SURGICAL AND RADIOGRAPHIC PARAMETERS TO GUIDE TIMING OF IMPLANT LOADING IN THE POSTERIOR MANDIBLE

Purpose of the Research: Dental implants have revolutionized oral health in a powerful way by providing a timely and reliable platform for definitive restorations. Subsequent to implant placement, a cascade of dynamic and unique biological events occur related to the remodeling of the host bone. Despite differences in the osteogenic response between individuals and implants, the existing body of literature suggests implants are to be loaded at three months, in accordance with the "one-size-fits-all" conventional loading protocol. It was the purpose of this study to determine if the incidence of osseointegration for early loaded implants in the posterior mandible was equivalent to that of implants loaded conventionally. It was the second objective of this study to determine if osseointegration could be predicted based on each patient's clinical presentation.

Methods and Materials: Partially edentulous subjects (21 subjects) requiring implant placement (22 implants) in the posterior mandible were examined in this prospective cohort study. On the day of surgery, a 2x4mm bone sample was removed from the surgical site for micro-computed tomography (Micro-CT) and histologic analyses. All implants were placed according to manufacturer's instructions. Clinical and radiographic parameters to include bone density at the surgical site, insertion torque (IT), and implant stability quotient (ISQ) were measured at placement (T0), 2 months (T1), 3 months (T2) and 6 months (T3) post-operatively. At T1, a reverse torque of 20Ncm was applied to the implants and osseointegration was confirmed. At T3, these parameters were analyzed, via descriptive statistics, and correlated with the incidence of early osseointegration. An ANOVA test with repeated measurements was done to determine the statistical significance of the changes found between T0, T1, T2, and T3 time periods. A regression curve was created to facilitate the evaluation of bone density at various times throughout the study.

Results: No subjects dropped out of the study, and at 6 months, 95% of the implants had achieved successful early osseointegration. The mean initial ISQ value of all implants that showed successful early osseointegration was 66. The percent of mineralized tissue in the bone core samples ranged from 29% - 82% and there was a strong, linear relationship between ISQ and bone volume density with a coefficient

of determination of 0.8. Regression analysis revealed the difference in measurements between T0 and T1 was the only time point at which the bone density difference was statistically significant (p >0.05). The sensitivity and specificity of utilizing IT as the sole predictor of early osseointegration was determined to be 64% and 50%, respectively.

Discussion: In this study, all of the well-healing implants showed higher ISQ values at the conclusion of the study than they did at T0. Additionally, these implants exhibited the greatest amount of healing within the first 2-months after implant placement, with the T1 and T2 ISQ values being nearly equivalent. The results of this study also indicate that the closer the baseline ISQ values were to 55, the higher the bone growth value was over the first two months. Implants that had an incredibly high ISQ value at the time of insertion, closer to 80, on the other hand, showed the least amount of bone growth. In both of these situations, there was a plateau in implant stability after 2 months, indicating the peri-implant bone was dense and uniform. Therefore, in all well healing implants, the results of this study indicate that you would not expect to see a downward trajectory in ISQ values at or after 2 months. This exponential and asymptotic pattern of bone growth seen in this study is consistent with the literature on implant wound healing and implant stability. Nevertheless, the healing process is predetermined by the host inflammatory response and any factor that influences these early events in wound healing has the potential to affect the rate of osseointegration. Therefore, the decision to load an implant in the posterior mandible should be personalized and based off of ISQ $\geq 66 \pm IT \geq 35$ N/cm.

Conclusions: The loss of posterior teeth can have widespread, detrimental effects on the systemic and oral health of an individual. To mitigate these effects, it is essential that both expediency and precision be at the forefront of treatment planning when restoring an edentulous site. The results of this study indicate early loading at 2 months is achievable in the posterior mandible, with equal success to conventional loading. This study also highlights the fact that osseointegration can be predicted on an individual basis, via ISQ measurements, and that osseointegration can be maintained after early loading is achieved.