shown results that are as reliable as those of total knee arthroplasty (TKA) at a 10-year follow-up [4–7]. Beyond this time frame, the risk of polyethylene wear related to the technical restrictions of the UKA is another consideration [8, 9]. Indeed, to prevent the risk of rapid extension of osteoarthritis to the opposite compartment, the procedure should be limited to restoring the patient's constitutional axis before wear phenomena had set in (Fig. 4.2). This makes UKA a surgical procedure at risk of failure due to wear phenomena.

Therefore, today, we can propose instructions for this intervention (Deschamps and Chol 1997), whose value compared to TKA is expressed not only in easier postoperative recovery but also because the flexion and function obtained at

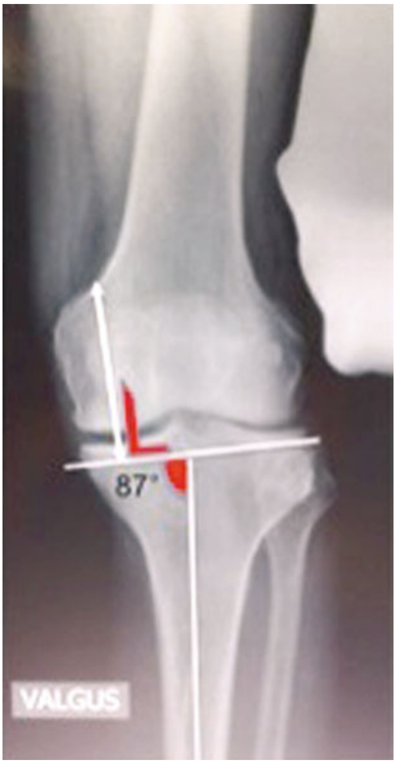

Fig. 4.2 Frontal stress x-ray demonstrating that UKA can be used to wedge the cartilage loss and to plan the ideal direction of the tibial cut

completion are highly advantageous compared to TKAs [10]. These arguments, which several recent publications have emphasized (Argenson et al. 2002) [1, 9], explain the renewed interest in this procedure and the refinement of modern rules for its indications and use.

4.2 Basic Technique: Balancing in Mobile UKA

C. Dodd

1. The prime indication (>90%) for the Oxford mobile-bearing UKR is a pathoanatomical condition where there is advanced medial compartment osteoarthritis centered in the anterior aspect with preserved posterior cartilage, intact ligaments, and a functionally intact lateral compartment. The disease is limited to the anterior part of the medial compartment and is therefore called anteromedial osteoarthritis (AMOA) (White et al. 1995). Stress radiography is the investigation of choice in the preoperative assessment of these patients [11]. Given these normal ligaments, the technique therefore never releases any ligaments. The preserved cartilage in flexion is used to align the components in flexion. In extension, the anatomy is damaged and the normal ligaments are used to align the components in extension.
2. A stylus system accurately and reproducibly resects the correct level of tibial bone in order to insert the tibial plateau and a 3- or 4-mm bearing (Fig. 4.3). There is a slotted shim which allows accurate resection of the horizontal cut.
3. An IM rod and a link pin accurately orientate the low profile femoral drill guide referenced from the normal femoral posterior cartilage, thus reproducibly restoring the joint line (Fig. 4.4). The femoral component is spherical and is very forgiving of up to 10° of femoral component malalignment and up to 5° of tibial component malalignment in any direction [12]. The device is therefore very tolerant of rotational malalignment.
4. A sophisticated technique employing a mill acting over a series of spigots with collars of differing thickness allows for incremental milling, thereby accurately balancing the flexion and extension gaps to within +/− 1mm and restoring the predisease alignment to +/− 1°. This technique also accurately restores normal ligament tension and normal kinematics [13].
5. An anti-impingement system removes anterior and posterior femoral bone, thus preventing dislocation of the mobile bearing [14].

