The Effect of Different Crown – Implant Ratios on Peri-Implant Crestal Bone Levels (A Clinical and CBCT Evaluation)

Thesis

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REVIEW OF LITERATURE

Dental implants are considered to be an important option for restoring partially and completely edentulous jaws ***(Papavsiliou et al., 1996; Chang et al., 2007).*** Their success is mainly related to the osseointegration process ***(Feller et al., 2014),*** which is the intimate bone to implant apposition that offers enough strength to cope with load transfer ***(Brånemark et al., 1985).***

Schroeder et al. (1995) used the term " functional ankylosis" to describe the rigid fixation of the implant to the jaw bone, and stated that new bone is laid down directly upon the implant surface, provided that the rules for atraumatic implant placement are followed and the implant exhibits primary stability.

The implant stability consists of primary stability and secondary stability ***(Brånemark et al., 1985; Brunski 1992; Sennerby and Roos, 1998; Raghavendra et al., 2005).***

The primary stability of an implant that comes from mechanical engagement with cortical bone is considered one of the important prerequisites for the osseointegration of endosseous implants ***(Meredith, 1998).***

Inadequate initial implant stability may allow micromovement between the implant and bone that results in formation of fibrous tissue ingrowth into the interface instead of osseointegration ***(Duyck et al., 2006).***

Secondary implant stability is the stability of implant after osseointegration. Secondary stability values are higher than primary stability values in cases of successful osseointegration ***(Meredith, 1998; Sennerby and Meredith, 2008).***

The secondary stability arises not only from the direct structural connection but also from the functional connection between the bone and the implant which is obtained by bone regeneration and remodeling ***(Brånemark et al., 1985; Brunski, 1992; Sennerby and Roos, 1998; Raghavendra et al., 2005).***

After installation of an implant, the primary stability gradually decreases by postoperative bone resorption while the secondary stability increases by osseointegration with bone formation ***(Raghavendra et al., 2005).***

The total stability of implant is maintained as long as the primary stability is normally supplemented and/or replaced by the secondary stability ***(Mall et al., 2011).***

Bone quality at implant site affects the interface between bone and implant, bone quality refers to the amount of cortical and cancellous bone, compact bone offers much greater surface area for mineralized tissue to implant contact than cancellous bone ***(Jaffin and Berman, 1991).***

Quality of residual alveolar bone is classified into four types according to ***(Lekholm and Zarb, 1985)*** as follows:

Type 1: ***Large homogenous cortical bone***

Type 2: ***Thick cortical layer surrounding a dense medullar bone***

Type 3: ***Thin cortical layer surrounding a dense medullar bone***

Type 4: ***Thin cortical layer surrounding a sparse medullar bone***

Bone is a highly dynamic tissue that has the capacity to adapt based on physiologic needs. Hence, bone adjusts its mechanical properties according to metabolic and mechanical requirements ***(Lerner, 2006).***

Poor bone quality and quantity have been indicated as the main risk factors for implant failure, as failure may be associated with excessive bone resorption ***(Jaffin and Berman, 1991; Hermann et al., 2005).***

In cases with poor bone structure, bone resorption occurs at the interface, so, the primary stability is insufficient due to gap between the implant and the bone, as a consequence, the osseointegration process is affected and fibrous tissue is formed around the implant that leads to implant unstability ***(Meredith, 1998).***

In addition, animal studies have shown that in implants with little stability, osseointegration rate is low ***(Sivolella et al., 2012).***

The macrogeometric features such as the implant design, shape, density, height and cutting ability of the threads may affect the biomechanics of the implant-bone interlocking, improving implant stability ***(Chun et al., 2002; Chang et al., 2010).***

Stability of the peri-implant crestal bone also remains one of the most important things that affects implant success ***(Canullo et al., 2010; Canullo et al., 2011).***

Adell et al. (1981) were the first to quantify and report peri-implant crestal bone loss. Their study indicated occurrence of bone loss during first year of prosthesis loading, averaging 1.2 mm with a range of 0.3 mm.

