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Grafting for periprosthetic femoral fractures: Strut, impaction or femoral replacement☆

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Summary Peri-prosthetic fractures are technically demanding to treat, as they require the skills of revision arthroplasty as well as those of trauma surgery. [Lindahl H, Malchau H, Herberts P, Garellick G. Periprosthetic femoral fractures classification and demographics of 1049 periprosthetic femoral fractures from the Swedish National Hip Arthroplasty Register. J Arthroplasty 2005;20:857–65.] reporting on 1049 periprosthetic femoral fractures found that the annual incidence varied between 0.045% and 0.13% for all THAs performed in Sweden and that the accumulated incidence for the primary hip arthroplasties was 0.4% while for the revision arthroplasties was 2.1% [Lindahl H, Malchau H, Herberts P, Garellick G. Periprosthetic femoral fractures classification and demographics of 1049 periprosthetic femoral fractures from the Swedish National Hip Arthroplasty Register. J Arthroplasty 2005;20:857–65.]. The elderly population is particularly vulnerable to low energy periprosthetic fractures attributed to osteopenia or osteoporosis leaving limited reconstruction options to the hip revision surgeon. Bone grafting in the form of autograft has well recognized limitations and allograft represents the gold standard of bone augmentation in the majority of the cases. Allograft can be used as morselised in the form of impaction grafting, reconstructing the bone from within out, or in the form of structural allograft. In the latter case, strut onlay plates or whole proximal femoral allografts can be used to augment the deficient bone or to totally replace it respectively. Immune reaction and disease transmission along with delayed revascularization of the cortical allograft can cause failure of the construct in the long term; however, the results to date from their use are promising. We here present an overview of the literature on the use of available bone grafts in the treatment of periprosthetic femoral fractures.

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Introduction

Periprosthetic femoral fractures are becoming an increasing and complex problem for orthopaedic surgeons. The incidence increases with the aging of the population and the popularity of hip arthroplasty.[82] Management requires the combined skills of revision arthroplasty and trauma surgery.[82] Periprosthetic fractures occur intraoperatively in about 1% of uncemented hip arthroplasty cases[32,82] and in 3—18% of cemented cases.[2,13,61,76] During revision surgery the figures are higher and have been estimated at around 6.3% and 17.6% in uncemented and cemented cases, respectively.[2,31] Periprosthetic fractures also occur postoperatively and reports indicate an incidence of about 1% in primary hip arthroplasty cases and 4% of revision hip arthroplasty cases.[55,62] The elderly population is particularly vulnerable to low-energy periprosthetic fractures attributed to osteopenia or osteoporosis, leaving limited reconstruction options to the hip revision surgeon. Bone grafting in the form of autograft has well recognised limitations and allograft represents the gold standard of bone augmentation in the majority of these cases.[34,46] Allograft can be used in a morselised form for impaction grafting, reconstructing the bone from within, or in the form of structural allograft.[24] In the latter case, strut onlay plates or whole proximal femoral allografts can be used to augment the deficient bone or to totally replace it, respectively.[37] Immune reaction and disease transmission together with delayed revascularisation of the cortical allograft can cause failure of the construct in the long term; however, the results to date from their use are promising.[37,38,48] We present an overview of the literature on the use of available bone grafts in the treatment of periprosthetic femoral fractures.

Grafts available in hip arthroplasty surgery

Autograft

Autogenous bone graft is osteoconductive, osteoinductive and provides osteogenic bone cells.[30] Animal models have been used to study the processes that occur when the graft is incorporated into the host bone.[30] The graft is initially invaded by inflammatory cells and is rapidly revascularised. Osteoprogenitor cells and osteoclasts are able to migrate from the host to the autograft and begin bone remodelling. This has been divided into two phases: (1) an early phase, in which formation and resorption dominate throughout the graft, and (2) a latter phase in which osteoconduction and creeping substitution take place.[34] Cancellous autografts can provide early and effective osteogenesis; however, they may not provide adequate structural support. On the other hand, cortical autografts are initially mechanically efficient, although because of their dense structure, revascularisation is slow, and as a consequence they become osteoporotic and mechanically deficient due to osteoclast bone resorption. Autogenous bone graft is effective; however, the supply is limited, donor site morbidity is common,[49] and complications that result from harvesting range from 10% to 25%.[1]

Allograft

Bone allografts are available as preserved (frozen or freeze-dried) or as fresh specimens.[36,67] The advantages of using allografts include availability and the avoidance of harvesting complications.[30,34] Bone allografts, however, lack osteoprogenitor cells and osteogenic factors and can be associated with an immune response and possibly disease transmission.[9,14,25] Processes such as freezing or freeze-drying can reduce the immunogenic potential of the graft, although these processes may also decrease the osteogenic potential of the graft.[36] Furthermore, freeze-drying can reduce the mechanical properties of the graft, making it inadequate in providing the mechanical support required for weight-bearing applications.[36,67] Extensive donor bone screening, blood testing and allograft treatment with radiation can help to eliminate the risk of infection and disease transmission.[9,14] The latter can decrease the infectivity of HIV and eradicates all bacteria and hepatitis B and C viruses.[9,14,25] Morselised or cancellous allografts can be used for revision total hip arthroplasty (THA) and mainly provide an osteoconductive matrix but with negligible osteoinductive properties.[30] Allografts may be used as corticocancellous and cortical grafts, or structural segments. The stages of incorporation of allografts are similar to those of autografts; however, revascularisation and remineralisation are slower.[66] Furthermore, it has been reported that necrotic bone tissue can remain for a prolonged period of time, which can contribute to a weaker construct when compared with autografts.[66,75]

Allograft immunology

Bone allograft implantation may induce a strong immune response triggered by many different bone components, such as cells, collagen or matrix proteins.[85] Failure can result from a combination of factors such as rejection, infection, fracture and