Long-term Results of Medial UKA for Knee Avascular Necrosis.

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ABSTRACT:

Background :

Numerous series have documented short and Mid-term successes with cemented, Metal-Backed modern unicompartmental knee arthroplasty (UKA) for avascular osteonecrosis of the knee (AVN). However data are lacking regarding long-term implant fixation and patient function. **The aim of this study was therefore to evaluate the long term clinical outcome and implant survivorship of patients that underwent UKA for medial knee osteonecrosis.**

Methods:

29 consecutive UKA performed by two senior surgeons (>50 UKA a year) in 28 patients (19 women and 9 men with a mean age of 67 years) with medial unicompartmental AVN of the knee between 1989 and 2001 were retrospectively reviewed. AVN was diagnosed using x-ray, MRI scan and finally confirmed by **postoperative** sample analysis. The mean patient body mass index was 27kg/m². Etiologies were spontaneous/idiopathic AVN in 19 knees (66%) and secondary AVN in 10 knees (33%). The Mean follow-up was 21 years (15 to 26).

Results:

At 15 years survivorship of the components free of revision for any cause was 92% (95% CI 87 to 97). **At latest follow-up**, 26 years, survivorship of the components free of revision for any reason was 83 % (95% CI 74 to 95). No survivorship difference was found between the patients suffering from spontaneous or secondary ON of the knee (83% vs 90%, p=0.6). At **latest follow-up** the mean Knee KSS was 89 points (range 68-100) and 83 (range 66-96) for Function KSS.

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Conclusion:

In the longest series to date, medial UKA for treatment of AVN was associated with high survival rates and stable clinical improvement. UKA is a durable and efficient option to treat patients with unicompartamental osteonecrosis of the knee.

Key Words : UKA; Avascular Osteonecrosis ; long-term results ; survivorship

Level Of Evidence :IV

INTRODUCTION

Avascular osteonecrosis (AVN) of the knee is a devastating disease conducting without appropriated treatment to severe osteoarthritis[1][2][3]. Conservative Surgical Procedures such as core decompression, arthroscopic debridement, [4][5] or high tibial osteotomy[6] are effective in the early stage of the disease, but when bone on bone osteoarthritis occurs, a knee arthroplasty is often required [7][8][9][10][11][12][13]. To replace involved compartment(s) Total Knee Arthroplasty (TKA) is a valuable option but only unicompartmental knee arthroplasty (UKA) [14][15][10][16] allows selective replacements of isolated medial or lateral compartment's necrosis. To date, satisfactory patients' outcomes and implants' survivorship have been reported in mid-term follow-up studies investigating on UKA performed for Knee AVN[10][17][18][19]. However, data are lacking regarding long-term implant fixation and patient function. The aim of this study was therefore to evaluate the long term clinical outcome and implant survivorship of patients that underwent UKA for medial knee osteonecrosis.

PATIENTS AND METHODS

Twenty-nine consecutive UKA, performed in twenty-eight patients, with unicompartmental AVN of the knee, between October 1989 and June 2001, were retrospectively reviewed. Institutional review board approval was obtained before starting the study.

The inclusion criteria included: minimum clinical follow-up of 15 years, confirmed diagnosis of unilateral and isolated knee's medial compartment osteonecrosis; preserved status of the patellofemoral and lateral tibio-femoral joints.

Indication for UKA included : preoperative range of knee flexion greater than 100°, and full range of knee extension, a stable knee in the frontal and sagittal planes, finally the possibility of full correction of the deformity to neutral (based on anteroposterior varus and valgus stress radiographs) [19]. Of all patients seen for osteonecrosis of the knee in the same period at our institution only 28 of 92 (30%) met the inclusion criteria.

Nineteen women and nine men with a mean age of sixty-seven years (range, fifty-one to eighty years) at the time of the UKA were included in this study. The mean patient body mass index (BMI) was twenty-seven kg/m² (range, eighteen to thirty-five kg/m²).