Albrektsson et al. (1986) proposed the criteria for implant success, including vertical bone loss less than 0.2 mm annually following implant's first year of function.

Clinical studies reported success rates higher than 90% for many implant systems. However peri-implant crestal bone loss surrounding the implants had also been reported, which may be related to the implant (shape, length or diameter) ***(Tada et al., 2003).*** Peri-implant crestal bone loss could be also due to forces, infection and stresses acting around the implant collar, the bone loss begins from the implant collar and progresses apically ***(Deepak et al., 2016).***

In the bone tissue, the distribution of stress may lead to peri-implant crestal bone loss, affecting the osseointegration process ***(Glauser et al., 2001; Vanden et al., 2005).***

Different implant-abutment interfaces imply different ways of functional load distribution upon the implant ***(Hansson, 2000).*** The abutment size has influence on stress distribution in bone due to different load transfer mechanisms at the implant-abutment interface ***(Chun et al., 2006).*** However, it was found that when abutments are smaller than the diameter of the implant body (platform switching), bone resorption could be reduced ***(Gardner, 2005; Degidi et al., 2008).***

Calvo-Guirado et al. (2007) noted the success of platform switched implants with minimal resorption (less than 0.8 mm) after 8 months. ***(Lazzara and Porter, 2006)*** also theorized that shifting the implant-abutment junction inward, repositioned the inflammatory infiltrate and confined it within a 90˚ area, therefore, reducing marginal bone loss.

Herman et al. (2001) studies proved that with submerged, two pieces approach, peri-implant crestal bone loss of about 2mm occurs, but minimal or no resorption occurs with non-submerged, one piece implant.

Implant-tissue interface begins at the crestal region in successfully osseointegrated endosteal implants ***(Adell et al., 1981; Jemt et al., 1990).*** It has been proposed that a minimum of 3 mm of peri-implant mucosa is needed for a stable epithelial connective tissue attachment to form ***(Cochran et al., 1997).***

This soft tissue extension is referred to as biologic width around implants, it is a protective mechanism for the underlying bone ***(Lindhe et al., 1992).*** The term biologic width is recently replaced by the term supracrestal attached tissues ***(Jepsen et al., 2018).***

Cochran et al. (1997) suggested that a biological width exists around non-submerged one-piece implants and this is a physiologically formed and stable dimension as is found around the teeth. The epithelial attachment around the natural tooth is 1.14 mm and 0.77 mm for the connective tissue attachment ***(Vacek et al., 1994). Berglundh and Lindhe, (1996)*** observed that the length of the connective tissue attachment varied within narrow limits (1.06-1.08mm), while the length of the attached epithelium was about 1.4mm at sites with normal periodontium, 0.8 mm at sites with moderate and 0.7mm at sites with advanced periodontal tissue breakdown. In other words, the biologic width of the attachment varied between about 2.5mm in the normal case and 1.8mm in the advanced disease case, and the most variable part of the attachment was the length of the epithelium attachment. ***Cochran et al. (1997)*** performed a study on non-submerged implants and found that the epithelial attachment is 1.88 mm and 1.05 mm for the connective tissue attachment around the implants after 12 months of loading.

The dimensions of the peri-implant biologic width are not always the same, but they are subject to interindividual variations from patient to patient and from implant to implant ***(Hermann et al., 2007).***

Histologic examination in a study made by ***(Berglundh et al., 1991)*** examining the structure of the mucosa that surround implants and comparing some anatomic features of the gingiva at teeth and the mucosa at implants, revealed that the two soft tissue units, had several features in common.

The epithelial attachment in both natural teeth and implants is composed of hemidesmosomes and basal lamina while in the connective tissue attachment, there is difference in the collagen fiber direction, being perpendicular to the natural tooth and parallel to the implant surface ***(Hansson et al., 1983).***

Berglundh et al. (2007) described the morphogenesis of the peri-implant mucosa and implied that the characteristics of gingival tissues may be important in this process.