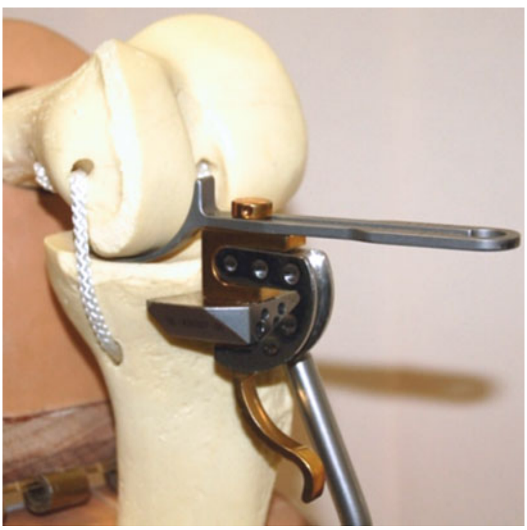

Fig. 4.3 The operative view showing how the system accurately and reproducibly resects the correct level of tibial bone in order to insert the tibial plateau and a 3- or 4-mm bearing

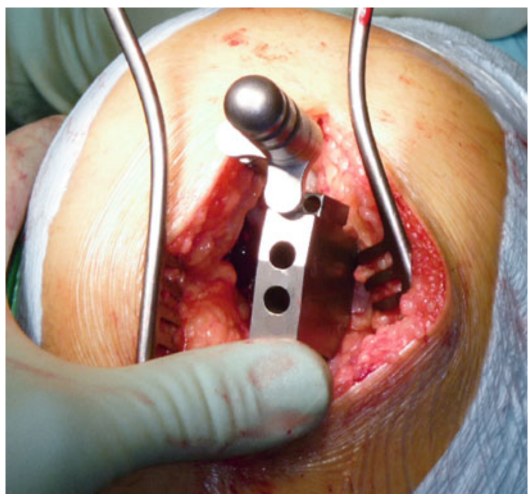

Fig. 4.4 An operative view showing the IM rod and a link pin accurately orientating the low profile femoral drill guide referenced from the normal femoral posterior cartilage

4.3 Basic Technique: Surgical Principles in Fixed UKA

P. Hernigou

4.3.1 Femoral Component Sizing and Final Distal Femoral Preparation

The femoral component size is selected by placing the foot of the femoral finishing guide underneath the posterior femoral condyle and selecting the largest size that will not overhang the junction between the remaining articular cartilage and the cut end of the distal femur. If the component overhangs and extends beyond this point, the native patella can impinge upon the femoral component. Thus, if the surgeon is choosing between sizes, in general the smaller size is selected. It is important to recognize that this is a posterior referencing system, and thus femoral component size does not affect flexion and extension gap balancing. In other words, the amount of bone removed from the posterior femoral condyle is the same regardless of the femoral component size selected with a resection that is equivalent to the thickness of the posterior condyle of the component. When placing the femoral finishing guide on the cut end of the distal femur, care is taken to ensure it is rotated appropriately so that the final femoral component will track centrally on the tibial tray. The removal of osteophytes from the intercondylar notch can also assist the surgeon in appropriately rotating this guide. The guide is then affixed to the femur with multiple pins, and the lugholes for the femoral component are drilled. The femoral chamfer and posterior femoral cuts are then made with an oscillating saw.

4.3.2 Tibial Component Sizing

The remainder of the posterior horn of the medial meniscus and any other remaining soft tissues are removed from the posterior aspect of the joint. The largest size that will not overhang the cut surface of the tibia is selected using the sizing guides; if the tibial cut was removed as a single piece, this can aid in tibial sizing. The trial tibial component is positioned into place.

4.3.3 Trial Reduction

The trial femoral component is inserted along with the trial polyethylene insert. The knee is brought through a range of motion to ensure that the femoral component tracks centrally on the tibial component throughout a range of motion and that the femur does not impinge against the patella. At this point, the knee is extended fully, and there should be 2 mm of laxity in this position. With the knee in extension, the 2-mm side of the spacer should be able to be inserted into the extension space. The knee is now flexed to 90° and the 3-mm side of the plastic spacer should be able to be placed between the trial femoral component and polyethylene spacer. If the flexion and extension spaces are unequal with the trials in place, balancing the extension and flexion space is necessary.

