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CASE REPORT

Unexpected wear of an unicompartimental knee arthroplasty in oxidized zirconium

Anais LUYET, Jean-François FISCHER, Brigitte M. JOLLES, Alexandre LUNEBOURG

From Department of Orthopedic Surgery and Traumatology, EHNV, Yverdon Hospital, Yverdon les Bains, Switzerland

Unicompartimental knee arthroplasty is a successful procedure for the treatment of localized osteoarthritis to one compartment of the knee with good long-term results. However, several modes of failure of unicompartimental knee arthroplasty have been described, namely aseptic or septic loosening, progression of disease, wear, and instability. Metallosis after unicompartimental knee arthroplasty is rarely reported and is most often related with polyethylene wear or break. We report on a case of rapid failure of unicompartimental knee arthroplasty in oxidized zirconium associated with metallosis secondary to the dislocation of the polyethylene.

Keywords : unicompartimental knee arthroplasty ; oxidized zirconium ; metallosis ; wear ; management.

INTRODUCTION

Unicompartimental Knee Arthroplasty (UKA) has been designed for the treatment of osteoarthritis localized to one compartment of the knee with several advantages for UKA over Total Knee Arthroplasty (TKA) (*20*). Good midterm and long term results have been reported (*2,5,7*). However, based on registry studies, the cumulative rate of revision at 5 years is between 7% and 15% (*8,18*). Loosening, progression of disease, wear and instability are the main reasons of UKA's failure (*8,18,19*)). Metallosis after TKA is well documented but after UKA is rarely reported and is most often related with polyethylene (PE) wear or breakage (*27,29*). Several risk factors predisposing to failure have been identified related to the patient, the design of the implant and the surgical technique (*3,11*). In order to be more resistant to abrasion, the quality and thickness of the PE have been improved and bearing surfaces as ceramics and oxidized zirconium (OZ) components have been introduced. In vitro experiments on OZ implants showed the superior resistance to roughening of OZ likely to contribute to the reduction in wear of ultra-high molecular weight PE in both clean and abrasive conditions (*26*). Security and efficacy of OZ components have been established and are the same as for Chrome-Cobalt (CrCo) components with no objective or subjective differences between these two materials (*13,14*). To best of our knowledge, damage to an UKA made of OZ is not

■ Anais Luyet.
■ Jean-François Fischer.
■ Alexandre Lunebourg.
Department of Orthopedic Surgery and Traumatology, EHNV, Yverdon Hospital, 11, Yverdon les Bains, Switzerland.
■ Brigitte M. Jolles.
Department of Musculoskeletal Medicine, Centre Hospitalier Universitaire Vaudois and Ecole polytechnique fédérale of Lausanne, Lausanne, Switzerland.
Correspondence : Alexandre Lunebourg, Department of Orthopedic Surgery and Traumatology, EHNV, Yverdon Hospital, 11, Rue Entremonts, 1440 Yverdon les Bains, Switzerland.
E-mail : alexandre.lunebourg@gmail.com
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yet reported in the literature. As such, we report a case of early failure of an OZ femoral implant in UKA leading to metallosis secondary to PE dislocation.

CASE REPORT

A medial UKA with a cemented femoral component in OZ and an 8 mm ultra-high molecular weight PE with a cemented metal backed tibial component (Journey Uni, Smith&Nephew, Inc. Memphis) was implanted in a 67 year old female for painful osteoarthritis localized to the medial compartment of the left knee. The preoperative Knee Society Knee (KSK) Score was 59 points and the Knee Society Function (KSF) Score was of 60 points. No complication was reported during surgery and the postoperative follow-up was simple.

Six weeks postoperatively, clinical outcome was satisfactory. She had no pain and could walk without limitation. The knee presented a light effusion with a range of motion (ROM) of 110-0-0° and the scar was calm. However, standard radiographs showed a minimal valgus position of the tibial component and capsular opacifications in the suprapatellar poach. The PE was dislocated anteriorly (Fig. 1). A CT scan performed to confirm this diagnosis showed a lot of small intrarticular opacifications (metallic aspect) without any evidence for calcifications (Fig. 2).

Future revision was decided, but a few days later, the patient was admitted with a swollen and painful knee at the emergency room. The onset was sudden without trigger factor. The knee was swollen, erythematous and the ROM limited to 90°-0-0°. At this point, radiographs showed a complete dislocation of the PE (Fig. 3).