Abrahamsson et al. (1996) compared the morphology and the composition of the transmucosal tissue in an animal study for 3 different implant systems using either one-stage or two-stage technique and found that the epithelial and the connective tissue components had similar dimensions and composition and that all the groups exhibited bone loss of around 0.5 mm.

There is a limited number of clinical studies evaluating the influence of keratinized mucosa on marginal bone level changes. ***(Lin et al., 2013)*** suggested that the presence of at least 1 to 2 mm wide keratinized mucosa might be beneficial in decreasing plaque accumulation, tissue inflammation, loss of clinical attachment as well as mucosal recession.

Berglundh and Lindhe (1996) reported in an animal experiment, that thin tissues can provoke peri-implant crestal bone loss during formation of the peri-implant seal. They also found that the marginal hard tissue-level changes during the formation of biologic width might be related to thin soft tissues around implants.

Another histological study showed that implants surrounded by thin mucosa had angular bone defects, while at implant sites with an even alveolar pattern, a wide mucosa biotype prevailed ***(Vacek et al., 1994).***

Claffey and Shanley (1986) said that periodontal disease may be correlated to thin gingival biotype. Similarly, the presence of thick soft tissue was considered a crucial factor for long term success of implant-supported restorations ***(Maia et al., 2015).***

Linkevicius et al. (2010) reported that the platform-switching concept doesn’t preserve bone when implants are inserted in thin tissues although it was proven to be an effective strategy to reduce per-implant bone resorption.

Favero et al. (2016) demonstrated that thickening thin soft tissues could produce minimal bone level changes similar to that with implants inserted in a native thick biotype.

Peri-implant crestal bone loss can lead to bacterial accumulation which results in secondary peri-implantitis that can further results in loss of bone support leading to occlusal overload and further crestal bone loss again ***(Hurzeler et al., 2007)***.

Definitions of peri-implant diseases have been agreed upon at previous European Workshops of periodontology, being the key parameter to define the inflammatory process within the peri-implant tissues. If the inflammation is restricted to the mucosa which is diagnosed by bleeding on probing of the peri-implant mucosa, this condition is defined as mucositis while if the inflammatory process is accompanied by per-implant bone loss then it is defined as peri-implantitis ***(Lang and Berglundh, 2011).***

Timing of prosthetic loading is also a factor that affects peri-implant crestal bone loss ***(Elsyad et al., 2014).*** Although, there is a lack of consensus on the definition of loading, some authors refer to immediate loading when the period of time between implant placement and prosthesis insertion is less than 48 hours ***(Liao et al., 2010 ; Mackie et al., 2011).*** However, delayed loading consists of loading an implant-supported prosthesis after a healing period ranging from 3 to 6 months ***(Cochran et al., 2004).***

Immediate loading of implants after surgery may result in micromotions at implant/bone interface, thus interfering with the healing process ***(Romanos et al., 2006).*** If these micromotions are relatively small, the tissue has the capacity to differentiate into bone.

Also the choice of the retention type (cemented or screw retained) might not have a crucial influence on the overall survival of the prosthesis, but may be responsible for the development of a certain complications ***(Julia et al., 2017).***

Cement retained implant is the most used restoration in the implant dentistry ***(Vindasiute et al., 2015).*** Its major advantages that it lies in the compensation of improperly inclined implants, easier achievement of passive fit due to the cement layer between the implant abutment and reconstruction, also, due to lack of the screw access hole, there is an intact occlusal table that offers easier control of occlusion, while the major disadvantage lies in the difficulty of removing excess cement that is associated with the development of peri-implant diseases such as peri-implantitis and peri-implant mucositis ***(Wilson, 2009; Wittneben and Weber, 2012).***

The major advantage of screw retained implants that they require a minimum amount of interocclusal space (min. 4mm). They are also easier to remove when hygiene maintenance, repairs or surgical interventions are required, while their major disadvantage is the access hole that is present in the occlusal table which might interfere with occlusion in posterior sites ***(Chee and Jivraj, 2006).***