4.3.4 Balancing the Extension and Flexion Space

The technique for fixed-bearing UKA includes resection of the same amount of distal femur as is replaced by the femoral component. However, preoperative assessment of the patient's flexion and extension can aid in adjusting the slope of the tibial resection, which assists in creating appropriate flexion and extension gaps. In a knee with both full extension and good flexion, the slope of the tibial resection should match the slope of the native tibia. With the leg in extension, and after the distal femur and proximal tibial have been resected, the extension side of the spacer is inserted. The thicker extension side of the spacer simulates the thickness of the distal femoral component combined with the tibial component and polyethylene liner. Therefore, at a minimum, the 10-mm block should fit into that space. This will then simulate the thickness of the femoral component with the thickness of the smallest tibial polyethylene liner and allow for 2 mm of laxity in extension, the appropriate amount of residual laxity for a UKA. Once the extension space is appropriately measured, the knee is flexed up to 90°. In 90° of flexion, the flexion side of the spacer (the thin side) is inserted into the flexion gap. This spacer simulates the thickness of the tibial component and the polyethylene liner, without resection of the posterior femoral condyle. At a minimum, a 10-mm spacer block should be able to fit into this space. Usually, the flexion and extension spaces will be similar or equal at this point. However, due to variations in the patient's preoperative ligament balance or bony anatomy or if the bony resections have not been performed accurately, a mismatch between the flexion and extension spaces may be present. The goal at this point is to have the flexion space approximately 1 mm larger than the extension space for a properly balanced medial UKA. The most common problem encountered is to have the extension space tighter than the flexion space. This is usually a residual of a preoperative flexion contracture. Several steps can fix these mismatched spaces. First, as is done routinely in a TKA, removal of posterior condylar osteophytes and the posterior capsule with a curved osteotome can increase the size of the extension gap. If this maneuver does not remedy the problem, the tibia can be recut with slightly less slope as previously described. Finally, the distal femur can be recut by a millimeter or two which will selectively increase the size of the extension space; this is typically required only in cases where initial distal femoral resection was inadequate (less than 6 mm of distal femur was resected). The final alternative is to move the femoral cutting block posteriorly, reducing the amount of posterior femoral condyle resected and thus reducing the size of the flexion space; balance is subsequently achieved by using a smaller polyethylene spacer. The less common scenario is to have the flexion space smaller than the extension space. When this occurs, the tibia can be recut with slightly more posterior slope as previously described. If this does not remedy the problem, the posterior femoral condyle can be shaved with a saw, by a millimeter or two, prior to fitting and sizing the femoral component. This additional resection of the posterior femoral condyle will move the femoral component anteriorly, enlarging the flexion space. The process of balancing the flexions and extension spaces can be an iterative process where slight corrections are made until the flexion and extension spaces are equal and of appropriate size (at least 10 mm) to allow for proper knee kinematics.

4.4 Fix Versus Mobile: Full Poly Versus Metal Back

A. Franz

In the three decades since its introduction, unicompartmental knee arthroplasty (UKA) has become an increasingly common treatment and is now capable of producing superior outcomes to total knee arthroplasty [15]. However, consistent debate surrounds the issue of whether mobile- or fixed-bearing designs are preferable in UKA. Meta-analysis data indicate that there in fact may be no significant difference in clinical outcomes or complication rates between mobile- and fixed-bearing UKA [16], a conclusion that is in accordance with both a recent clinical study [17] and a comprehensive review of research in the field [18]. However, individual studies do point to limitations for each design. Despite several authors reporting robust survival rates at more than 10 years with mobile-bearing designs, other studies with less favorable results have cited the difficult surgical technique required for these devices, the presence of radiolucent lines, and a potential for bearing dislocation as reasons for their inferiority in comparison with fixed-bearing components [18]. Additionally, a recent in vitro analysis, observed that mobile-bearing components exhibited significantly higher wear rates than their fixed-bearing counterparts [19]. In terms of fixed-bearing components, results appear highly dependent on the tibial component utilized. Whereas metal-backed components commonly result in survival rates comparable with the most encouraging studies with mobile-bearing designs, outcomes with all-polyethylene components are not so consistent. Although certain all-polyethylene designs have resulted in excellent medium-term survival, others led to notable complications such as increased rates of loosening and failure [18].