Bone osteonecrosis was diagnosed on x-ray and MRI scanner, then confirmed postoperatively using an histologic analysis of bone samples. Preoperative magnetic resonance imaging was used to confirm diagnosis but not to assess lesion size. MRI slides were also used to detect any sign of patent osteonecrosis in the uninvolved compartments. The Mont et al [8] classification was used to describe joint space, bone contours, and trabecular patterns.

According to this classification all patients in the study were graded Stage 4. The etiologies of the AVN were spontaneous in 19 knees (66%) and secondary in 10 knees (33%). All surgeries were performed according to a previously published procedure **by two senior surgeons (performing >50 UKA a year)** through a medial para-patellar approach using a cemented metal-backed tibial and a **cut-based type femoral implants** (Miller- Galante; Zimmer, Warsaw, IN)

This type of femoral implant (opposed to a resurfacing implant) allows to remove a significant amount of the lesion. In terms of surgical technique, an extra-medullary road with 2 metallic paddles linking the tibial and distal femoral cuts was used for all the cases. As the wear on the tibial side is, often, very limited in AVN, the tibial paddle is sitting high on the tibial side and consecutively artificially proximalizes the femoral cut.

This allowed to remove more AVN lesion on the femoral side without compromising the extension gap. We also tried to select the biggest femoral size possible to cover as much femur as possible and bridge the areas of AVN. A very careful curettage of the remaining areas of AVN and a drilling (with a 2.7 mm drill) of the deepest part of the defects was performed. After the cleaning of all the bony surfaces, a potential bone grafting (using cancellous bone from the tibial cut) of the defects was done before the final cementation of the implants cemented. In this series, autologous bone grafts were used in 9 cases (30%).

Clinical and radiographic evaluation was done at yearly intervals until the last follow-up. At last follow-up the clinical evaluation was performed by an independent observer (XX). Patients were asked to fill the Knee Society Scoring system (KSS) and Knee Osteoarthritis outcomes score (KOOS) [20]. **Radiographic analysis was completed by two of the authors not involved in the surgical interventions (XX and YY): on last follow-up x-ray, position of the femoral and tibial components was assessed on AP and ML radiographs and compared to postoperative position.** The presence, extent, or progression of femoral or tibial radiolucencies was also recorded. **Progression** of osteonecrosis and/or osteoarthritis were evaluated in the **lateral** compartment on AP radiographs and in the patello-femoral joint on **merchant views**.

Statistics

Data are presented as mean values associated to standard deviation or range. The Student's t-test was used for comparisons of continuous variables, implant survival was estimated with use of the Kaplan-Meier technique [21]. Confidence intervals at the 95% level were determined. Two end points were defined: (1) revision or implant removal for any

reason, including revision for septic and aseptic complications, (2) revision because of progression of **osteonecrosis and/or osteoarthritis**.

Sources of Funding

There was no external funding source for this study.

RESULTS

No patient was lost to follow-up but four patients have died and 3 UKA were converted into TKA during follow-up, leaving 21 patients (22 knees) with a clinical and radiological evaluation of their implants at mean 21 years (range 15-26 years) after surgery.

Survivorship

At last follow-up available four knees showed non-progressive radiolucencies at the tibial bone-cement interface. One femoral progressive radiolucencies was found and counted as mechanical failure. **Four knees were converted into TKA, two due to progression of osteoarthritis in the uninvolved compartments (at 12 and at 15 years) and Two due to aseptic loosening of the implants (at 30 months and at 11 years).** Regarding our first endpoint, at fifteen years survivorship of the components free of revision for any cause was **92%** (95% confidence interval [CI] = 87 to 97%) (Fig. 1). Survivorship of the components free of revision for progression of ON or osteoarthritis was 95% (95% CI = 91 to 99%).

