



Lateral unicompartmental knee arthroplasty is a safe procedure for post-traumatic osteoarthritis after lateral tibial plateau fracture: a case–control study at 10-year follow-up

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Abstract

Purpose Very few studies focus on lateral unicompartmental arthroplasty (LUKA) in the setting of post-traumatic osteoarthritis (PTOA). The hypothesis of our study is that LUKA is an effective procedure for isolated lateral PTOA with similar outcomes to non-traumatic LUKA.

Methods Between 1990 and 2016, eighteen LUKA performed for isolated lateral tibiofemoral osteoarthritis secondary to tibial plateau fracture were retrospectively reviewed (post-traumatic group) and matched with a control group of thirty-six LUKA performed for non-traumatic OA. Clinical (International Knee Score), radiological outcomes and revision rate were compared between the two groups with a minimum follow-up of three years.

Results With a mean follow-up of 10.1 years, postoperative IKS scores were similar between the two groups (IKS Knee: 89.1 (control) versus 85 ($p=0.03$) and IKS Function: 85.9 (control) versus 77.9 (n.s.)). Clinical improvement was greater for the post-traumatic group. No difference was observed with regard to revision rate (3/18 (16.7%) cases in the post-traumatic group and 7/36 (19.4%) in the control group, n.s.) or polyethylene wear per year between the two groups. The revision free-survival rate was 64.8% for the post-traumatic group and 58.8% for the control group at 22-year follow-up (n.s.).

Conclusion LUKA is an effective procedure at long-term for patients suffering from isolated lateral PTOA with similar clinical and radiographic results compared to LUKA performed for non-traumatic OA and without increased risk of revision or prosthetic wear.

Level of evidence IV.

Keywords Knee replacement · Tibial plateau fracture

Introduction

The lateral compartment is much less frequently affected by OA than the medial compartment. Lateral unicompartmental knee arthroplasty (LUKA) represents 5–10% of all UKA performed [2, 28, 30]. Outcomes of LUKA have already been reported in the literature, with excellent clinical and radiological results and good survivorship similar to medial UKA at mid- and long term [2, 3, 8, 11, 32]. The main indications for LUKA are isolated lateral tibiofemoral degeneration due to osteonecrosis or to osteoarthritis [2, 27].

Post-traumatic OA (PTOA) represents approximately 10% of knee OA [7, 31]. It is a special entity causing early degeneration of the joint and subsequent disability in younger patients [28]. Intra-articular fracture leads to PTOA in 23–44% of cases due to malunion, intra-articular

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osteochondral defects, poor bone quality, limb malalignment, which in turn lead to an increased risk of arthroplasty [31, 33, 35]. Surgical options, such as total knee arthroplasty (TKA), have been well analyzed in PTOA. Even where there is a clinical improvement in knee function, several studies have demonstrated a higher risk of post-operative complications and revision [1, 24, 29, 34, 36]. PTOA is a rare indication for LUKA. Ashraf et al. reported only three cases of previous fracture in a cohort of 83 LUKA (3.6%) [3]. Very few studies focus specifically on post-traumatic OA and LUKA [22].

The aim of this study was to analyse the clinical outcomes, survivorship, and radiological outcomes of LUKA performed for PTOA. Our hypothesis was that lateral UKA is a safe procedure in PTOA with similar clinical and radiological outcomes and no increased risk of revision compared to LUKA performed for non-traumatic OA.

Methods

Patients

Between May 1990 and April 2017, 134 lateral UKA were performed by four senior surgeons at our institution. Inclusion criteria were all LUKA performed for lateral compartmental OA secondary to tibial plateau fracture with a minimum follow-up of three years. Exclusion criteria

were additional procedures performed during the LUKA or previous knee surgery (ligament reconstruction or osteotomy), medial collateral ligament insufficiency and anterior laxity.

Eighteen isolated post-traumatic LUKA (13.4%) were retrospectively reviewed (post-traumatic group).

The post-traumatic group was matched with a control group of LUKA with a 1:2 ratio.

A control group of 36 LUKA was created according to the following matching criteria: age, gender, body mass index (BMI), comorbidity according to the American Society of Anesthesiologists (ASA) score, and OA stage according to the Ahlback classification (Fig. 1).

