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Does Patellar Eversion in Total Knee Arthroplasty Cause Patella Baja?

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Abstract Several proponents of minimally invasive surgery-total knee arthroplasty (MIS-TKA) have suggested patellar eversion during a standard exposure of the knee may cause shortening of the patellar tendon and poorer outcomes secondary to acquired patella baja. To explore this suggestion, we retrospectively reviewed 135 consecutive TKAs in 110 patients to ascertain the effect of TKA on the postoperative Insall-Salvati ratio. All surgeries were performed using standard TKA techniques with a midline incision, medial parapatellar arthrotomy, partial excision of the fat pad, and routine eversion of the patella. One patient developed a postoperative patella baja, defined as an Insall-Salvati ratio of less than 0.8. The Knee Society score for knee and function in this patient was 75 and 70, respectively. Five additional patients had a decrease in Insall-Salvati ratio by 10% or more but without patella baja. Mean Knee Society score for knee and function in these five patients was 94 (range, 73–99) and 96 (range, 90–100), respectively, as compared with 93 (range, 37–99) and 94 (range, 40–100) in the remaining 104 patients. Our data suggest the incidence of patella baja is low after TKA despite routine patellar eversion. Furthermore, a 10% or more decrease in the Insall-Salvati ratio without patella baja was not associated with a worse clinical outcome.
Level of Evidence: Level IV, therapeutic study. See the Guidelines for Authors for a complete description of levels of evidence.

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Each author certifies that his or her institution has approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

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Introduction

Patella baja after TKA has been reported to alter the femoropatellar joint mechanics and result in decreased range of motion, extensor lag, anterior knee pain, polyethylene impingement and subsequent wear, and diminished outcomes [1, 9–11, 19, 24–26]. Proponents of minimally invasive surgery-TKA (MIS-TKA) have suggested that patellar eversion during a standard exposure of the knee causes shortening of the patellar tendon and poorer outcomes secondary to the development of patella baja [11, 26]. Weale et al. reported an incidence of 34% patella baja with a standard TKA as compared with 5% after a unicompartmental knee arthroplasty (UKA) [26]. Similarly, Floren et al. found an incidence of 37% patella baja after a standard TKA as compared with 12% after a MIS-TKA [11]. This reduced incidence of patella baja after a less invasive approach, in which the patella is only displaced and not everted, was also associated with a better functional outcome, less pain, and better range of motion.

We have not clinically observed many cases of patella baja despite our routine use of a standard approach for knee

exposure with eversion of the patella. We therefore evaluated the effect of TKA on postoperative length of the patellar tendon (as evaluated by the Insall-Salvati ratio [ISR]) with routine eversion of the patella during surgery. In addition, we analyzed the effect of the decrease in the ISR on clinical outcome by means of Knee Society scores (KSS) [15], anterior knee pain, and difficulty with stairs.

Materials and Methods

We retrospectively reviewed 118 patients with 145 consecutive primary TKAs performed between January 2005 and January 2006. We assessed pre- and postoperative ISRs and their changes in all patients. Eight of the 118 patients (10 knees) had incomplete data and were excluded. One patient (one knee) died before the first year followup as a result of unrelated cause and one patient (two knees) had incomplete clinical data resulting from substantial comorbidities. The available radiographs on these patients did not show patella baja. Three patients (four knees) were lost to followup. We also excluded three additional patients (three knees) with preoperative patella baja. Therefore, 110 patients (135 knees) were available for review with 1-year followup. There were 69 women and 41 men with a mean age of 69 years (range, 35–94 years). The mean body mass index was 30.1 kg/m^2 (range, 20.1–45.8 kg/m^2). The diagnosis was osteoarthritis in 101 patients, rheumatoid arthritis in eight patients, and osteonecrosis in one patient. Institutional Review Board approval and informed consent were obtained for this study.

All surgeries were performed by the senior authors (CSR, ASR) using standard TKA techniques with hypotensive anesthesia, a midline incision, and a medial parapatellar arthrotomy with a split in the rectus-vastus medialis obliquus interval of approximately 5 to 6 cm. The tibia was subluxated anteriorly and the infrapatellar fat pad was partially excised to facilitate exposure of the proximal tibia (Fig. 1). The patella was routinely everted during exposure of the tibia, the tibial cut, and preparation of the patella (Fig. 2A–B). It was then retracted laterally without eversion during femoral preparation. The extension gap was balanced by appropriate soft tissue release in extension and the flexion gap was balanced by appropriate femoral component rotation by the balanced gap technique [14]. The tourniquet was inflated only for the preparation of the tibial keel and cementation of the implants. The patella was resurfaced in all patients and the component was placed centrally. The tibial and femoral components were lateralized to improve patellofemoral kinematics. Lateral release was not required in any case. We routinely used a steroid containing peri-articular injection during the surgery [21].