4.5 Bicompartmental UKA and Patellofemoral Joint Replacement

S. Parratte, J.M. Aubaniac, and Jean-Noël Argenson

Outcome and kinematic studies suggest that maintaining the anterior cruciate ligament in bi- and tricompartmental knee arthroplasty may be advantageous in terms of survivorship, stair climbing ability, patient satisfaction, and joint kinematics (Argenson et al. 2002). Considering these results and as bicompartmental arthritis of the knee is not rare, bicompartmental knee arthroplasties have been proposed to bridge the gap between UKA and TKA [20]. There is a renewal of interest for bicompartmental knee arthroplasties, including combined medial UKA and femoropatellar arthroplasty [21]. Smaller implant size, less operative trauma, the preservation of both cruciate ligaments and bone stock, and a more "physiologic" knee joint are considered advantageous over total knee replacement. Patient selection includes a clinical and radiological analysis [5]. Range of motion and stability in the frontal and in the sagittal planes should be analyzed. Radiological analysis including full-length radiographs of the considered knee and stress x-rays should confirm that the wear is limited to the two concerned compartments and that there is no excessive bony deformation. If there is any doubt concerning the status of the ACL, an MRI should be performed to confirm that the ACL is intact. The procedure is performed under general anesthesia without any tourniquet. A subvastus approach is systematically performed to preserve the quadriceps. The trochlea is prepared first using a dedicated instrumentation to perform an anterior femoral cut first. The rotation is controlled relatively to the Whiteside line and the high of the cut relatively to the anterior cortex of the femur. The UKA is then performed using a metal-backed fixed-bearing implant. All the implants are cemented in one step starting with the UKA. Weight-bearing and full-range of motion rehabilitation is stated the day after surgery. It is important to consider systematically the use of two independent implants (Fig. 4.5) to set properly the rotation of each implant [22].

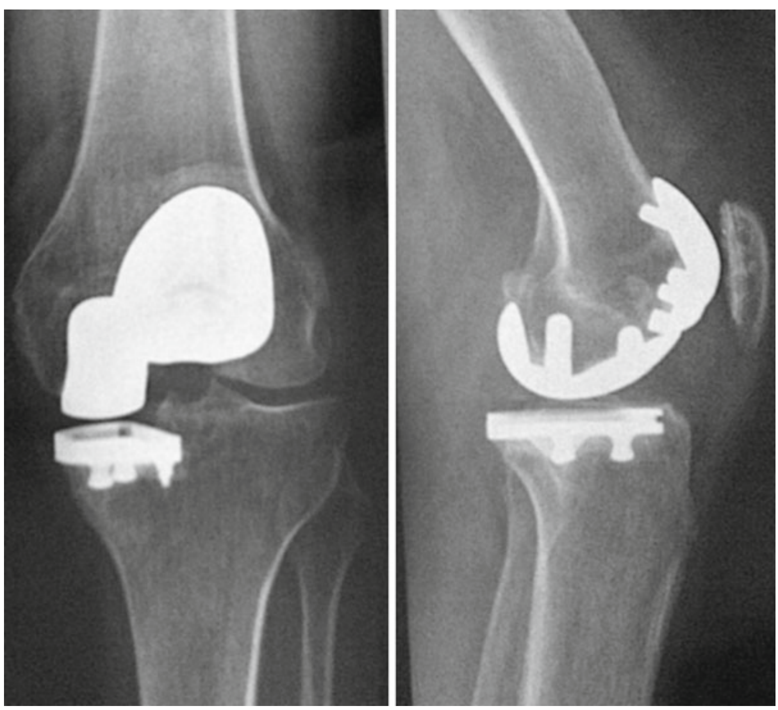

Fig. 4.5 The use of two independent implants, medial UKA and patellofemoral replacement as shown on the frontal and lateral views, is routinely decided in order to set properly the rotation of each implant

