Does the integration of robotic technology improve outcomes in unicompartmental knee arthroplasty?

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Response/Recommendation: Robotic-assisted unicompartmental knee arthroplasty (R-UKA) offers several significant technological advantages, including precision and accuracy, repeatability, reliability, and real-time feedback. However, there are also studies in which conventional unicompartmental knee arthroplasty (C-UKA) was associated with shorter operative time and lower cost. Thus, the benefits of using robotics should be weighed against the added cost and longer operative time.

Level of Evidence: Moderate

Rationale:

Current studies have highlighted that the survivorship of unicompartmental knee arthroplasty (UKA) is closely linked to various intra-operative factors such as lower extremity mechanical alignment, component fixation and alignment, joint-line maintenance and soft tissue balancing**. (1-3)** To enhance surgical accuracy, precision, and ultimately improve survivorship rates in UKA, several robotic-assisted arthroplasty surgery systems have been developed. **(4)**

The studies in 14 meta-analyses have demonstrated that robotic assistance can significantly enhance the accuracy of surgery, particularly in UKA. One of the key reasons for this improvement lies in the advanced 3-dimensional (3D) visualization capabilities offered by robotic systems during the surgical procedure. **(5-7)** On the other hand, controversial issues such as surgery time and functional results exist. The studies did not find a statistically significant difference in KSS and WOMAC *(p-value 0.490, and 0.700 based on a z-test)* between R-UKA and C-UKA.

The low overall complication rates suggest that both R-UKA and C-UKA are generally safe procedures with low risk of adverse events. Superficial and deep infections were identified as the most prevalent complications, but the specific rates or comparative incidences between R-UKA and C-UKA were not detailed. The complication data demonstrated no significant differences in superficial and deep infection rates (OR 2.8 (95% CI 0.93 to 8.38); p = 0.070, z-test) or in early re-intervention rates (OR 2.20 (95% CI 0.79 to 6.09); p = 0.130, z- test) in the C-UKA group compared to R-UKA group in short-term follow-up.

Findings in the literature suggest that while both procedures are generally safe with low complication rates, R-UKA may offer advantages in terms of reducing complications and potentially lowering the need for revision surgeries compared to C-UKA (OR 2.18 (95% CI 1.06 to 4.49); p = 0.040, z- test). This is consistent with the data from national joint registries, which also indicate lower revision rates for R-UKA compared to C-UKA over similar timeframes. **(8-9)**

There are three current financial studies comparing the cost of R-UKA and C-UKA. Two of the studies using Markov decision analysis concluded that R-UKA is generally cost-effective compared to C-UKA, particularly in scenarios with higher case volumes and potential reductions in length of hospital stay. **(10-12)**

In summary, while R-UKA offers technological advancements that enhance surgical precision and reduce revision rates compared to manual techniques, it does not significantly differ in functional outcomes. As the costs associated with R-UKA approach those of C-UKA in high-volume settings, the rationale for adopting robotic technology becomes increasingly compelling, potentially offering both clinical and economic benefits in the field of knee arthroplasty.

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