Fig. 1 This clinical photograph shows partial excision of the infrapatellar fat pad to facilitate eversion of the patella and exposure of the proximal tibia.

Eighty-four knees were implanted with a mobile-bearing high-flexion PFC® Sigma™ RP-F and 51 with a fixed-bearing PFC® Sigma™ Knee system (DePuy Orthopedics, Inc, Johnson & Johnson, Warsaw, IN). The mean size of the polyethylene insert was 10.5 mm (8 mm in 17 knees, 10 mm in 85 knees, 12.5 mm in 25 knees, 15 mm in seven knees, 17.5 in one knee).

The postoperative pain control and rehabilitation consisted of a multimodal approach [21, 22], which aims at the avoidance of parenteral narcotics and early postoperative mobilization. Continuous passive motion was used on all patients during the hospital stay.

The patients were evaluated at 6 weeks, 12 weeks, and 1 year postoperatively. KSS [15] were assessed preoperatively as well as at each postoperative visit. Anterior knee pain and difficulty with stairs were also assessed by using a self-administered questionnaire. Radiographs were obtained preoperatively and at 6 weeks and 1 year postoperatively. The radiographic technique was standardized and radiographs were obtained by the same group of technicians. The lateral radiograph was obtained at approximately 30° of flexion [19]. All radiographs were digitalized.

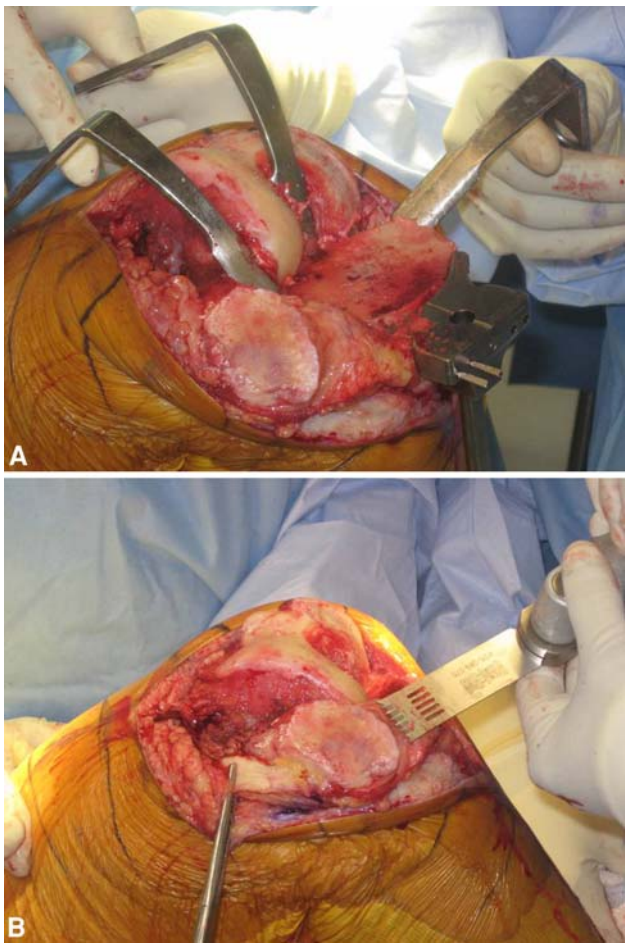

Fig. 2A–B The patella was routinely everted during (**A**) exposure of the tibia and (**B**) preparation and resurfacing of the patella.

The ISR was calculated on the preoperative and the 1-year postoperative radiographs according to the original description by Insall and Salvati [16]. Radiographic evaluation was performed by two independent observers (PGT, AVM) who were blinded to the clinical outcome. Paired preoperative and postoperative radiographs were evaluated simultaneously to minimize the error resulting from landmark identification [11, 26]. Enhancing the digital images by adjusting the brightness, contrast, and zoom allowed proper identification of the landmarks, especially of the patellar tendon. Variation in magnification was corrected by the method described by Weale et al. [26]. We determined differences in the measurements for the two observers with a paired t-test and the associations with an intraclass correlation coefficient (ICC). We observed no differences ($p = 0.6$) in the mean measurements between the two observers; the mean difference in the measurement was 0.1 mm (range, −2.7 to 3; standard deviation [SD], 1.2) with an ICC of 0.9 ($p = 0.001$).