After surgical exposure, the PE was found under the patellar tendon. The whole intra-articular soft tissues and particularly the synovial tissue presented an aspect of black sludge due to excessive metallosis. This was explained by premature wear of the posterior part of the femoral implant which was in contact with the tibial metal-backed implant due to PE dislocation (Fig. 4). Then, the femoral component was removed carefully using a bone scissor with interchangeable blade and the tibial component was removed by a recut of 2 mm. A large synovectomy was performed but a complete removal of wear metallic particles was not possible. As bone surfaces and cartilage in the two other compartments were intact after the removal of the two components, a revision by a new UKA was done using an all-PE cemented tibial. Both femoral and tibial implants were replaced by a new cemented femoral implant in OZ (same size as the primary UKA) and a 11 mm all-PE highly crossed-linked cemented tibial implant (same size as the primary UKA) (Journey Uni, Smith&Nephew, Inc. Memphis). Microbiological samples were sterile and histological examination confirmed metallosis with histiocytic reaction to foreign body. There were no postoperative complications. Two months after the revision she was satisfied and the same surgery was performed on the other knee. On the basis of clinical and radiographic assessments at the 2 year follow-up, no evidence of implant loosening or wear were noted (Fig. 5). The knee was indolent without intra-articular effusion. She was able to walk without limitation and the ROM was 110-0-0 with a Knee Society Knee score of 87 points and the Knee Society Function score of 90 points.

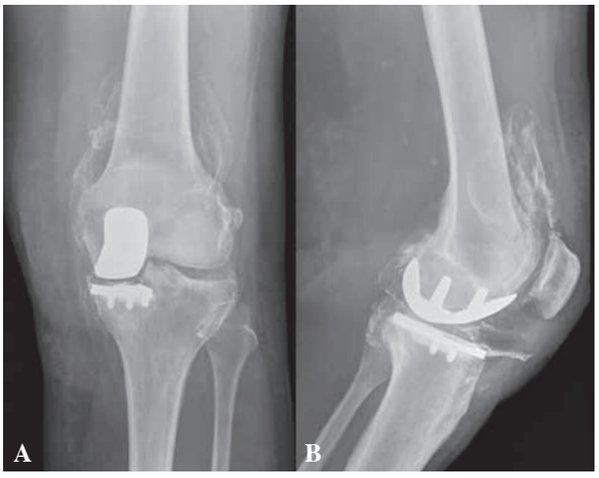

Fig. 1. — At six weeks postoperative, (A) anteroposterior (AP) and (B) lateral radiographs showed a minimal valgus position of the tibial component and capsular opacifications in the suprapatellar poach. The PE was dislocated anteriorly.

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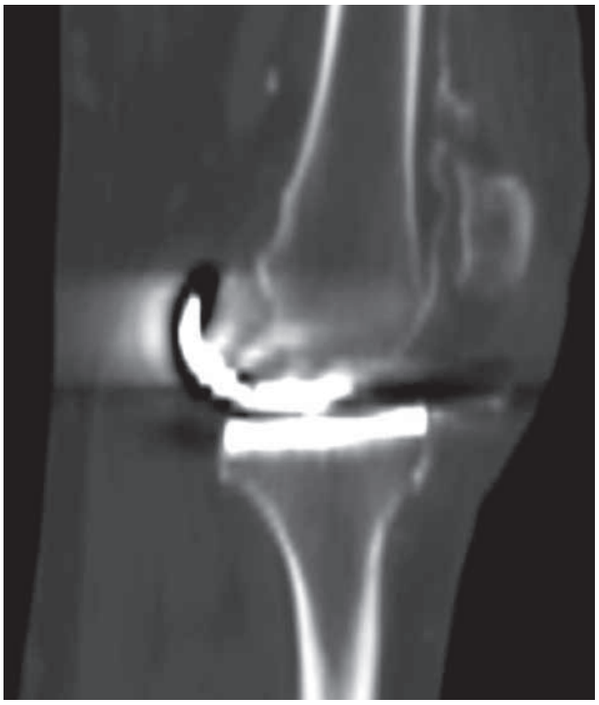

Fig. 2. — A CT scan performed to confirm the disclocation of the polyethylene showed a lot of small intrarticular opacifications (metallic aspect) without any evidence for calcifications.

