Evaluation of conventional and patient-specific instrumentation for total knee arthroplasty using RSA

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Non-technical summary

A variety of disease conditions can lead to degeneration and loss of function of joints, including osteoarthritis and trauma. In many cases, end-stage joint disease can only be treated surgically with total joint replacement (arthroplasty). Total knee arthroplasty (TKA) remains one of the most common surgical procedures performed in North America. Limitations to conventional TKA surgery include the use of multiple tools with numerous jigs and fixtures, the risk of infection from repeated-use instruments, and the risk of bleeding, embolism and fracture associated with the insertion of an alignment guide in the intramedullary canal. One of the most current advances in intra-operative surgical guidance for TKA procedures is the development of single-use, patient-specific instrumentation. With this approach, pre-operative imaging (using magnetic-resonance imaging (MRI) or computed tomography (CT)) is used to determine the 3D contour of femoral and tibial anatomy, which is then used to specify the shape of patient-specific cutting guides, fabricated out of plastic using rapid-prototyping techniques. The patient-specific cutting guide is combined with an appropriate surgical plan is employed at the time of surgery to optimize limb alignment and component position. During the past several years, this approach has become very common, mainly due to rapid advances in medical imaging and rapid-prototype manufacturing technology.

However, the use of patient-specific instrumentation has recently been the subject of several studies of feasibility and efficacy. The majority of studies published so far have found no improvements in implant alignment, and have also identified situations in which guides would result in the implants being placed inappropriately, requiring intra-operative adjustments to their positioning. Radiostereometric analysis (RSA) is the gold standard technique for the evaluation of implant fixation, wear, and longevity. The highly precise nature of RSA enables studies utilizing only small numbers of patients, and can predict within the first two post-operative years whether the implant will go on to failure. To the best of our knowledge, RSA has not been used to evaluate conventional versus patient-specific cutting guides. The primary purpose of the present study, therefore, is to determine whether there is improved implant fixation within the patient-specific instrumentation group. Secondary objectives are to determine whether patient satisfaction is improved by using patient-specific instrumentation, to determine whether radiographic alignment of the implant components and mechanical axis of the limb improves from using patient-specific instrumentation, and to determine whether using patient-specific instrumentation reduces costs and operative time.