At latest follow-up, 26 years, survivorship of the components free of revision for any reason was 83%(95% confidence interval [CI] = 74 to 95%).

Survivorship of the components free of revision for progression of AVN or osteoarthritis 89% (95% CI = 82 to 96%).

No survivorship difference (free from revision for any cause) was found between the patients suffering from spontaneous or secondary ON of the knee (83% vs 90% and p=0.6) **as well as**

*for patients requiring bone grating because of important subchondral defect (78% vs 90%
p=0.4).*

Clinical Outcome

At last follow-up mean Knee KSS was 89 points (range 68-100) and 83 (range 66-96) for function KSS. The mean improvement was 33 points (range 11-48 points) for the knee score (p<0.0001) and 33 points (range 22-58 points) for the function score (p<0.0001). The results of the KOOS at last follow-up are presented in Figure 2.

DISCUSSION

The purpose of the present study was to evaluate the long-term results of cemented UKA for treatment of medial knee compartment osteonecrosis. After a 15-year follow-up, we found a ninety-five percent survivorship free from any reason and eighty-nine percent after 26 years.

Only few studies provided data on the long-term results of UKA for ON [19][22][23][18][15][10][24][17][25]; The mean follow-ups of these reports vary between 4,5 and 10,9 years. These studies reported survivorship rates between 76 and 100%. In our series 15 to 26 years survivorship free from revision for any cause ranged from 95 to 89%. **Only few studies investigated on survivorship of UKA for ON with a follow-up superior to ten years (Table1) and comparison of our result to existent literature is limited.** Heyse et al. [17] provided data at 10,9 years, survivorship of UKA free from revision for any cause was similar to our series (93,1% at ten year vs 95% at fifteen years).

Bruni et al. studied the largest series of UKA for ON with 84 patients followed during an average of 8.2-year. The survival rate at 10 years was 89%. Our survival rates seem superior to those of Bruni et al., however, they reported eight mechanical failures on the tibial side of

their full-polyethylene UKA. The exclusive utilization of metal-backed UKA in our series may explain these survival differences. The results of a recent study of Pandit et al. [26] investigating on **ten years results of 1000 Oxford UKAs**, highlights implants' good survivorship of modern implants: 94% at 10 years and 91% at 15 years. The pathological diagnosis was osteoarthritis for 98% and ON for 2% of the patients.

In their recent study Chalmers et al. [25] obtained lower survival rates than those reported in our series (89% at 5 years and 76% at 10 years). Our two populations present a major difference that makes comparison difficult to draw (Mean BMI respectively 31 vs 27 kg/m²) as BMI is a potential risk factor for early implants' revision [27]. Their series also included 2 lateral UKAs whose survival rates are described to be inferiors to medial UKAs [28]. Those differences, as well as the limited number of failure observation in our two series might explain why Chalmer et al [25] found higher revision rate for patients suffering from secondary osteonecrosis when our two subgroups (primary and secondary AVN) exhibited similar 15 years results.

At latest follow up, we found a mean KSS function of 83 points and 89 points for the KSS Knee. These results are inferior (as our patients are older) than clinical scores we had reported at 12 years follow up for the same series (KSS function was 95 and KSS Knee was 88). Heyse et al.[17] have similar result in a series of 66 UKA for ON at 10.9 follow up with 81 for the KSS function and 92 for the KSS Knee. **Pandit et al. [26] found a mean KSS knee of 80 and a mean KSS function of 76, which is slightly inferior to the clinical score of our study.**

Only few series compared long-term results of UKA versus TKA in the treatment of ON[11][10]. Only one them gave advantages to TKA: Radke et al. [11] compared 23 UKA to 16 TKA. For patients with more than 5 years follow-up, function and pain scores were better for the TKA group. Furthermore, 4 patients in the UKA group were revised versus 0 in the

TKA group. The authors explain this result by better fixation of TKA implant in necrotic lesion and a lack of secondary arthritic and potential osteonecrotic transformation of further knee compartments. Thus, inclusion criteria for UKA were not clearly defined by the authors. Myers et al. compared UKA and TKA for patients suffering from osteonecrosis. Considering outcomes of modern implants only, they showed no difference neither on survivorship nor on clinical scores after 8-year follow-up [10].