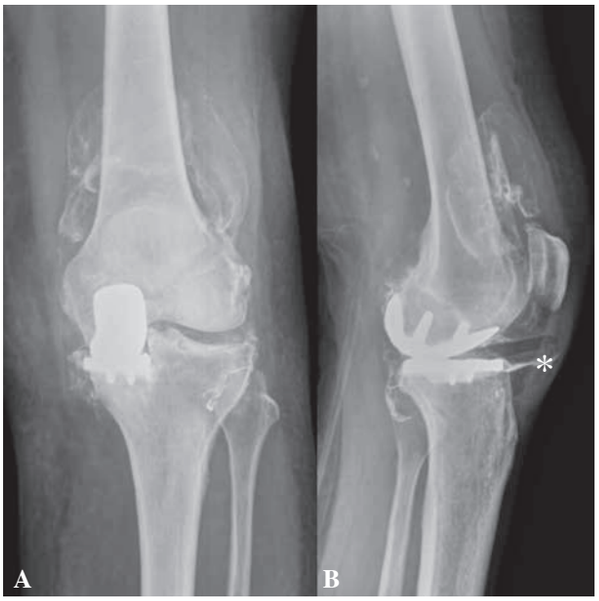

Fig. 3. — The patient was admitted in emergency with a swollen and painful knee. At this point, (A) anteroposterior (AP) and (B) lateral radiographs showed a complete dislocation of the PE (*).

DISCUSSION

PE dislocation is a rare complication following UKA and is more common after mobile bearing lateral UKA (*15*). In Total Knee Arthroplasty (TKA), several cases of failure of tibial PE insert locking mechanism have been reported (*10,28*). In our case, a fixed metal-backed implant was used and the insertion of the PE was done by slidding anterio-posteriorly the insert as far posteriorly as possible and until the anterior lock portion of the insert engaged the tibial base, then a tibial impactor was used to seat the insert. Its dislocation occurred early and could be related either to a human mistake or to the design of the locking mechanism. In Total Knee Arthroplasty (TKA), they are three types of locking mechanism to capture the polyethylene insert within the metal baseplate : they can be categorized as linear, peripheral, or central (*24,28*). The linear locking mechanisms use a tongue and groove design, peripheral capture mechanisms use a snap fit with bevelled edges and central mechanisms use a mushroom-shaped pin with a peripheral flange (*24,28*). In UKA, the peripheral design is commonly used as was used in our case. In TKA, it has been demonstrated that motion between the polyethylene insert and the metal baseplate in contemporary modular tibial designs increases after a period of *in vivo* loading, which could leed to backside wear (*6*). More, it has been advocated that new locking mechanism designs directed toward better methods of securing the polyethylene insert to the tibial tray are needed (*24,25*). In UKA, as the locking mechanism is comparable to TKA, it is also mandatory that design has to be improved to better secure the insert in the metal-back. It follows that care has to be taken during the surgery procedure, like clearing all soft tissues before positioning the bearing surface and to make sure nothing interferes between the metal-back and the tibial insert (*28*), and implant design has to be safe in order to achieve the best outcome.

Metallosis is generally the result of the abrasion between the metallic surfaces of the implants secondary to PE wear or break, or due to third-body wear (*9,29*). This condition has been described after

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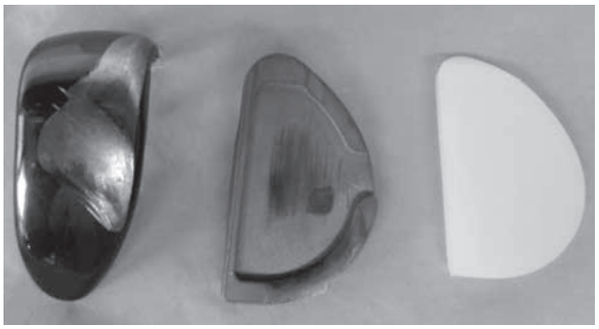

Fig. 4. — Components explanted which presented a major defect of the posterior part of the femoral implant, a minor defect of the tibial component and an intact PE.

metal-on-metal bearing total hip arthroplasty (*16,23*) and after TKA (*29*) but rarely in UKA (*27*). Moreover, no report was issued about metallosis and OZ component. Clinically, patients generally complain of pain, effusion and decrease range of motion (*27,29*) as it was in our case. Radiogically, three typical signs of metallosis have been described : metal-line sign, bubble sign and cloud sign (*9*).