For this study, patella baja was defined as an ISR of less than 0.8 [16, 19]. A change of 10% or more in the postoperative ISR was also calculated to compare our results with previously published studies [11, 18, 26]. Because the purpose of this study was to find the true postoperative patella baja resulting from shortening of the patellar tendon, no attempt was made to evaluate the joint line elevation and the resultant pseudo-baja [13].

Differences in the ISR and the length of the patellar tendon from pre- to postoperatively were assessed by t-tests. Differences in nonparametric variables were assessed by Mann-Whitney U test. The relationship between the KSS and the postoperative ISR and between the KSS and the difference in the preoperative and postoperative ISR was estimated by the Kendall tau rank correlation coefficient. Data were analyzed with the SPSS/PC + statistical package (SPSS version 16.0, Chicago, IL).

Results

The incidence of postoperative patella baja in this series was 0.7% (one of 135 knees) (Fig. 3A–B). The pre- and postoperative ISR was similar ($p = 0.4$) with a mean of 1.17 (range, 0.8–1.4; SD, 0.1) preoperatively and 1.16 (range, 0.7–1.4; SD, 0.1) postoperatively. The pre- and postoperative length of the patellar tendon was also similar ($p = 0.2$) with a mean of 39.1 mm (range, 30–50 mm; SD, 4.9) preoperatively and 39.7 mm (range, 30–48 mm; SD, 4.6) postoperatively. There was a mean increase of 0.6 mm (range, −6 to 10 mm; SD, 3.3) in length of the patellar tendon postoperatively as compared with the preoperative length.

Five additional knees (3.7%) had a decrease in the ISR by 10% or more but with an ISR of 0.8 or greater (no patella baja). The numbers were similar ($p = 0.3$) in the RP-F and Sigma groups (two and three, respectively). The clinical outcome in these five patients was similar to those in the remaining 104 patients (Table 1). None of these five patients reported anterior knee pain or difficulty with stairs. The one patient with postoperative patella baja had KSS for knee and function of 75 and 70, respectively, with a knee flexion of 95°. Of the six patients with substantial reduction in ISR, four were women. Seven other knees (5.2%) had an increase in the postoperative ISR by 10% or more with no clinical consequence. We found no correlation between the postoperative ISR and the KSS for knee ($r = 0.006$; $p = 0.9$) and function ($r = 0.1$; $p = 0.7$). Similarly, we observed no correlation between the reduction in ISR and the KSS for knee ($r = 0.13$; $p = 0.3$) and function ($r = -0.4$; $p = 0.8$).

Discussion

Several studies in the literature suggest TKA may be associated with a high incidence of patellar tendon

Fig. 3A–B Lateral radiographs of the knee show (**A**) a preoperative Insall-Salvati ratio (ISR) of 0.88 and (**B**) a postoperative acquired patellar baja (ISR 0.76).

Table 1. Summary of clinical data

Variable	Group 1	Group 2	p Value
Mean KSS for knee (range)	94 (73–99)	93 (37–99)	0.6
Mean KSS for function (range)	96 (90–100)	94 (40–100)	0.7
Mean flexion (range)	122° (100°–135°)	124° (85°–135°)	0.7

One patient developed postoperative patella baja; Group 1 = five knees with a decrease in the ISR by 10% or more, but with an ISR 0.8 or greater (no patella baja); Group 2 = the remaining 104 patients; KSS = Knee Society score; ISR = Insall-Salvati ratio.

shortening and resultant patella baja [11, 18, 19, 26]. Moreover, two studies using a minimally invasive technique showed a decreased incidence of patella baja as compared with a standard TKA [11, 26]. These authors suggested extensive surgical exposure and eversion of the patella may be involved in the pathomechanics of postoperative patella baja. Despite use of a standard TKA technique with routine eversion of the patella, we have not observed a high incidence of patella baja. Therefore, this retrospective study was designed to evaluate the effect of patellar eversion in TKA on development of patella baja as evaluated by ISR and to ascertain the effect of a decreased postoperative ISR on the clinical outcome.