The long-term results of UKA for osteonecrosis are comparable to UKA for osteoarthritis [29][22][24]. Servien et al [22] and Langdown et al [24] compared the patients undergoing UKA for two indications with respective follow-ups of 4,5 and 5 years: they did not show any clinical or implants' survival differences.

When performing UKA for knee AVN, the choice of the implants is, in our experience, detrimental. First to remove as much of the lesion as possible, we prefer cut-based femoral implants allowing broader necrotic areas resection. Then, to improve the bone-implant contact-surface, we always select the biggest femoral size. Finally, on the tibial side, as the wear is often less important than in standard arthritic knees, bone's cut should be minimal to ensure adequate bone quality below the implant (and avoid early subsidence).

Some limitations should be outlined in the current study. Foremost, the retrospective design of the series, limits extrapolation of our results, but the prevalence of medial compartment ON of the knee in the general population also limits prospective data collection with a sufficient number of patients. Our sample size is thus modest but represents a ten-year inclusion period in a high-volume institution. Even though this study is retrospective, no patient was lost to follow-up. Only four patients died. All dead patients had no pain on their knee and died for reasons unrelated to UKA surgery, with the implants still in place. Another limit of this study is its non-comparative nature, we

aimed in this protocol to estimate knee function and implant survivorship of patient undergoing a UKA for ON of the knee. Despite these limitations, to our knowledge, there is no other study, investigating specifically on UKA for treatment of ON, providing clinical and radiological results with such a long follow-up track record.

Conclusion

In the longest series to date, cemented medial UKA for treatment of ON was associated with high survival rates and stable clinical improvement. UKA is a durable and efficient option to treat patients with unicompartmental osteonecrosis of the knee.

REFERENCES :

- [1] Aglietti P, Insall JN, Buzzi R, Deschamps G. Idiopathic osteonecrosis of the knee. Aetiology, prognosis and treatment. The Journal of Bone and Joint Surgery British Volume 1983;65:588–97.
- [2] Ahlbäck S, Bauer GC, Böhne WH. Spontaneous osteonecrosis of the knee. Arthritis and Rheumatism 1968;11:705–33.
- [3] Muheim G, Böhne WH. Prognosis in spontaneous osteonecrosis of the knee. Investigation by radionuclide scintimetry and radiography. The Journal of Bone and Joint Surgery British Volume 1970;52:605–12.
- [4] Perez Carro L, Gomez Cimiano FJ, Gomez del Alamo G, Garcia Suarez G. Core decompression and arthroscopic bone grafting for avascular necrosis of the knee. Arthroscopy : The Journal of Arthroscopic & Related Surgery : Official Publication of the Arthroscopy Association of North America and the International Arthroscopy Association 1996;12:323–6.
- [5] Mont MA, Tomek IM, Hungerford DS. Core decompression for avascular necrosis of the distal femur: long term followup. Clinical Orthopaedics and Related Research 1997;124–30.
- [6] Koshino T. The treatment of spontaneous osteonecrosis of the knee by high tibial osteotomy with and without bone-grafting or drilling of the lesion. The Journal of Bone and Joint Surgery American Volume 1982;64:47–58.
- [7] Bergman NR, Rand JA. Total knee arthroplasty in osteonecrosis. Clinical Orthopaedics and Related Research 1991;77–82.
- [8] Mont MA, Rifai A, Baumgarten KM, Sheldon M, Hungerford DS. Total knee arthroplasty for osteonecrosis. The Journal of Bone and Joint Surgery American Volume 2002;84-A:599–603.
- [9] Mont MA, Myers TH, Krackow KA, Hungerford DS. Total knee arthroplasty for corticosteroid