For all patients in this study, LUKA was performed for isolated lateral tibiofemoral OA, with preserved medial tibiofemoral or patellofemoral compartments as assessed by clinical and radiological evaluation. Clinical and radiological examination confirmed frontal and sagittal plane stability of the knee, complete range of motion, and a fully correctible valgus deformity [26]. A valgus deformity greater than 15° was considered a contra-indication for lateral UKA. For the post-traumatic group, a preoperative Computed Tomography (CT) scan was sometimes required to better assess subchondral bone quality and bone loss due to previous fracture (Fig. 2). These scans also allowed better preoperative planning, to determine whether bone grafting or a reinforcement osteosynthesis was required.

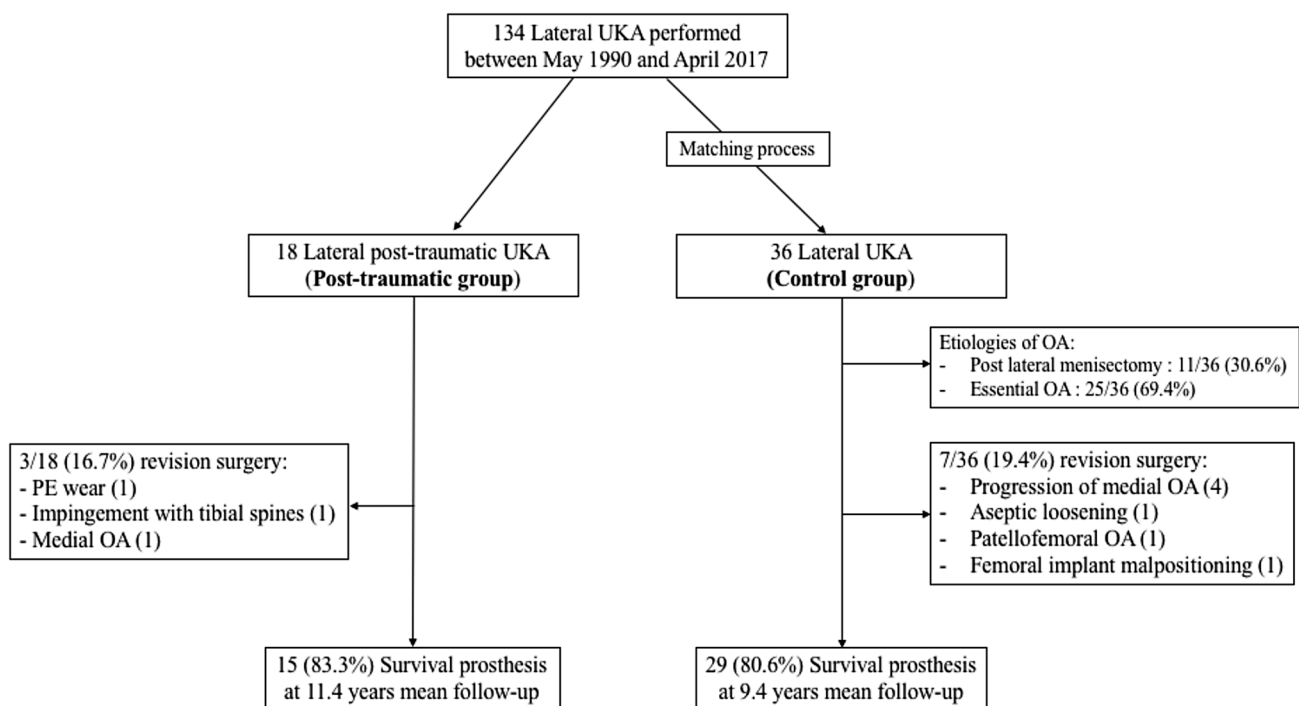


Fig. 1 Flowchart of the study

Fig. 2 42 year old male presenting with lateral PTOA secondary to a tibial plateau fracture (Schatzker 2) [15]. An open reduction and internal fixation was performed initially but there was a residual valgus deformity of 15° degrees with depression of the central part of the lateral tibial plateau (a). Pre-operative CT-scan showed the subchondral bone loss and hardware penetration requiring removal (b). A lateral UKA was performed after hardware removal, and reinforcement of the lateral tibial plateau with 2 screws was performed during the same procedure to ensure adequate support for the prosthesis (c)

Surgery

For all cases (post-traumatic and control group), a lateral parapatellar approach was performed and the same prosthesis was implanted, the HLS Uni Evolution (Tornier, Saint-Ismier, France), which is a fixed-bearing resurfacing implant with a cemented all-polyethylene tibial component.