Clinicians used certain guidelines related to natural teeth and applied them to implant dentistry. One of these guidelines is the crown- root ratio which is defined as the physical relationship between the portion of the tooth embedded in the alveolar bone and that portion not within the alveolar bone ***(J Prosthet Dent, 2005).***

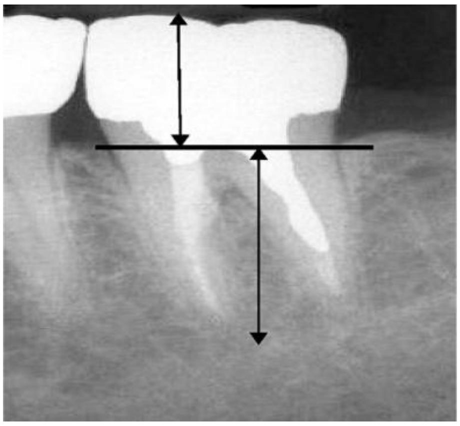

Figure (1): Crown to root ratio

The crown to root ratio is used as an indicator for the prognosis of a given tooth ***(Schillingburg et al., 1997; Car et al., 2004).*** It extrapolates the biomechanical concept of a class I lever (figure 2), the fulcrum is lying in the middle portion of the root residing in alveolar bone, as bone loss occurs, the fulcrum moves apically and the tooth is more susceptible to harmful forces ***(Grossmann et al., 2005).***

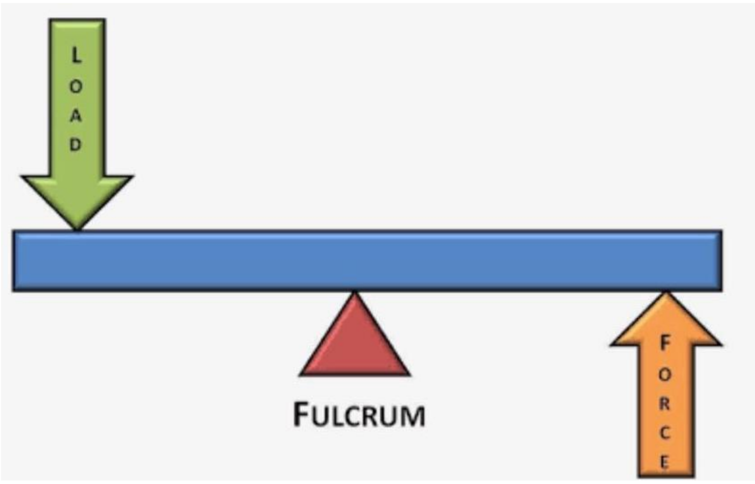

Figure (2): Class I Lever

Newman et al. (2008) reinforced this by saying that the reduced root surface available for periodontal support, is more likely to be affected by occlusal forces.

A similar clinical situation regarding the c/r length ratio was often encountered in edentulous areas restored with implant-supported reconstructions. Because of vertical loss of the alveolar bone after tooth extraction ***(Schropp et al., 2003 ; Araujo and Lindhe, 2005)***, the supracrestal part of the implant borne reconstruction is often long in relation to the supporting implant. Despite the findings in the above-mentioned studies with natural dentitions, clinicians tend to insert the longest implants possible, presuming a higher success rate with increasing crown-to-implant length ratio ***(Schneider et al., 2012).***

The C/I ratio is the relationship between the length of the restoration and the length of the implant embedded in the bone so the implant length is measured from the apex to the most coronal bone-implant contact while the crown length is measured from the top of the restoration to the most coronal bone-fixture contact ***(Laney, 2007).***

Misch (2008) stated that the crown to implant ratio shouldn't be considered the same way as a crown to root ratio. He also stated that the implant length is not related to mobility and does not affect its resistance to lateral forces.