Bone implant fixation: novel approaches for improving and imaging

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The principles for establishing and maintaining fixation of orthopaedic and dental implants are now generally agreed upon, including immediate mechanical stability and close initial contact with the host skeleton. The material composition and surface characteristics of the implant must also be appropriate. Under these ideal conditions, most efforts at enhancing implant fixation focused on modifications to the implant itself, including various surface treatments. Locally delivered biologics such as bone morphogenetic protein or transforming growth factor-beta and systemically administered drugs such as bisphosphonates, intermittent PTH and sclerostin antibody can enhance implant fixation in this situation. There is now interest in enhancing implant fixation when the microenvironment is not ideal, including bone loss due to the presence of particulate debris or osteoporosis. In these situations, most of the effort is on the systemic agents with the treatment tested as a preventive strategy, a logical place to start for proof-of-concept studies. A bigger challenge is the treatment of established disease. For instance, we found that sclerostin antibody is effective at preventing particle-induced peri-implant osteolysis in a rat model when the treatment is initiated early, but we have not yet determined if sclerostin antibody is effective at rescuing implant fixation in the presence of established particle-induced bone loss. In the rat model of ovx-induced bone loss, we found that sclerostin antibody enhances implant fixation but not nearly as well as when there is normal bone volume at the time of implant placement. Since sclerostin antibody works by stimulating bone formation on existing bone surfaces, the reduction in surface area associated with ovx presents a significant challenge. In this low bone volume microenvironment, future work should focus on the use of bone inducing agents followed by anabolic agents. Our lab has recently developed a microcomputed tomography method for assessing bone-implant contact in the rat model. Using this method, we are now able to predict the fixation strength of the implant to the host bone quite accurately using a statistical model. Thus, in future studies mechanical testing may be avoidable, permitting other types of analyses to be performed.