In the post-traumatic group, no bone graft was required to compensate the bone loss due to malunion. In three cases (16.7%), internal fixation under the tibial component was required to reinforce the subchondral bone (Fig. 2). This occurred in cases with comminution and depression of the lateral tibial plateau. A plate with screws (one patient) or two parallel screws in the transverse plane (two patients) were placed through the tibial plateau under the tibial cut from lateral to medial. In one case, old hardware was left in place as it did not interfere with the tibial component. In two cases, hardware was removed without the need for new internal fixation (Fig. 3).

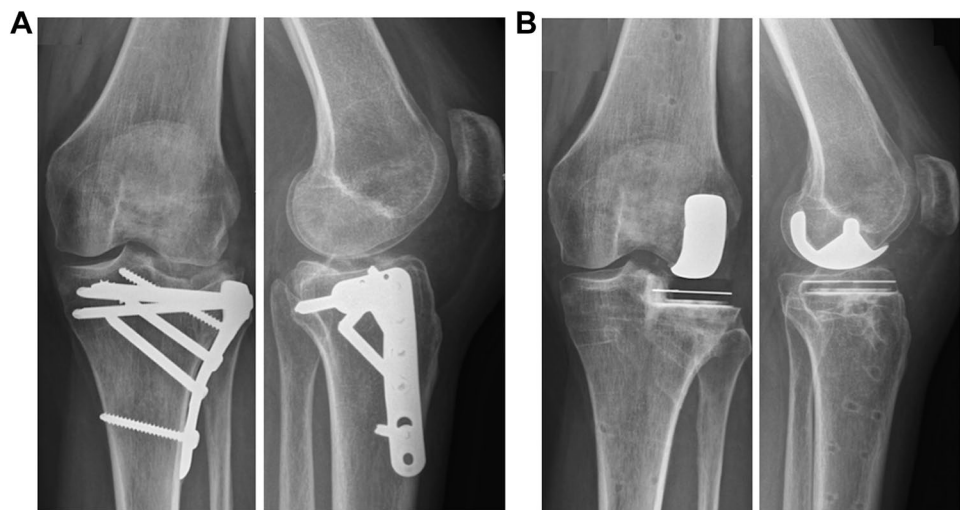
Rehabilitation was not different for the post-traumatic group. In all cases, full weight-bearing was allowed immediately.

Outcomes

All data were obtained from medical records and radiographs. Clinical evaluation was performed using the International Knee Society (IKS) knee and function scores [13, 18]. Radiological analysis included assessment of polyethylene wear, radiolucent lines around the prosthesis, progression of degenerative disease in the other compartments using the Ahlbäck classification, and postoperative coronal alignment using the mechanical femorotibial angle (mFTA) [4, 23]. Patients were reviewed and assessed in clinic with repeat X-rays (standard antero-posterior and lateral knee radiographic, full-length bilateral standing radiograph and patellar axial view) at the most recent follow-up. The thickness of the polyethylene (PE) was measured in millimetres at the thinnest part of the PE and was compared to the thickness measured on the initial postoperative radiographs as described by Deroche et al. [11]. Data from the most recent follow-up were reviewed by two independent observers (AS, TB).



Fig. 3 51 year old female suffering from lateral PTOA secondary to a lateral tibial plateau fracture which occurred 4 years ago (a). A lateral UKA was performed with hardware removal in one stage (b). The comminution and the defect of the sub-chondral bone were limited and reinforcement was not required. No radiolucency are visible 4 years follow-up (b)



Any surgical reintervention, such as prosthesis removal for TKA or a second partial knee arthroplasty for OA progression (medial UKA or patellofemoral knee arthroplasty), was considered as failure and an end-point for the study.