OZ is made of 97.5% Zirconium and 2.5% Niobium and a thermic oxidization of the first 5 μm creates a ceramic outward which reduces the risk of delamination (*26*). In vitro studies showed that resilience of OZ makes it less brittle than ceramic while its smooth outward creates less PE debris than CrCo (*26*). OZ is nickel free while CrCo contains 0.5% of nickel and 0.1% of titanium and could be used in patients presenting a metal hypersensitivity (*12*). However, in vivo studies show no objective and subjective significant difference between OZ and CrCo components (*12-14*). Furthermore, there is no difference of PE debris' quantity and quality in puncture one year after TKA in OZ and CrCo (*22*). But there is currently no study about OZ effects on local and systemic effects. More, damage to OZ components was reported for TKA where the femoral component in OZ was in contact with titanium alloy tibial tray resulting in the removal and cracking of the oxide and exposure of the zirconium-niobium alloy substrate (*4*). Therefore, contact between the femoral component and tibial tray should be avoided to prevent surface damage to the femoral condyles, which could potentially accelerate PE wear. Based on registry studies, when a UKA requires revision, the best outcome is achieved when it is converted into a TKA (*8*). However in our situation, we decided to replace the UKA by another UKA, because it was an early failure and the lateral and the patella-femoral compartment were intact. Indeed, Lecuire et al. advocated that it is possible and reasonable to perform partial or total replacement of UKA by another UKA without using a TKA especially if there is no deterioration of the

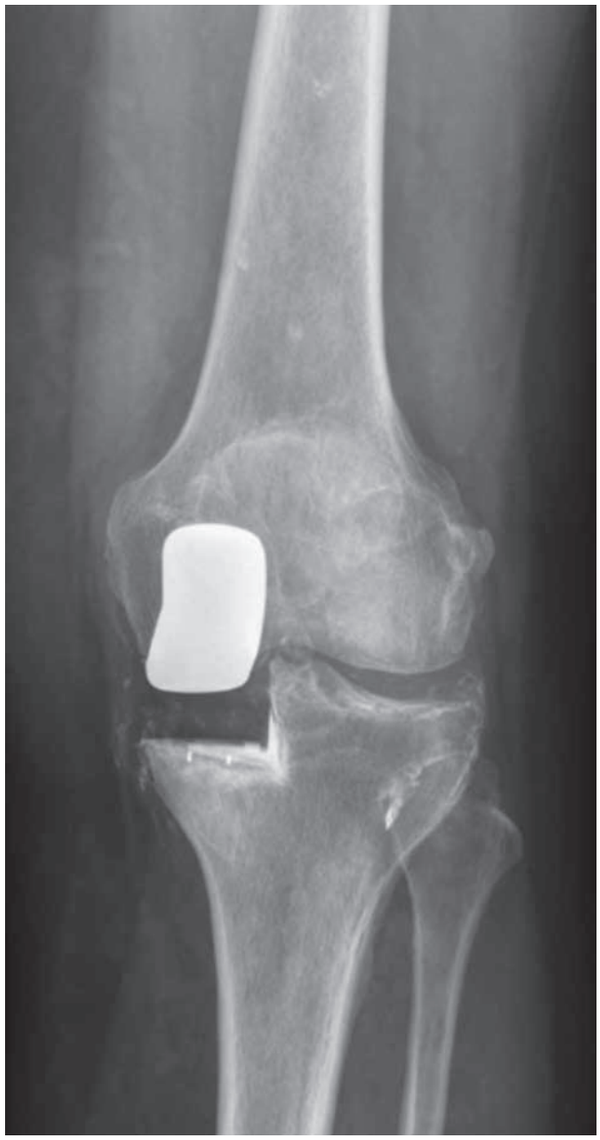

Fig. 5. — The revision UKA AP radiographs at 2 year postoperatively reveal that the components are well-fixed and well-aligned.

