weak and larger, prospective, multicenter clinical trials are needed. Of note, two prospective randomized trials are currently recruiting with the aim to compare single- and two-stage revision surgery in the United Kingdom and North America with outcome measures including reinfection, mortality and patient reported outcomes [33].

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5.4. TREATMENT: TWO-STAGE EXCHANGE, SPACER RELATED

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QUESTION 1: What are the indications for the use of non-articulating vs. articulating spacers during resection arthroplasty of the hip or knee?

RECOMMENDATION: Articulating spacers appear to provide better range of motion and less functional limitations to the patients undergoing resection arthroplasty and should be used whenever possible. The indications for the use of non-articulating spacers during resection arthroplasty include patients with major bone loss, lack of ligamentous integrity (knee) or abductor mechanism (hip) that places these patients at elevated risk for dislocation or periprosthetic fracture and patients who have major soft tissue defects in whom motion is protected to allow better wound healing.

LEVEL OF EVIDENCE: Strong

DELEGATE VOTE: Agree: 91%, Disagree: 7%, Abstain: 2% (Super Majority, Strong Consensus)

RATIONALE

There is no clear consensus on the ideal type of spacer for management of periprosthetic joint infections (PJIs) of the hip and knee. Articulating spacers have been shown to be associated with improved range of motion, better function and also with the ability to facilitate ease of dissection at the second stage [1–5]. Citak et al. [6] reported superior functional outcomes with the use of articulating spacers when compared to static spacers.

Della Valle and colleagues recently demonstrated in a multicenter randomized controlled trial (American Association of Hip and Knee Surgeons (AAHKS) abstract) that articulating spacers for hip are associated with reduced lengths of hospital stay after both the first and second stage. Furthermore, they demonstrated improved range of motion of the knee at one year in the articulating spacer group (113 vs. 100 degrees ($p = 0.033$)) and a more significant improvement from preoperative and postoperative range of motion (18 vs. 3 degrees($p = 0.045$)).

The cost of articulating spacers as well as complications demonstrated with these have been highlighted [7–10]. However, these studies are heterogeneous and are predominantly retrospective case series. Citak et al. [6] observed that surgeon-made articulating spacers were more likely to fracture compared to preformed spacers despite having equivalent functional outcomes and infection eradication rates.

Dislocation rates of hip articulating spacers have been reported to range from 6.4 - 17.5% [5,7,9,11]. Dislocation was significantly higher in designs without an acetabular component or those implanted without cement in the acetabulum [7]. This finding is likely design related. Biring et al. reported a 3% dislocation rate with the prosthesis with antibiotic-loaded acrylic cement (PROSTALAC) spacer and satisfaction scores of 90.5 points at 10 - 15 years mean follow-ups [12]. A total of 44% of the group treated by Tsung et al. experienced such encouraging results with the custom-made articulating spacer (CUMARS) based on the Exeter stem that they opted to not have the second stage [13]. The incidence of periprosthetic fractures has been reported to be up to 11.4% with the use of mobile spacers [9].

Several authors have attempted to compare the results of static and articulating spacers in the knee [1,2,4,14]. However, there is a paucity of high quality evidence. Choi et al. [15], Johnson et al. [14], Chiang et al. [2] and Park et al. [1] found that non-articulating spacers were associated with more bone loss (in keeping with the conclusion of Della Valle et al.), increased rates of patella baja, lower Knee Society scores and range of motion (ROM) and required the use of more extensile approaches at the time of reimplantation. These studies are mainly case series and likely subject to selection bias, as patients with more important bone loss at the time of resection arthroplasty are also more likely to have undergone revision to a static spacer.

More recently, Faschingbauer et al. [16] reported a 9.1% fracture rate and an overall 15% rate of complications in 133 patients treated with static knee spacers. Lichstein et al. [17] reported a 94% eradication rate (in the presence of 25% drug resistant organisms), 100° median ROM after reimplantation and Knee Society Scores similar to those published in two recent systematic reviews [18,19]. Neither Voleti et al. [19] nor Pivec et al. [18] were able to identify significant differences between articulating ($n = 1,934$) and non-articulating ($n = 1,361$) spacers with respect to eradication of infection, complication rates or knee function following implantation. The former study [19] did, however, identify improved knee motion among patients with articulating spacers.

The current evidence does suggest improved function, better patient satisfaction and reduced lengths of hospital stay when an articulating spacer is used during resection arthroplasty compared to non-articulating spacers. In the absence of high level data, we recommend that articulating spacers be used in patients undergoing resection arthroplasty whenever possible. There are, however, circumstances when an articulating spacer is not likely to function well, which include patients with a lack of collateral ligaments in the knee,or with absent abductor mechanisms in the hip. These circumstances place these patients at increased risk for spacer dislocation. In addition, massive bone loss may also preclude the use of articulating spacers as fixation of the spacer may be suboptimal in the first place or its use may result in an elevated risk for periprosthetic fracture. There are also other circumstances when surgeons prefer to immobilize the joint with the use of a non-articulating spacers, which may allow for better healing of the wound.

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