Radiological analysis was performed on the most recent X-rays for forty-four patients (fifteen in the post-traumatic group and twenty-nine in the control group) with a mean follow-up of 10.1 years. Patients who had undergone revision surgery were excluded from radiological analysis ($n = 10$).

Demographic data for the two groups are presented in the Table 1.

Ethics approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. For this type of study formal patient consent is not required. The paper was approved by the Inst. Review Board. The Advisory Committee on Research Information Processing in the Field of Health (CCTIRS) approved this study in Paris (university Paris-Descartes V) on February 17, 2016 under number 16–140.

Table 1 Comparison of the patient demographics for each group

	Post-traumatic group ($n = 18$) ^a	Control group ($n = 36$) ^a	<i>p</i> value
Age at surgery (year)	54.1 ± 17.8 (25–85)	59.9 ± 4.6 (49–66)	n.s
Follow-up (year)	11.4 ± 7.2 (3.7–21.2)	9.4 ± 7.1 (3.1–23)	n.s
Sex (female)	12/18 (66.7%)	26/36 (72.2%)	n.s
BMI	25.6 ± 3.2 (19.5–30.6)	25.5 ± 4.3 (16–33.9)	n.s
ASA score	1.4 ± 0.7 (1–3)	1.3 ± 0.5 (1–3)	n.s
OA stage (Ahlback)	2.1 ± 0.6 (1–4)	2.4 ± 0.8 (1–4)	n.s
Preoperative mFTA (°)	186.6 ± 5.4 (177–195)	184.2 ± 2.9 (177–190)	0.04
Preoperative IKS score			
Knee	45.6 ± 16.3 (19–73)	62.9 ± 12.9 (25–88)	0.0006
Function	50 ± 14.3 (29–80)	66.4 ± 16.8 (20–90)	0.001
Delay from tibial plateau fracture (year)	4.1 ± 3.7 (0.41–16.2)		
Initial treatment			
Non-operatively (cast)	6/18 (33.3%)		
Open reduction and internal fixation	12/18 (66.7%)		

BMI body mass index (kg/m^2), *ASA* American society of anesthesiologists, *mFTA* mechanical femorotibial angle, *IKS* international knee society, *n.s.*: non-significant

^aData are presented as mean ± standard deviation [minimum – maximum] or number (proportion)

Statistical analysis

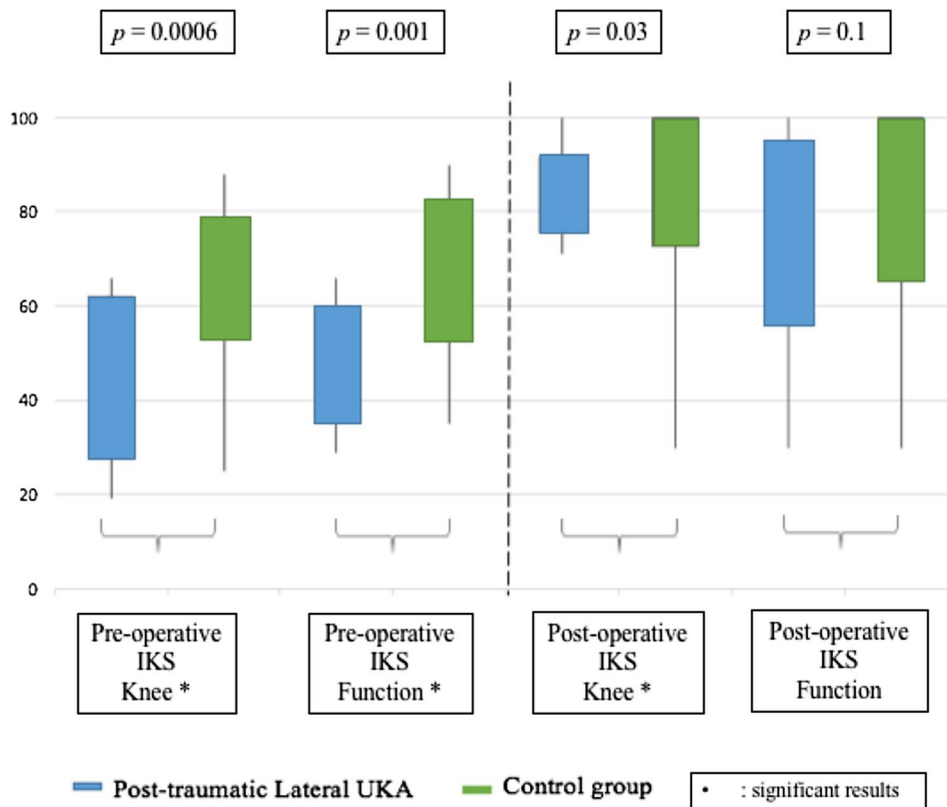
Statistical analysis was performed with the online software EasyMedStat® (<https://www.easymedstat.com>; Neuilly-Sur-Seine; France). Distributions of continuous variables were reported as mean with range and standard deviation. Statistical analysis was performed using the Fisher’s test or Mann–Whitney tests. Categorical variables were compared using a Fisher’s exact test. Survival analysis was conducted with reintervention as the endpoint. Global survival curves were estimated with Kaplan–Meier model and the comparison of survivorship between the different initial etiologies was estimated with log-rank. The level of significance was set at $p < 0.05$ for all tests.