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two others compartments and if the cruciate ligaments are intact (*17*). The use of an all-PE cemented tibial component was decided to prevent the patient from experimenting another dislocation of the PE. Moreover, using an all-PE prevent the risk of the femoral component in OZ to be in contact with titanium alloy tibial tray as was previously described with TKA (*4*). Finally, the recent literature shows that all-PE tibial implant have the same survivorship and clinical outcome as metal backed components (*21,30*). However, patient and surgeon have to be aware that using all-PE tibial component could lead to a tibial component collapse and thus induce a harder revision surgery of UKA (*1*). At the one year follow-up the outcome was good, but longer follow-up is required to demonstrate that our treatment option was correct in this situation.

This report describes the first case of failure of UKA in OZ secondary to PE dislocation resulting in severe metallosis. Care has to be taken when UKA is performed and close follow-up is mandatory in order to identify clinical and radiological signs of complication like metallosis. So far, OZ seems to be safe and has good in vitro and in vivo results but longer follow-up is needed to confirm these mid-term results. The use of an all-PE tibial component could represent a valuable option to prevent damage to femoral component in OZ.

REFERENCES

1. **Aleto TJ, Berend ME, Ritter MA, Faris PM, Meneghini RM.** Early failure of unicompartmental knee arthroplasty leading to revision. *J Arthroplasty* 2008 ; 23 (2) : 159-63.
2. **Argenson JN, Blanc G, Aubaniac JM, Parratte S.** Modern unicompartmental knee arthroplasty with cement : a concise follow-up, at a mean of twenty years, of a previous report. *J Bone Joint Surg [Am]* 2013 ; 95 (10) : 905-9.
3. **Argenson JN, Parratte S.** The unicompartmental knee : design and technical considerations in minimizing wear. *Clin Orthop Relat Res* 2006 ; 452 : 137-42.
4. **Burnell CD, Brandt JM, Petrak MJ, Bourne RB.** Posterior condyle surface damage on retrieved femoral knee components. *J Arthroplasty* 2011 ; 26 (8) : 1460-7.
5. **Emerson RH, Higgins LL.** Unicompartmental knee arthroplasty with the oxford prosthesis in patients with medial compartment arthritis. *J Bone Joint Surg [Am]* 2008 ; 90 (1) : 118-22.
6. **Engh GA, Lounici S, Rao AR, Collier MB.** In vivo deterioration of tibial baseplate locking mechanisms in contemporary modular total knee components. *J Bone Joint Surg [Am]* 2001 ; 83-A (11) : 1660-5.
7. **Foran JR, Brown NM, Della Valle CJ, Berger RA, Galante JO.** Long-term survivorship and failure modes of unicompartmental knee arthroplasty. *Clin Orthop Relat Res* 2013 ; 471 (1) : 102-8.
8. **Hang JR, Stanford TE, Graves SE, Davidson DC, de Steiger RN, Miller LN.** Outcome of revision of unicompartmental knee replacement. *Acta Orthop* 2010 ; 81 (1) : 95-8.
9. **Helito CP, Buarque de Gusmão CV, Angelini FJ, Tirico LE, Pécora JR.** Severe metallosis following total knee arthroplasty : a case report and review of radiographic signs. *Skeletal Radiol* 2014 ; 43 (8) : 1169-73.
10. **Hepinstall MS, Rodriguez JA.** Polyethylene subluxation : a radiographic sign of locking mechanism failure after modular total knee arthroplasty. *J Arthroplasty* 2011 ; 26 (1) : 98-102. Epub 2010 Feb 4.
11. **Hernigou P, Deschamps G.** Alignment influences wear in the knee after medial unicompartmental arthroplasty. *Clin Orthop Relat Res* 2004 ; (423) : 161-5.
12. **Hofer J., Ezzet K.** A minimum 5-year follow-up of an oxidized zirconium femoral prosthesis used for total knee arthroplasty. *The Knee* 2014 ; 21 (1) : 168-71.
13. **Hui C., Pinczewski L. Villano M.** Five-year comparison of oxidized zirconium and cobalt-chromium femoral components in total knee arthroplasty : a randomized controlled trial. *J Bone Joint Surg [Am]* 2011 ; 93 (7) : 624-30.
14. **Inocenti M.** The 5-year results of an oxidized zirconium femoral component for TKA. *Clin Orthop Relat Res* 2010 ; 468 : 1258-1263.
15. **Kim SJ, Postigo R, Koo S, Kim JH.** Causes of revision following Oxford phase 3 unicompartmental knee arthroplasty. *Knee Surg Sports Traumatol Arthrosc* 2014 ; 22 (8) : 1895-901.
16. **Korovessis P, Petsinis G, Repanti M, Repantis T.** Metallosis after contemporarymetal-on-metal total hip arthroplasty : five- to nine-year follow-up. *J Bone Joint Surg [Am]* 2006 ; 88-A : 1183-91.
17. **Lecuire F, Galland A, Basso M, Vinel H, Rubini J.** Partial or total replacement of a unicompartmental knee prosthesis by another unicompartmental knee prosthesis : a reasonable option ? About 22 cases. *Eur J Orthop Surg Traumatol*. 2013 ; 23 (8) : 933-8.
18. **Lewold S, Robertsson O, Knutson K, Lidgren L.** Revision of unicompartmental knee arthroplasty : outcome in 1,135 cases from the Swedish Knee Arthroplasty study. *Acta Orthop Scand* 1998 ; 69 (5) : 469-74.
19. **Liddle AD, Judge A, Pandit H, Murray DW.** Adverse outcomes after total and unicompartmental knee replacement in 101 330 matched patients : a study of data from the National Joint Registry for England and Wales. *Lancet* 2014 ; 384 (9952) : 1437-45.