- associated avascular necrosis of the knee. *Clinical Orthopaedics and Related Research* 1997;124–30.
- [10] Myers TG, Cui Q, Kuskowski M, Mihalko WM, Saleh KJ. Outcomes of total and unicompartmental knee arthroplasty for secondary and spontaneous osteonecrosis of the knee. *The Journal of Bone and Joint Surgery American Volume* 2006;88 Suppl 3:76–82. doi:10.2106/JBJS.F.00568.
- [11] Radke S, Wollmerstedt N, Bischoff A, Eulert J. Knee arthroplasty for spontaneous osteonecrosis of the knee: unicompartmental vs bicompartmental knee arthroplasty. *Knee Surgery, Sports Traumatology, Arthroscopy : Official Journal of the ESSKA* 2005;13:158–62. doi:10.1007/s00167-004-0551-3.
- [12] Ritter MA, Eizember LE, Keating EM, Faris PM. The survival of total knee arthroplasty in patients with osteonecrosis of the medial condyle. *Clinical Orthopaedics and Related Research* 1991;108–14.
- [13] Seldes RM, Tan V, Duffy G, Rand JA, Lotke PA. Total knee arthroplasty for steroid-induced osteonecrosis. *The Journal of Arthroplasty* 1999;14:533–7.
- [14] Lotke PA, Abend JA, Ecker ML. The treatment of osteonecrosis of the medial femoral condyle. *Clinical Orthopaedics and Related Research* n.d.:109–16.
- [15] Marmor L. Unicompartmental arthroplasty for osteonecrosis of the knee joint. *Clinical Orthopaedics and Related Research* 1993:247–53.
- [16] Soucacos PN, Xenakis TH, Beris AE, Soucacos PK, Georgoulis A. Idiopathic osteonecrosis of the medial femoral condyle. Classification and treatment. *Clinical Orthopaedics and Related Research* 1997:82–9.
- [17] Heyse TJ, Khefacha A, Fuchs-Winkelmann S, Cartier P. UKA after spontaneous osteonecrosis of the knee: a retrospective analysis. *Archives of Orthopaedic and Trauma Surgery* 2011;131:613–7. doi:10.1007/s00402-010-1177-1.
- [18] Bruni D, Iacono F, Raspugli G, Zaffagnini S, Marcacci M. Is unicompartmental arthroplasty an acceptable option for spontaneous osteonecrosis of the knee? *Clinical Orthopaedics and Related Research* 2012;470:1442–51. doi:10.1007/s11999-012-2246-2.
- [19] Parratte S, Argenson J-NA, Dumas J, Aubaniac J-M. Unicompartmental knee arthroplasty for avascular osteonecrosis. *Clinical Orthopaedics and Related Research* 2007;464:37–42. doi:10.1097/BLO.0b013e31812f7821.
- [20] Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. *The Journal of Bone and Joint Surgery American Volume* 1969;51:737–55.
- [21] Kaplan EL MP. Nonparametric observation from incomplete. *J Am Stat Assoc* 1958;53:457–481.
- [22] Servien E, Verdonk PCM, Lustig S, Paillot JL, Kara AD, Neyret P. Medial unicompartmental knee arthroplasty for osteonecrosis or osteoarthritis. *Knee Surgery, Sports Traumatology, Arthroscopy : Official Journal of the ESSKA* 2008;16:1038–42. doi:10.1007/s00167-008-0617-8.
- [23] Choy W-S, Kim KJ, Lee SK, Yang DS, Kim CM, Park JS. Medial unicompartmental knee arthroplasty in patients with spontaneous osteonecrosis of the knee. *Clinics in Orthopedic Surgery* 2011;3:279–84. doi:10.4055/cios.2011.3.4.279.
- [24] Langdown AJ, Pandit H, Price AJ, Dodd CAF, Murray DW, Svärd UCG, et al. Oxford medial unicompartmental arthroplasty for focal spontaneous osteonecrosis of the knee. *Acta Orthopaedica* 2005;76:688–92. doi:10.1080/17453670510041772.
- [25] Chalmers BP, Mehrotra KG, Sierra RJ, Pagnano MW, Taunton MJ, Abdel MP. Reliable outcomes and survivorship of unicompartmental knee arthroplasty for isolated compartment osteonecrosis. *Bone Joint J* 2018;100-B:450–4. doi:10.1302/0301-620X.100B4.BJJ-2017-1041.R2.
- [26] Pandit H, Hamilton TW, Jenkins C, Mellon SJ, Dodd CAF, Murray DW. The clinical outcome of minimally invasive Phase 3 Oxford unicompartmental knee arthroplasty: a 15-year follow-up of 1000 UKAs. *The Bone & Joint Journal* 2015;97-B:1493–500. doi:10.1302/0301-620X.97B11.35634.
- [27] Kandil A, Werner BC, Gwathmey WF, Browne JA. Obesity, morbid obesity and their related

