Finding and defining the ideal patellar resection plane in total knee arthroplasty

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INTRODUCTION

Failing to achieve equal thicknesses on all sides of the patellar bone remnant when cutting the patella during total knee arthroplasty can lead to anterior knee pain, bony impingement and patellar maltracking. Asymmetry of greater than 2 mm (equivalent to 7°) occurs in approximately 10% of cases, even for experienced surgeons. Reasons include the small, hard bone; difficulty identifying landmarks; poor visibility; and the low priority normally put on patellar resection. There is no consensus regarding the desired landmarks; the cut is often done freehand, and there has been no quantitative comparison of proposed resection planes. With the goal of improving resection symmetry, the objectives of this study were to: (1) determine the intra- and inter-surgeon repeatability of two definitions for drawing resection lines on preoperative radiographs; (2) calculate two additional definitions based on the radiographic patellar circumferences; (3) determine the angular differences amongst these four definitions; (4) compare these to the postoperative resection line before and after implementing a new resection method clinically, and (5) identify distinguishing features of pateallae with a better vs. worse resection angle.

METHODS

Three experienced surgeons drew lines on 40 digital X-rays plus 10 interspersed repetitions of three of these X-rays using two different definitions: a newly-developed medial divot (MD) technique, connecting an indentation on the medial side to 1 mm above the lateral cartilage surface, and the commonly-reported medial-lateral extents (MLE) technique, connecting the farthest medial and lateral points. There was no consideration for the thickness of the resection.

We calculated two other definitions from the digitized patellar circumferences. To define a line parallel to the anterior surface (ANT), a common recommendation, we fit a least-squares line to the surface. To define the line perpendicular to the caliper tangent points (PERP), nominally considered the thickest anteroposterior direction, we calculated the patellar rotation required to minimize the vertical distance.

Clinical resection angles were compared to the definitions by calculating the translation, rotation and scaling required to transform the postoperative circumference to the preoperative one. Our study included 20 patients from before and 20 patients from after the senior surgeon implemented the medial divot method. Resection angles were further analyzed by gender (26 female, 14 male) and asymmetry (six greater than 7°). Statistical analyses were made using Student’s t-tests for comparisons of means and F-tests for standard deviations (α = 0.05). Our institutional review board approved the study.

RESULTS

Both the intra-surgeon and inter-surgeon repeatability were significantly better using the MD method compared to the MLE method (0.8° vs. 1.6° intra, 1.4° vs. 2.0° inter, p<0.001; Fig. 1). The mean MD and mean MLE resection definitions were very similar to the anterior surface definition (theoretically symmetric) whereas PERP resulted in on average 8° greater medial under-resection (p<0.001; Fig. 2). Implementation of the MD method clinically resulted in greater asymmetry, not less (p=0.03; Fig. 2). Female patients had an overall worse resection angle than male patients (mean 5.0° vs. 0.6°, p<0.001; Fig. 3) and all patellae with 5° or greater asymmetry (38%) were female. Asymmetric patellae were significantly more deformed than symmetric patellae, based on a newly-defined lateral lip angle (p<0.001; Fig. 3).

DISCUSSION

There is considerable variability in the patellar resection angle both radiographically and clinically. Computer-assisted surgery (CAS) may be able to provide improved resection symmetry. The anterior surface definition, which theoretically produces perfect symmetry, should be easier to achieve using CAS since the computer can automatically transfer the cutting plane to the correct height, entry point and orientation. High radiographic repeatability of the MD method suggests the potential for CAS implementation if the landmarks can be identified intraoperatively. Calculation of the PERP definition highlighted the fact that the patella rotates when applying calipers (due to the off-centre median ridge), which is important for clinicians to appreciate. The greater asymmetry for female patients appears related to greater arthritic fact when resecting deformed patellae and researchers should be aware that there is not a single unambiguous patellar horizon; several repetitions should be used to improve the estimate. This is the first study we are aware of to examine and compare different patellar resection definitions, which can be valuable for both conventional and computer-assisted surgery.

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