4.6 Anterior Cruciate Ligament and UKA

M. Ollivier, S. Parratte,
and Jean-Noël Argenson

Some patients have isolated unicompartmental arthritis of the knee. But the association with an ACL deficiency is frequent [23]. A total knee arthroplasty will be preferred in these cases because of the increased failure rate reported after UKA when the ACL is not efficient [24]. Patients with an intact contralateral and femoropatellar compartment may however not require total knee arthroplasty. The knee kinematics is significantly different when the anterior cruciate ligament (ACL) is deficient (Argenson et al. 2002). Komistek et al. concluded in 2002 that a deficient anterior cruciate ligament conduced to a more posterior contact between femur and tibia during the flexion and more sliding movements than in normal knees [25]. The actual techniques of reconstruction of the ACL are promising and may restore the knee stability to almost normal. Some combined techniques of surgery have been developed in order to associate UKA and ACL reconstruction with very good short-term results [26]. In case of clinical laxity of the ACL in young patients, plain radiographs with anteroposterior and lateral view and long-leg standing radiographs must be performed. Stress radiographs may be additionally realized in order to verify the anterior instability. MRI is also recommended in order to evaluate accurately the ACL. We use both semitendinosus and gracilis tends for the ACL reconstruction. A subvastus approach can be performed to preserve the quadriceps. Osteophytes are removed from the joint particularly in the intercondylar notch to avoid late impingement with the graft on the notch. This point is very important to preserve the graft and avoid any so-called Marie Antoinette effect on the graft. We first prepare the tibial and femoral component of the UKA as described previously. Second, we reconstruct the ACL. We locate the tibial canal position using a 55° guide set to and placed into the anatomical footprint of the tibial insertion. Then we prepare the femoral tunnel with guide wire placed "over the top" in a 2 or 10 o'clock position according to side of the knee. The ACL graft is finally pulled into the femur via the tibial canal and is fixed on both sides (tibial and femoral site) after cycling the graft by repeated flexion/extension. Rehabilitation is started the day after surgery and a clinical and radiological evaluation performed every 6 months. For young patients

Fig. 4.6 The full leg frontal view at 14-year follow-up of a 42-year-old female patient who had UKA combined to ACL reconstruction using at that time patellar tendon grafting

presenting with both instability and pain, this combined solution may delay the time for total knee arthroplasty (Fig. 4.6).