Our study is a retrospective review of a consecutive series of a typical TKA patient population. One limitation is the short followup of 1 year, but previous studies suggest there is no further substantial change in the ISR or the patellar tendon length beyond the first postoperative year [11, 18, 26]. The identification of radiographic landmarks is another potential source of error for the calculation of the ISR, which was minimized by digitally enhancing the images. This is reflected by a high ICC between the two observers (0.9) with no differences in the mean measurements. The use of the ISR offers further benefit because this is a ratio and is not affected by magnification.

Patella baja has been reported after anterior cruciate ligament reconstruction [7], high tibial osteotomy [20, 23], tibial tubercle surgery [4], and TKA [5, 6, 11, 18, 19, 26]. Proposed causes are shrinking of the tendon itself, scarring of the tendon to the tibia, new bone formation at the tendon insertion, and restricted postoperative motion [6, 23]. Patella baja after TKA has been reported in 10% to 65% of cases and has been linked to patellar eversion, radical excision of the fat pad, and lateral release [11, 17–19, 26]. Twice as many female patients as males have been reported to develop a postoperative patella baja [19]. In our series, the incidence of postoperative patella baja was 0.7%. Thus, our data support routine eversion of patella and excision of the fat pad do not lead to an increased incidence of patella baja after a TKA. A 10% or more decrease in the ISR without patella baja occurred in five other knees (3.7%), but this was not associated with an inferior clinical

outcome as compared with the rest of the group. Twice as many women as men (4:2) had a postoperative decrease in ISR of 10% or more in our series also, but this number was too small to draw any conclusion.

In a retrospective review of 1055 consecutive TKAs in 720 patients [19], the incidence of patella baja was 9.8% (92 of 943). No difference was found between the cruciate-retaining and cruciate-sacrificing implants. However, the surgical technique used was not discussed. Furthermore, a decrease in the ISR was associated with diminished stair and function scores but had no effect on range of motion, KSS, or pain scores. In another study on 94 TKAs performed in 61 women [18], the ISR decreased by more than 10% of its preoperative value in 61 knees (64.9%). Although lateral release was performed in all patients, the fat pad was not resected. However, this decrease in ISR had no influence on the range of motion or power of the quadriceps muscle. In a prospective randomized, controlled trial of 84 patients who had had either TKA or UKA [26], 34% (14 of 41) of the TKA group developed patella baja, defined as 10% or more shortening of the patellar tendon postoperatively, compared with 5% (two of 43) in the UKA group. The authors associated restricted motion and knee pain with patella baja; lateral release was linked to the development of patella baja (six of seven). Another study reported no correlation between ISR and postoperative range of motion in 154 primary TKAs in 135 patients [12]. Recently, Floren et al. [11] suggested the incidence of patella baja was reduced by a MIS-TKA, in which the patella was not everted and only partial excision of the fat pad was done. When 5% shortening of the tendon was considered as the cutoff, the incidence of patella baja in the MIS-TKA group was 12% (nine of 74) as compared with 37% (21 of 63) in the standard TKA group. They reported no difference when a 10% cutoff was used. At 1 year, patients with patella baja had reduced range of motion and more pain.

We offer several possible explanations for our results, which compare favorably with the previous reports. Although we do perform partial fat pad excision to facilitate proximal tibial exposure, we avoid radical excision of the fat pad. This along with a lateral release may cause ischemia of the patella and its tendon [17] and lead to scarring and tissue contraction [26]. Moreover, aligning the femoral component rotation using the balanced gap technique and by lateralizing the components, no patient required lateral release in this series. Although the cause of patella baja after TKA is multifactorial, it appears from previous studies that a lateral release is consistently associated with an increased risk [18, 26]. The use of a tourniquet has also been associated with patella baja [2, 8]. We inflate the tourniquet only during preparation of the tibial keel and cementation. Finally, our low incidence of patella baja may also be associated with better pain control and accelerated rehabilitation [3, 23, 27]. We routinely use periarticular injection of a steroid-containing cocktail during the surgery [21]. The injection may reduce postoperative pain and subsequent fibrosis and scarring of the tendon. However, none of these issues will be resolved until a well-controlled, prospective, randomized study is performed to assess these variables.

We found an incidence of patella baja of less than 1% despite routine patellar eversion during TKA. Although patella baja was associated with worse clinical outcome, a 10% or more reduction in the ISR without patella baja had no adverse effect.

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