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Retropatellar contact characteristics in total knee arthroplasty with and without patellar resurfacing

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Abstract Total knee replacement with and without patellar resurfacing was performed in 6 cadaver specimens. The contact pressure and contact area between femur and patella was measured at 60° of flexion. In comparison to specimens without resurfacing the specimens with small size resurfacing showed a significant decrease in contact area, whereas average and maximum pressure were unchanged. In specimens with medium size resurfacing, contact area and average pressure increased slightly, whereas maximum pressure increased significantly. Patellar resurfacing did not change the retropatellar pressure, but was associated with reduced contact area.

Résumé 6 cadavres ont été examinés après implantation d'une prothèse totale du genou avec et sans implants de restructuration de la surface rotulienne. Les mesures de la pression et de la surface de contact ont été réalisées avec une flexion du genou à un angle de 60°. En comparant les résultats de genoux sans implants et genoux avec implants de la rotule de taille "petite", on remarque que ces derniers ont causé une diminution significative de la surface de contact rétro-rotulienne. Les pressions moyenne et maximum n'ont pas changé de manière déterminante. Les implants de taille "moyenne" ont conduit à une augmentation considérable de la pression maximum et à une diminution significative de la force alors que la surface de contact et la pression moyenne ont elles, légèrement augmenté. Après la pose des deux types d'implants de la rotule on a constatée une réduction significative de la surface de contact, mais ne pas de la pression rétro-rotulienne.

Introduction

It has been suggested that the significant complication rate following patellofemoral replacement, including patellar displacement, pain and fracture, may be related to increased retropatellar pressure [1, 5, 6, 10, 13, 14, 17, 18, 35] and some authors therefore advise against patellar resurfacing as part of total knee replacement (TKR) [4, 22, 29]. The routine inclusion of patellar resurfacing may depend upon the design of the prosthesis [2, 7, 28, 31, 32]. While some authors report satisfactory results [5, 11, 13, 16, 18, 20, 28], others advise against patellar resurfacing [4, 22, 36]. Improved function after patellar resurfacing during daily activities such as stair climbing has been reported [5, 9, 27, 29], and others report increased muscle power and reduced pain [9, 33]. Differing views have also been reported from younger, more active patients [23, 32]. There are fewer complications if correct alignment is achieved [19, 28, 29, 30], and a lateral release may be required [9]. No difference is noted when comparing the results in bilateral cases with and without patellar resurfacing [2, 10, 19, 22]. Changes in retropatellar pressure and altered contact area are deemed to be the cause of persistent symptoms after TKR. Current patellar resurfacing techniques do not prevent further local problems.

Materials and methods

We examined 6 cadaver knees. The mean age of the subjects was 71.6 years (range: 60–86). Requirements for inclusion in the study were: no previous knee surgery, a full range of movement, an age range of 60–90 years to correspond with the age of patients requiring TKR, and no radiological evidence of degenerative disease. A cemented, posterior cruciate ligament retaining, large size Genesis I prosthesis (Smith and Nephew Surgical, Schenefeld, Germany) was used. Pressure and contact area measurements were performed using a super low pressure Fuji Prescale Film, with a normal pressure range from 0.5–2.5 MPa. The film includes an A- and a C-film. The A-film has micro-capsules containing indicator color on one side. The C-film reacts to this color with a red stain. When pressure is applied micro-capsules release color and the in-

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tensity of the red stain reflects the amount of pressure with a precision of 10% within a temperature range of 200 and 350°C and a humidity of 35–80%. Evaluation of the contact zones and pressure measurements was performed with specialized software (Tiedemann and Betz, Garmisch-Partenkirchen, Germany). The prostheses were introduced with routine instrumentation. The Fuji films were placed in predefined positions between the femur and the patella and pressure recorded while a force was applied and held for 5 s, with the knee flexed to 60°. Measurements were made with and without patellar components and using small and medium sized components. The original patellar thickness was resected to 15 mm before introducing the components.

The statistics were reviewed with the Stat View 4.5 program (SAS Institute Corp.). Student's *t*-test, Friedman and Wilcoxon tests were performed.

Results

The average contact area was 147 mm² without patellar implant and reduced significantly to 72 mm² ($P=0.007$) with the small implant and to 82 mm² ($P=0.03$) with the medium implant. The average pressure was minimally increased from 1.50 MPa to 1.56 MPa with the small sized implant and 1.62 MPa with the medium implant. The maximum pressure was 2.64 MPa before and 2.76 MPa after implantation with a small component and 2.78 with a medium component. The retropatellar force was significantly reduced from 217 N to 115 N ($P=0.03$), with no difference between the small and medium sized

Fig. 1 Retropatellar area (left: area) and force measurements (right: load) before and after total knee arthroplasty with "small" and "medium" sized patellar replacements

Fig. 2 Retropatellar pressure measurements, (left: Av. pressure) and (right: Max. pressure), before and after total knee arthroplasty with "small" and "medium" sized patellar replacements

components (Figs. 1 and 2). Thus, after patellar resurfacing the contact area and force were significantly reduced and the mean and maximum pressures were only slightly increased, with no difference between the small and medium sized components.

Discussion

Increased retropatellar pressure is thought to be the cause of failure of patellar implants. McLain et al. [25] reported a threefold increase in pressure beyond 30° of flexion after resurfacing and related this to decreased contact area. Goldstein et al. [12] found the highest pressure values between 45° and 60° flexion. Hsu et al. [15] showed that increased contact area may be obtained by improving the conformity of patellar components; and McNamara et al. [26] showed less contact stress associated with less conforming designs. Takeuchi et al. [34] did not show any relationship between failure of patellofemoral components and the Q-angle. We found a decrease in contact area with patellar resurfacing. There was no significant difference in the average and maximum retropatellar pressures after resurfacing. Increased pressures have been reported after resurfacing [3, 21, 24], and the combination of increased pressure and decreased contact area may lead to increased polyethylene wear and loosening [3, 21, 34]. In view of our findings of reduced contact area without significantly increased pressure we would not recommend routine patellar resurfacing.

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