References

1. Berger R, Meneghini RM et al (2005) Results of unicompartmental arthroplasty at a minimum of 10 year follow up. J Bone Joint Surg Am 87A: 999–1006
2. Cartier P, Sanouillet JL et al (1996) Unicompartmental knee arthroplasty after 10-year minimum follow up period. J Arthroplasty 11:782–788
3. Marmor L (1988) Unicompartmental knee, arthroplasty. Ten to 13 year follow up study. Clin Orthop 226:14
4. O'Rourke M, Gardner J et al (2005) Unicompartmental knee replacement. A minimum 21 year follow-up. End result study. Clin Orthop 440:27–37
5. Parratte S, Argenson JN et al (2009) Medial unicompartmental knee replacement in the under 50's. J Bone Joint Surg Br 91B:351–356
6. Pennington DW, Swienckowski JJ et al (2003) Unicompartmental knee arthroplasty in patients sixty years of age or younger. J Bone Joint Surg Am 85A:1968–1973
7. Squire M, Callaghan J et al (1999) Unicompartmental knee replacement: a minimum 15 year follow up study. Clin Orthop 367:61
8. Deshmuckh RV, Scott RD (2001) Unicompartmental knee arthroplasty: long term results. Clin Orthop 392:272–278
9. Geller J, Yoon RS et al (2008) Unicompartmental knee arthroplasty. A controversial history and a rationale for contemporary resurgence. J Knee Surg 21:7–14
10. McAllister CM (2008) The role of UKA versus TKA in providing maximal performance and satisfaction. J Knee Surg 21:286–292
11. Gibson PH, Goodfellow JW (1986) Stress radiography in degenerative arthritis of the knee. J Bone Joint Surg Br 68B:608–609
12. Gulati A, Pandit H et al (2009) The effect of leg alignment on the outcome of unicompartmental replacement. J Bone Joint Surg Br 91:469–474
13. Goodfellow J et al (2006) Unicompartmental arthroplasty with the Oxford knee. Oxford University Press, Oxford
14. Price AJ (2003) Medial meniscal bearing arthroplasty: wear, mechanics and clinical outcome. D Phil Thesis, University of Oxford
15. Furnes O, Espehaug B et al (2007) Failure mechanisms after unicompartmental and tricompartmental primary knee replacement with cement. J Bone Joint Surg Am 89:519–525
16. Smith TO, Hing CB et al (2009) Fixed versus mobile bearing unicompartmental knee replacement: a meta-analysis. Orthop Traumatol Surg Res 95:599–605
17. Parratte S, Pauly V et al (2012) No long-term difference between fixed and mobile medial unicompartmental arthroplasty. Clin Orthop Relat Res 470:61–68
18. Bonutti PM, Dethmers DA (2008) Contemporary unicompartmental knee arthroplasty: fixed vs mobile bearing. J Arthroplasty 23(7 Suppl):24–27
19. Kretzer JP, Jakubowitz E et al (2011) Wear analysis of unicondylar mobile bearing and fixed bearing knee systems: a knee simulator study. Acta Biomater 7:710–715
20. Parratte S, Pauly V et al (2010) Survival of bicompartmental knee arthroplasty at 5 to 23 years. Clin Orthop Relat Res 468:64–72
21. Argenson JN, Parratte S et al (2009) The new arthritic patient and arthroplasty treatment options. J Bone Joint Surg Am 91(Suppl 5):43–48
22. Rolston L, Bresch J et al (2007) Bicompartmental knee arthroplasty: a bone-sparing, ligament-sparing, and minimally invasive alternative for active patients. Orthopedics 30:70–73
23. Trompeter AJ, Gill K et al (2009) Predicting anterior cruciate ligament integrity in patients with osteoarthritis. Knee Surg Sports Traumatol Arthrosc 17:595–599
24. Deschamps G, Lapeyre B (1987) Rupture of the anterior cruciate ligament: a frequently unrecognized cause of failure of unicompartmental knee prostheses. A propos of a series of 79 Lotus pros theses with a follow-up of more than 5 years. Rev Chir Orthop Reparatrice Appar Mot 73:544–551, 1
25. Komistek RD, Allain J et al (2002) In vivo kinematics for subjects with and without an anterior cruciate ligament. Clin Orthop 404:315–325
26. Pandit H, Beard DJ et al (2006) Combined anterior cruciate reconstruction and Oxford unicompartmental knee arthroplasty. J Bone Joint Surg Br 88-B:887–892
27. Argenson JN, Chevrol-Benkeddache Y et al (2002) Modern unicompartmental knee arthroplasty with cement. J Bone Joint Surg Am 84A:2235–2239
28. Argenson JN, Komistek RD et al (2002) In vivo determination of knee kinematics for subjects implanted with a unicompartmental arthroplasty. J Arthroplasty 17:1049–1054
29. Deschamps G, Chol Ch (2011) Fixed-bearing unicompartmental knee arthroplasty. Patients selection and operative technique. Orthop Traumatol Surg Res 97:648–661. doi:10.1016/j.otsr.2011.08.003
30. Stern SH, Becker MW et al (1993) Unicondylar knee arthroplasty. An evaluation of selection criteria. Clin Orthop 286:143–148
31. White SH, Ludkowski PF et al (1991) Anteromedial osteoarthritis of the knee. J Bone Joint Surg Br 73-B:582–586