Results

Clinical outcomes

For both groups, post-operative IKS scores were significantly improved compared to pre-operatively (Fig. 4). The clinical improvement was significantly higher for the post-traumatic group than for the control group (Fig. 5). Better outcomes were observed in the control group with a significant difference for the IKS Knee score ($p = 0.03$) but not for the IKS Function score (n.s.).

Fig. 4 Distribution and variation of IKS scores (Knee and function) between the pre-operative and postoperative for the post-traumatic group (blue) and the control group (green)



Details of the clinical results are summarized in Table 2.

Radiological outcomes

Concerning polyethylene wear, after a mean follow-up of 10.1 years, there was no difference in mean polyethylene (PE) wear per year between the groups. Two patients (13.3%) in the post-traumatic group had greater than 1 mm of PE wear. In the control group, 3/29 (10.3%) patients had greater than 1 mm of PE wear. The measurements of the PE wear showed an excellent interobserver reproducibility with an agreement of 0.96.

Progression of medial OA was greater in the control group (22/36; 61.1%) than in the post-traumatic group (5/18; 27.8%) ($p = 0.02$). No difference was observed concerning patello-femoral OA between the two groups (3/18 (16.7%) in the post-traumatic group versus 8/36 (22.2%) in the control group) (n.s).

Details of the radiological outcomes are summarized in Table 3.

Surgical revision

The revision rate was similar between the two groups with 3/18 (16.7%) cases in the post-traumatic group and 7/36 (19.4%) cases in the control group undergoing revision surgery (n.s.).

Fig. 5 Gain of IKS scores (Knee and Function) between the preoperative and the postoperative period for the post-traumatic group (blue) and the control group (green)