luyet-.indd 794 18/01/16 13:37

20. Lim JW, Cousins GR, Clift BA, Ridley D, Johnston LR. Oxford Unicompartmental Knee Arthroplasty Versus Age and Gender Matched Total Knee Arthroplasty – Functional Outcome and Survivorship Analysis. *J Arthroplasty* 2014 ; 29 (9) : 1779-83.

21. Lustig S, Elguindy A, Servien E, Fary C, Munini E, Demey G, Neyret P. 5- to 16-year follow-up of 54 consecutive lateral unicondylar knee arthroplasties with a fixed-all polyethylene bearing. *J Arthroplasty* 2011 ; 26 (8) : 1318-25.

22. Minoda Y. No difference in in vivo polyethylene wear particles between oxidized zirconium and cobalt-chromium femoral component in total knee arthroplasty. *Knee Surg Sports Traumatol Arthrosc* 2014 ; 22 : 680-6.

23. Ollivere B, Darrah C, Barker T, Nolan J, Porteous MJ. Early clinical failure of the Birmingham metal-on-metal hip resurfacing is associated with metallosis and soft-tissue necrosis. *J Bone Joint Surg [Br]* 2009 ; 91-B : 1025-30.

24. Parks NL, Engh GA, Topoleski LD, Emperado J. The Coventry Award. Modular tibial insert micromotion. A concern with contemporary knee implants. *Clin Orthop Relat Res* 1998 ; (356) : 10-5.

25. Rao AR, Engh GA, Collier MB, Lounici S. Tibial interface wear in retrieved total knee components and correlations with modular insert motion. *J Bone Joint Surg [Am]* 2002 ; 84-A (10) : 1849-55.

26. Ries MD, Salehi A, Widding K, Hunter G. Polyethylene wear performance of oxidized zirconium and cobalt-chromium knee components under abrasive conditions. *J Bone Joint Surg [Am]* 2002 ; 84-A Suppl 2 : 129-35.

27. Sanchis-Alfonso V. Severe metallosis after unicompartmental knee arthroplasty. *Knee Surg Sports Traumatol Arthrosc* 2007 ; 15 (4) : 361-4. Epub 2006 Oct 7.

28. Thienpont E. Failure of tibial polyethylene insert locking mechanism in posterior stabilized arthroplasty. *Knee Surg Sports Traumatol Arthrosc* 2013 ; 21 (12) : 2685-8. Epub 2012 May 1.

29. Willis-Owen CA, Keene GC, Oakeshott RD. Early metallosis-related failure after total knee replacement : a report of 15 cases. *J Bone Joint Surg [Br]* 2011 ; 93 (2) : 205-9.

30. Zambianchi F, Digennaro V, Giorgini A, Grandi G, Fiacchi F, Mugnai R, Catani F. Surgeon's experience influences UKA survivorship : a comparative study between all-poly and metal back designs. *Knee Surg Sports Traumatol Arthrosc* 2015 ; 23 (7) : 2074-80.

luyet-.indd 795 18/01/16 13:37