What are the indications for using sleeves and/or cones during revision total knee arthroplasty?

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Response/Recommendation

In AORI type II or III bone defects of the knee, metaphyseal fixation may limit the risk of aseptic loosening. Porous metal metaphyseal sleeves and cones provide similar outcomes in terms of prosthesis survival due to aseptic loosening.

Level of Evidence: Low

Rationale:

The long-term goal of revision knee arthroplasty is to achieve durably well-fixed implants that restore the joint line, restore alignment and provide stability through a functional range. It is common for revision total knee arthroplasty (rTKA) to present the challenge of bone loss. The epiphyseal zone in revision surgery is often compromised, either through pre-existing bone loss or due to damage sustained on removal of the revised prosthesis [1]. Over the past decade in rTKA there has been a shift towards obtaining fixation in the metaphysis [2]. Morgan-Jones et al introduced the concept of zonal fixation (epiphysis, metaphysis and diaphysis), and advocated for a minimum of 2 zones of solid fixation to obtain a durably well fixed revision prosthesis [3]. A cemented or cementless stem can be used to obtain fixation in the diaphysis. A variety of methods to achieve stability in the metaphysis have been described such as morselized or structural allografts or autografts as well as bone cement [4]. More recently, porous-coated sleeves or cones have been used to obtain fixation in the metaphyseal zone. The strategy of gaining metaphyseal fixation has a growing body of evidence with porous metaphyseal metal implants at 10 year follow up reported [5].

The Anderson Orthopaedic Research Institute (AORI) classification system is widely used to classify bone loss associated with rTKA [6]. This describes type I defects, which are small defects amenable to the use of cement or morselized allograft. Type 2A, 2B and type 3 defects are larger defects which may benefit from metaphyseal fixation in the form of a cone or sleeve. This grading system was developed in 1999 and as such predates the current revision techniques available. Furthermore, it does not address the concept of zonal fixation. More recent attempts have been made to classify bone loss with reference to the zones affected, which may apply more directly to metaphyseal fixation options such as cones and sleeves [7]. The concept of zonal fixation has been examined further with a proposed scoring system based on

the fixation achieved with respect to the Morgan-Jones zones and has provided validation for this concept in correlating with durable fixation [8].

Both cones and sleeves can theoretically provide biologic fixation through ongrowth in the metaphyseal region in addition to an initial press fit which provides immediate rigid stability. Cones are modular components that obtain fixation in the metaphysis but are not inherently linked to the prosthesis. Cement is used to unitise the cone with the femoral or tibial component. Sleeves, similarly engage the metaphysis but are attached to the femoral or tibial component via a morse taper. The difference in implant design means that sleeves dictate the implant position as it is unified to the stem, where as cones can accommodate offset stems which can then be unitised with cement. This difference in design may have an impact on outcomes.

Determining superiority of cones versus sleeves is limited by a lack of high quality literature. The evidence base is limited to retrospective, uncontrolled, level IV studies It is however generally accepted that cones or sleeves should be utilised in rTKA dealing with AORI type IIB and III defects [4]. A recent meta-analysis comparing outcomes of sleeves to cones evaluated the results of 43 included studies and 3008 rTKA (1911 cases in the sleeve group and 1097 cases the cone group). All papers included were level III (retrospective cohort studies, case–control studies) and IV (case series) studies. The analysis showed no significant difference in relation to prosthesis survival. Aseptic loosening occurred at a rate of 0.4% in SG (LT) and 4.1% in CG (LT) ($p = 0.09$)[9]. It is important to note the limitations of this literature. In some reports, both cones and sleeves were routinely utilised in revisions with AORI I and IIA-type bone loss. This was at the intraoperative discretion of the surgeon to enhance metaphyseal fixation, or with revisions using highly constrained prostheses [10,11]. This highlights the heterogenous nature of the patients underlying pathology which may skew the results of one technique over another. Recent published reports on the outcomes of sleeves and cones provide similar findings, with no superiority of one construct over the other [5, 12-19].

Few studies have compared porous metal metaphyseal implants (cones or sleeves) with earlier graft options (bulk allograft or autograft) [20-22]. Interestingly, the results of the few published studies are heterogeneous with mixed results. A lack of high quality comparative studies limits the conclusions that can be drawn with respect to the superiority of metal metaphyseal implants as compared to traditional graft options.

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