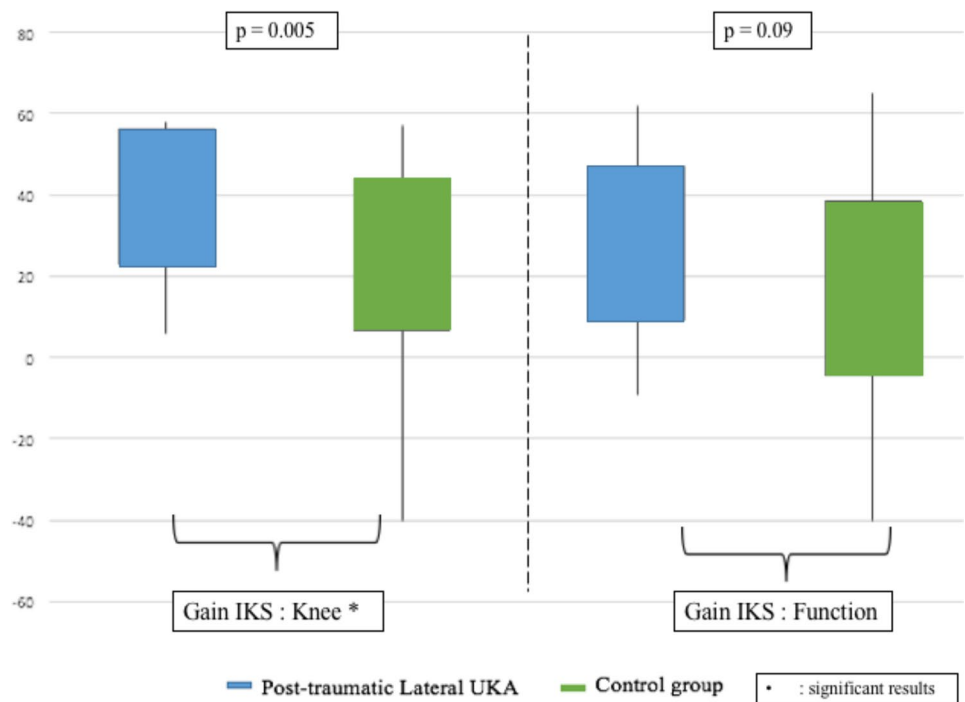


Table 2 Comparison of the International Knee Score for each group at different time points

IKS score type	Post-traumatic group ^a	Control group ^a	p value
Preoperative			
Knee	45.6 ± 16.3 (19–73)	62.9 ± 12.9 (25–88)	0.0006
Function	50 ± 14.3 (29–80)	66.4 ± 16.8 (20–90)	0.001
Postoperative			
Knee	85.0 ± 8.4 (71–100)	89.1 ± 14.8 (30–100)	0.03
Function	77.9 ± 19.5 (30–100)	85.9 ± 19.1 (30–100)	n.s
Improvement			
Knee	39.7 ± 16.7 (6–58)	25.5 ± 18.9 (– 40–57)	0.005
Function	28.1 ± 18.7 (– 9–62)	17.1 ± 21.6 (– 40–65)	0.09
p value			
Knee	0.01	0.0001	
Function	0.01	0.0004	

IKS international knee score, n.s. non-significant

^aData are presented as mean ± standard deviation [minimum—maximum] or number (proportion)

The two groups did differ, however, regarding the indication for revision.

For the post-traumatic group, the causes of failure leading to reintervention were PE wear (one case which had reinforcement internal fixation during the LUKA), pain secondary to a prosthesis impingement with the tibial

spine (one case) and progression of medial OA (one case). For these three cases, a TKA was performed.

In the control group, the causes of revision were progression of medial OA (four cases) treated by TKA (two cases) or medial UKA (two cases), aseptic loosening of the femoral component (one case) treated by TKA, patellofemoral OA treated with a patellofemoral partial knee arthroplasty (one case) and malpositioning of the femoral component leading to impingement with the tibial spines treated by a revision lateral UKA.

Survival

There was no difference between the two groups with respect to long-term revision free survivorship (n.s.) (Fig. 6).

Discussion

The most important finding of our study was the similarity of the different postoperative outcomes between the two groups.