- 346 medical comorbidities are associated with increased complications and revision rates after
347 unicompartmental knee arthroplasty. *J Arthroplasty* 2015;30:456–60.
348 doi:10.1016/j.arth.2014.10.016.
- 349 [28] van der List JP, McDonald LS, Pearle AD. Systematic review of medial versus lateral
350 survivorship in unicompartmental knee arthroplasty. *Knee* 2015;22:454–60.
351 doi:10.1016/j.knee.2015.09.011.
- 352 [29] Zhang Q, Guo W, Liu Z, Cheng L, Yue D, Zhang N. Minimally invasive unicompartmental knee
353 arthroplasty in treatment of osteonecrosis versus osteoarthritis: a matched-pair comparison. *Acta*
354 *Orthopaedica Belgica* 2015;81:333–9.

Studies	Number of patients	Age (years)	Mean Follow up (years)	Survivorship	KSS	Other score
Bruni et al [1]	84 UKA AVN	66	8.2	89% at 10 years	87.1	
Marmor et al[2]	34 UKA AVN	68	5.5	88.3%		
Servien et al[3]	33 UKA AVN 35 UKA OA	74	4.5 5.1	95.4% 92.8 %		No IKS Difference
Parratte et al [4]	31 UKA AVN	71	7	96.7% at 12 years	K : 95 F :88	
Myers et al [5]	10 UKA AVN 52 TKA AVN	39	8	100% 96%	91 94	
Langdown et al [6]	29 UKA AVN 28 UKA OA	71	5	100% 100%		OKS=38 OKS=40
Heyse et al [7]	52 UKA ON	66	10.9	93.1% at 10 years 90.6% at 15 years	K : 92 F :81	WOMAC= 7.7
Chalmers et al [8]	45 UKA AVN	66	5	89% at 5 years 76% at 10 years		IKS preoperatively 60 IKS postoperatively 94
This study	29 UKA ON	67	21	95% at 15 years 89% at 26 years	K :89 F: 83	

Table 1. Summary of Literature in the Treatment of Knee avascular osteonecrosis using UKA

UKA : unicompartmental knee arthroplasty

AVN : avascular osteonecrosis

OA : osteoarthritis

WOMAC : Western Ontario and McMaster Universities Arthritis Index

IKS : International knee society score

KSS : Knee Society Score K: Knee F: Function

OKS : Oxford Knee Score

1 FIGURES LEGEND.

2 **Figure 1.** Kaplan-Meier survivorship curve showing fifteen-year survivorship free from
3 any reason to be 92 per cent.

4 **Figure 2.** Illustrating the KOOS evaluation at last follow-up available.

5 **KOOS :** Knee injury and Osteoarthritis Outcomes Score

6 **ADL :** Activity of Daily Living

7 **QOL :** Quality Of Life.

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