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CORR Insights

CORR Insights®: Is There Benefit to Free Over Pedicled Vascularized Grafts in Augmenting Tibial Intercalary Allograft Constructs?

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Where Are We Now?

Limb-salvage surgery following resections of bone tumors in the tibia can be complex and difficult. Fortunately, treatment options for limb preservation have benefited greatly from innovations in both surgical techniques and advances in three-dimensional imaging.

In the current study, Manfrini and colleagues compared the effectiveness of vascularized fibular autografts with pedicled vascularized fibular autografts. By concentrating their review on a single area of reconstruction, and limiting their comparison to two specific techniques, the authors demonstrated the overall utility (and noninferiority) of the pedicled fibular graft compared to the contralateral, free-fibula-transfer method. Their findings suggest that when appropriately selected for specific reconstructions of the tibia, pedicled vascularized fibular autografts are the simpler, and presumably, more cost-effective and time-efficient technique. The authors also note, however, that there are situations where the pedicled graft was not the best choice such as previous radiation, fracture of the fibula infection or vascular compromise, and they continue to use the free vascularized technique.

Although massive allograft reconstructions usually unite to the host bone and provide structural support for the limb [2, 6], mechanical failures can complicate intercalary reconstructions requiring revision surgery [1]. Enneking and Mindell [5] demonstrated histologically that in retrieved allograft samples, large allografts often heal only partially with limited penetration and remodeling of the new bone into the nonviable allograft. Used alone as an intercalary construct [8], for repair of failed grafts [3], or occasionally in conjunction with large autografts [7], the addition of a vascularized fibula has been shown to increase the healing and long-term effectiveness of allografts when used to reconstruct intercalary defects of the tibia [4]. Vascularized bone reconstructions (either pedicle grafts rotated on their blood supply) or free-tissue transfers (such as the contralateral fibula grafts) can hypertrophy over time, which in theory, could provide greater durability over the long run.

This CORR Insights® *is a commentary on the article* "Is There Benefit to Free Over Pedicled Vascularized Grafts in Augmenting Tibial Intercalary Allograft Constructs?" *by Manfrini and colleagues available at:* DOI: 10.1007/s11999-016-5196-2.

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Where Do We Need To Go?

Although near-equivalency of the two techniques incorporating a vascularized fibula graft has been demonstrated, several important questions remain concerning such composite allograft reconstructions, including: (1) What biological factors, surgical methods or additional treatments might further augment the initial healing (and later graft hypertrophy) of these constructs? (2) Are additional methods available that could minimize the potential adverse events such as graft fracture, nonunion and local recurrence of the tumor? (3) What histological changes occur in the massive allograft over time because of the juxtaposition of the vascularized fibula?

Practical considerations and the rarity of skeletal sarcomas limit the opportunity to acquire the sufficient number of patients needed to study these questions in a rigorous prospective or controlled clinical trial. Alternatively, cooperative groups and multi-institutional reviews to could provide the number of patients to sufficiently answer major clinical questions regarding skeletal reconstructions following sarcoma resections.

How Do We Get There?

A better understanding of the factors affecting the local environment surrounding the bone surfaces and potential interactions at the graft interfaces could provide valuable information toward understanding the overall healing process. Histological examination of retrieved, composite allograft tissues would be valued, particularly when including a vascularized fibula at the host-graft junction and the hypertrophied interfaces between the living and remodeling grafts. This information could lead to experiments that investigate methods to increase the rate and extent of revitalization of the grafts or ways to prevent healing delays, nonunions, and the subsequent late fatigue fractures.

Naturally occurring osteosarcoma in the canine may be an option for additional study. Investigation of an animal model where vascularized grafts are combined with allografts and carefully studied (both radiographically and histologically) in vivo could have the potential to add additional insight to underlying biological principles and physiology of graft healing and remodeling in the long-term. The use of an animal model with sarcoma limb-salvage could also give insight to the effects that additional treatments such as chemotherapy impose on graft healing, similar to the situation in human patients. Such work could begin with local pedicle bone grafts used to augment allograft reconstructions. Once an appropriate animal model can be developed, additional work could investigate methods to modify and negative effects of the drugs and possibly enhance graft incorporation or subsequent bone hypertrophy.

With the rapid advances in many areas of medicine, some information is likely to come from smaller studies with prospectively collected data, particularly those centralized at regional centers where innovation and new techniques can be developed, analyzed, and reported. Such work should be encouraged, but will likely require scrutiny and corroboration before achieving wide acceptance.

Additional options for biological skeletal reconstruction, using constructs such as bone transport, induced-membrane bone-grafting techniques, biomedical scaffoldings, and stem-cell regeneration or combinations of such techniques hold promise. Finding an ideal, durable solution for segmental skeletal reconstruction could include advances in such techniques, possibly combining them with allografts or vascularized constructs. Gaining additional insight into the biological interactions of the construct and local host tissues is critical to realizing this goal.

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