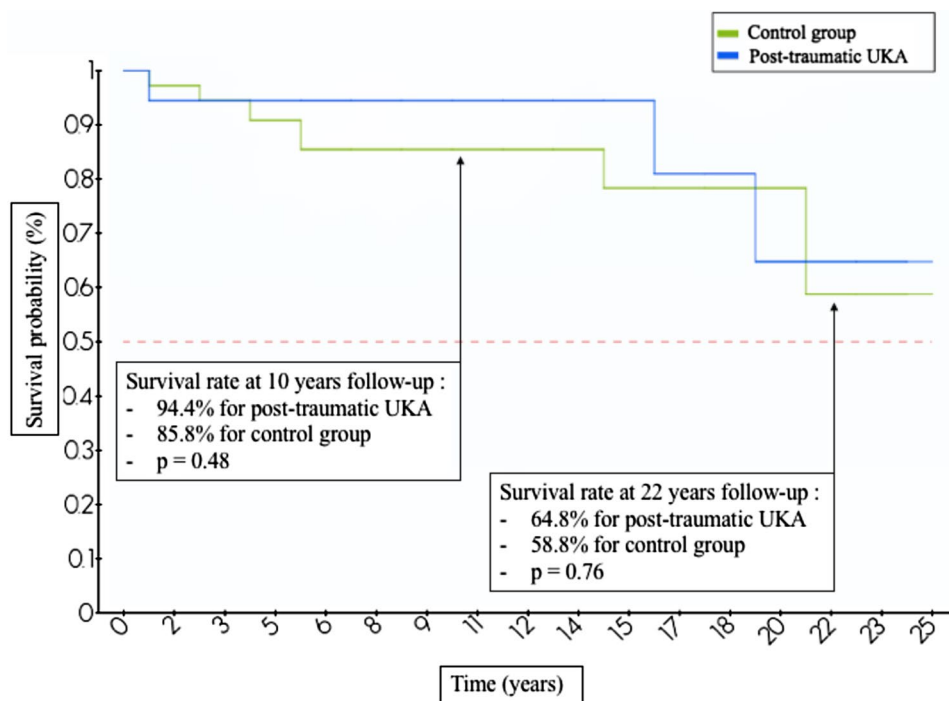
A significant difference was observed between the two groups for the postoperative IKS Knee score (4.1 points, p=0.03) (Table 2), with better results for the control group. However, the minimum clinically important difference (MCID) of the IKS score has not been defined in the literature. Concerning the known MCID of other clinical scores, such as the WOMAC score (Western Ontario and MacMaster), the Oxford Knee Score and the Short Form-36, a

Table 3 Comparison of radiological outcomes between the groups

	Post-traumatic group ^a	Control group ^a	<i>p</i> value
Postoperative mFTA (°)	182.0 ± 4.7 (177–190)	181.6 ± 3.0 (175–188)	n.s
PE Wear (mm)	0.43 ± 0.49 (0–2.1)	0.56 ± 0.36 (0–1.63)	0.001
PE Wear per year (mm/year)	0.002 ± 0.003 (0–0.0133)	0.003 ± 0.002 (0–0.008)	> 0.05
Progression medial OA	5/18 (27.8)	22/36 (61.1)	0.02
Progression PF OA	3/18 (16.7)	8/36 (22.2)	> 0.05
Tibial radiolucency			
<i>N</i> (%)	8/15 (53.8)	2/29 (6.9)	0.0009
Size (mm)	0.58 ± 0.6 (0–2)	0.08 ± 0.4 (0–2)	0.02
Femoral radiolucency			
<i>N</i> (%)	1/15 (7.7)	6/29 (20.7)	n.s
Size (mm)	0.04 ± 0.14 (0–0.5)	0.23 ± 0.4 (0–2)	n.s

mFTA mechanical femorotibial angle, PE polyethylene, OA osteoarthritis, PF patello-femoral, mm millimeter, n.s. non-significant

^aData are presented as mean ± standard deviation [minimum – maximum] or number (proportion)

Fig. 6 Revision-free survival curves comparing post-traumatic group (blue) and control group (green)

difference of less than 5% is considered less than the MCID. Extrapolated to our data, the difference of less than 5% that we observed could be interpreted as lower than the MCID for the IKS score [9, 10, 17, 25]. Considering this difference of IKS Knee score as not clinically significant, and given that no significant difference in the IKS Function score was observed, we could conclude that the postoperative clinical outcomes are similar between the two groups.

A second important finding of this study was the greater IKS Knee score improvement observed for the posttraumatic group (+ 39.7 points versus + 25.5 points, *p* = 0.005) (Fig. 5, Table 2).

The literature reports similarly good outcomes for LUKA performed for lateral PTOA as Lustig et al. [22] which reported slightly superior post-operative IKS knee and function scores at 88 and 87 points. Conversely, Sah and Scott [28] reported lower IKS scores for post-traumatic lateral UKA (Knee = 74, Function = 65) compared to UKA for degenerative OA (Knee = 95, Function = 86). However, the pre-operative IKS scores were also inferior for the PTOA group (36/40 versus 41/48). In their study, no specific analysis of post-operative improvement was performed; however, this could explain, at least partially, why they found lower post-operative post-traumatic

IKS scores. This point is similar to our study, where the pre-operative IKS scores were lower for the post-traumatic group and could explain the lowest postoperative outcomes.

