Biomechanics in Implant Osteotomy Preparations

The connection between bone density and higher insertion torque

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Osseodensification is a novel biomechanical bone preparation to place a dental implant. It is a low plastic deformation of bone caused by rolling and sliding contact with a densifying bur that has flutes to densify the bone as it drills into it.

Contrary to drilling away bone using traditional drills, Densah™ Burs (Versah, LLC, www.versah.com) are rotated in reverse at 800 to 1500 rpm. When coupled with irrigation, they densify bone hydrodynamically through compaction autografting. This supplements the basic bone compression effect in the inner walls of the osteotomy, creating this density crust along the entire depth of the osteotomy. The result is a consistently cylindrical, densified osteotomy. Consistent osteotomies and densification are important to increased insertion torque (IT), implant primary stability, and early loading.

With osseodensification and the high IT, concern about pressure osseonecrosis during implant placement is neither scientifically nor biomechanically valid. Bone pressure necrosis is not a concern with the high IT values achieved using the Densah Burs. In fact, higher IT values and more dense surrounding bone are a combination that enhances primary stability and healing, and minimizes implant micro-motion.[1]

The term pressure osseonecrosis (bone pressure necrosis) has never been clearly defined in the literature, other than being viewed as generally limited to cortical bone.[2]

The theory is that high IT values for implant placement above 40 to 45 N/cm may create pressure ischemia and microcirculation disturbances to osteocytes, leading to bone resorption. Compression of bone beyond its physiologic limits may result in ischemia, leading to osseous necrosis.[3,4] There is no scientific data or evidence to support these opinions.

On the other hand, both animal histological and human controlled clinical studies have shown that high IT does not induce bone necrosis.

Trisi and colleagues demonstrated that high IT in dense bone does not induce bone necrosis or implant failure. In fact, histologically, high IT increased initial BIC (bone to implant contact) and promoted primary healing and remodeling for weeks 1 through 6 when compared with low IT placed implants.[5]

A study by Ottoni and colleagues correlated high IT with increased survival rate of single tooth implants under functional loading. For every 9.8 Ncm of torque added, the risk of implant failure was reduced by 20%.[6]

Khayat and colleagues concluded that the use of high IT up to 176 N/cm did not prevent or inhibit osseointegration.[7]

Perren and colleagues inserted compression plates in the tibia of sheep and observed that pressure of about 40 MPa at the screw sites did not result in pressure necrosis, but rather in a gradual decrease in pressure due to bone viscoelasticity.[8]

In summary, there is a slow, gradual decline in bone stress produced at implant insertion. This is the result of two phenomena: viscoelastic relaxation of bone, and normal remodeling by basic multicellular units, whereby pre-stressed bone is replaced by new bone through internal remodeling rather than surface resorption.[9,10] Thus, higher IT combined with the enhanced osseodensification of the implant site is highly desired.[1]

References

1. Trisi P, Perfetti G, Baldoni E, et al. Implant micromotion is related to peak insertion torque and bone density. *Clin Oral Implants Res*. 2009;20(5):467-471.
2. Winwood K, Zioupos P, Currey JD, et al. The importance of the elastic and plastic components of strain in tensile and compressive fatigue of human cortical bone in relation to orthopaedic biomechanics. *J Musculoskelet Neuronal Interact*. 2006;6(2):134-141.
3. Bashutski JD, D'Silva NJ, Wang HL. Implant compression necrosis: current understanding and case report. *J Periodontol*. 2009;80(4):700-704.
4. Haider R. Histomorphometric analysis of bone healing after insertion of IMZ-1 implants independent of bone structure and drilling method. *Z Stomatol*. 1991; 88:507-521.
5. Trisi P, Todisco M, Consolo U, Travaglini D. High versus low implant insertion torque: a histologic, histomorphometric, and biomechanical study in the sheep mandible. *Int J Oral Maxillofac Implants*. 2011;26(4):837-849.
6. Ottoni JM, Oliveira ZF, Mansini R, Cabral AM. Correlation between placement torque and survival of single-tooth implants. *Int J Oral Maxillofac Implants*. 2005;20(5):769-776.
7. Khayat PG, Arnal HM, Tourbah BI, Sennerby L.Clinical outcome of dental implants placed with high insertion torques (up to 176 Ncm). *Clin Implant Dent Relat Re*s. 2013;15(2):227-233.
8. Perren SM, Huggler A, Russenberger M, et al. The reaction of cortical bone to compression. *Acta Orthop Scand Suppl*. 1969;125:19-29.
9. Halldin A, Jimbo R, Johansson CB, et al. The effect of static bone strain on implant stability and bone remodeling. *Bone*. 2011;49(4):783-789.
10. Perren SM. Evolution of the internal fixation of long bone fractures. The scientific basis of biological internal fixation: choosing a new balance between stability and biology. *J Bone Joint Surg Br*. 2002;84(8):1093-1110.

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