Our results are similar to those found by other authors who analyzed all indications of lateral UKA. Argenson et al. [2] reported IKS knee scores ranging from 88 and function scores ranging from 78 at 12-year follow-up.

Concerning the radiological outcomes, our two groups differ regarding the localization and the rate of radiolucency. The post-traumatic group had a higher tibial radiolucency rate which was not progressive or associated with aseptic loosening. This higher rate could be related to the previous fracture and the altered sub-chondral bone quality leading to a poorer bone–cement interface. For the control group, the global rate of radiolucency was 27.6% (8/29) which is similar to the result of Kleeblad et al. [16].

Concerning PE wear, we found a similar wear rate per year between the two groups. Our results seem to be similar to the literature even if the wear rate varies between 0.036 and 0.07 mm/years depending the study, the follow-up and the implant used [11, 14]. As reported by Deroche et al. [11], fixed all-PE UKA is a safe option for lateral partial knee arthroplasty with good long-term survivorship and low PE wear.

For both groups, we observed good long-term survivorship similar to Argenson et al. [2] (Fig. 6). No difference was observed for the revision-free survival curves between the two groups. The greater rate of tibial radiolucency in the post-traumatic group, and the potential poorer bone quality, did not impact prosthesis survival.

In our study, PTOA was not associated with an increased risk of revision with similar results reported in the literature. Bertani et al. [6] found 14.3% of revision at 9-year follow-up for a population of lateral UKA including all indications.

A number of studies have analysed the outcomes of TKA for PTOA. They generally report a higher risk of complications and revision, between 8.5% and 20.9%, after TKA for PTOA compared to degenerative OA [19, 29, 34, 36], with the exception of Abdel and et al. [1] who found no increased risk of revision at long term. Our population is not comparable to the population requiring TKA; however, when PTOA is isolated to the lateral tibiofemoral compartment, LUKA seems to be an interesting solution with no greater revision risk compared to non-traumatic indications.

Concerning the main reason for revision in this cohort, no specific aetiology was identified for the post-traumatic group. In the control group, the principal reason for reintervention was progression of medial OA in 57% of cases, consistent with the published literature [5, 11, 12, 20, 21]. This evolution is logical due to the fact that post-traumatic OA is secondary to localized damage of the articular joint surface in a specific area, while degenerative OA, even when isolated to one

compartment at presentation, is a global joint disease which can progress to other compartments over time.

A strength of this study is that all LUKA were performed by senior knee surgeons using the same implant. Second, it is a case–control study with two comparable groups concerning demographic characteristics, especially patient age, which is an important factor as PTOA more commonly affects young people. This comparability reduces the risk of bias concerning clinical outcomes and prosthesis wear. Third, the long follow-up is an advantage for the assessment of complications, such as medial OA progression, aseptic loosening and PE wear.

Our study has several limitations. First, it is a retrospective series. Second, the number of post-traumatic lateral UKA is very limited. Third, the incidence of this specific indication, post-traumatic OA, is also rare which limits the number of patients [3, 22]. The results of this study should be read with caution because they are based on a small cohort of patients. In our study, we found that LUKA appears to be an efficient option in agreement with the literature and, performed by a trained surgeon, it should be considered as an option in the treatment of isolated lateral PTOA.

Conclusion

Lateral UKA seems to be an effective procedure for selected patients suffering from isolated post-traumatic osteoarthritis after lateral tibial plateau fracture with good clinical outcomes close to those after lateral UKA performed for non-traumatic indications, without increased risk of revision or early prosthetic wear confirming our hypothesis.

Funding There is no funding source.

Compliance with ethical standards

Conflict of interest No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. For this type of study formal patient consent is not required. The paper was approved by the Inst. Review Board. The Advisory Committee on Research Information Processing in the Field of Health (CCTIRS) approved this study in Paris (university Paris-Descartes V) on February 17, 2016 under number 16–140.

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