CHAPTER — 7

Discussion
Contemporary implant dentistry, coupled with the higher expectations of the patients, continually challenge the implant providers. Today, optimal function and esthetics, long term survival and patient satisfaction are the holistic integrated goals in our treatment philosophy. In spite of precise duplication of color, contour and vitality of the natural dentition, the treatment may ultimately be categorized as an esthetic failure if the optimal gingival profile is not achieved or if it recedes apically in due course. In addition, the soft tissue should form a barrier that withstands the attack from bacterial toxins and be stable on function of occlusion.

To pre-evaluate a case in terms of implant esthetic success, various biological, clinical and technical parameters have been discussed in literature. These parameters interplay with each other and hence assessing their influence is subjective and difficult to validate due to the variation across cases presented in the dental office.

Biologic parameters such as patient’s relative tooth position, biotype of the periodontium, tooth shape, position of the osseous crest (Esposito et al, 1993), crestal alveolar bone height, inter-proximal bone height adjacent to the natural tooth, dimension of inter-proximal spaces both horizontally and vertically, and the morphological features of the adjacent natural tooth may influence the peri-implant soft tissue esthetics (Tarnow et al, 1992; Esposito et al, 1993).

Clinical parameters of treatment planning decisions such as extrusion via orthodontic interventions prior to root extraction (Brindis & Block, 2009), extraction and immediate surgical implant placement, extraction with socket preservation and staged approach, soft tissue grafting prior to or in conjunction with implant placement (Palacci & Nowrazi, 2008), osseous grafting in the horizontal and vertical component (Hof et al, 2013), maintaining a horizontal distance of 2.5mm to 4mm between implant and adjacent tooth (Lops et al, 2011), immediate provisionalization to support adjacent papillae, papilla sparing incision flap techniques, creative second stage surgical protocols, and alterations to the contralateral natural tooth to artificially, apically adjust the location of the contact area have all been reported to optimize the esthetic results (Jivraj & Chee, 2006).

Technical parameters such as implant design, type and surface, design of
the abutment or prosthetic component or altered designed abutments such as “platform switching”, abutment connections-internal or external hex, contoured provisionals, size and contour of the final restoration, type of abutment material, crown material and location of the contact area have all been suggested to influence the preservation or regeneration of the peri implant bone and soft tissue formation (den Hartog et al, 2011; Rompen, 2012; Penarrocha-Diago et al, 2013; Wittneben et al, 2013).

With customization becoming a reality due to the computer aided design/computer aided manufacturing (CAD/CAM) innovation, newer concepts, hypotheses and products are being offered for enhancing the soft tissue esthetic end result around implants. A recent study states the influence of customized titanium and zirconia CAD/CAM abutments having similar benefits to help preserve the interproximal papilla in single teeth implants, however the considerations in designing the customization was not documented, neither was it compared to the standard custom abutment for its influence on the interdental papilla (Borges et al, 2013). The tangible benefits of all these newer offerings will have to be evaluated in every aspect. This underscores the general aim of the present study. It was investigated if an altered abutment design when compared with a conventional one could result in better peri-implant soft tissues in terms of attachment strength, soft tissue stability, soft tissue development, maintenance of bone levels, effect on gingival biotype, esthetic perceptions of both dentists and patients, and finally, patient satisfaction. The data collected in this prospective study allowed in detail, an opportunity of studying the various factors which may directly or indirectly affect esthetics of a single tooth implant in the esthetic zone. Further, a comparative study between the Indian and the Dutch population in terms of the gingival morphotypes suggested the crown width-length angle as a diagnostic parameter for thick and thin biotypes.

In the clinical experiment we used stock, conventional divergent (control) and curved (experimental) abutments. The objective was to compare the development of soft tissue around the abutments in terms of stability and measuring the thickness of tissue to see whether there was any evidence of actual increase in the tissue volume, which would suggest a shift in biotype. The results
obtained from the study showed no statistically significant difference in the control and experimental group indicating that the biotype did not change on alteration in the abutment geometry. This was completely contrary to the results from the study by Rompen et al (2007), but in line with the findings from others (Weinlander et al, 2011).

The second aspect that was assessed was whether the soft tissue formation around the two abutment types differed in terms of resistance to the force of displacement. The abutments were disengaged by a dontrix gauge and the force required to displace it was measured and analyzed. Around the curved experimental abutment it was observed that there was a formation of connective tissue “O-ring” type attachment. It was hypothesized that this would make a better seal around the implants and possibly be more resistant to bacterial invasion (Rompen et al, 2007). If this seal was different in terms of resistance it offered to a very mild, controlled force, then we could believe that a stronger attachment was produced. However in our study no measurable statistically significant difference was seen in the dislodgment forces applied between experimental and control group, despite the apparent different shape created in the soft tissues. Cases in which angled abutments were used showed more labial recession post abutment placement than in cases where straight abutments were employed. This however may not compromise the end result in terms of survival, as well as good esthetics and function (Sethi et al, 2000). Upon the dislodgment of abutment, bleeding occurred from sites with the curved experimental abutment group, but not from the divergent abutment control group. This could be due to the interference of the soft tissue in the undercut on the abutment or possibly a more vascular area formed at the attachment in the curved abutment experimental group.

Assessments made after a one year loading period to evaluate the soft tissue response objectively measured the appearance through Pink Esthetic Score (PES) (Fürhauser et al, 2005). In fact, since the whole study focused on the development of soft tissues, and many other variables were assessed as well, this is considered the primary outcome measure of the experiment. Resulting from a lack of evidence from literature that could have served as a reference, no sample size calculation was performed. It was decided to include at least 25 patients as a
convenience sample. In clinical practice it is difficult to include patients with bilateral missing teeth in the anterior zone that are suited for implant replacement. Variation was minimized as much as possible because of the study design and the fact that one operator performed all procedures. The grooved surface of experimental abutment could provide more space for connective tissue attachment, therefore leading to a better soft tissue development, as compared to the divergent control abutment design. Also ingress of soft tissue into this design could contribute clinically to enhancing esthetic outcome. However, mean PES score values showed no statistically significant difference ($P=0.46$), thus one cannot conclude that one abutment is clearly clinically superior to the other. The mean values and their variation appear so similar that it is unlikely that expanding the sample size would result in a clinically relevant, statistically significant difference, which could be an important finding for others who intend to research a similar topic.

Both, the control and experiment abutment group provided stable soft tissues. Radiographic assessments of marginal bone levels were also studied where standard periapical radiograph was made at periodic intervals. Average loss of mesial and distal bone levels was considered until one year after final crown cementation. There was no statistically significant difference ($P=0.25$) in bone loss in the experimental and control group. In a different study, when comparing a morse taper connection with platform switch (test group) to an internal connection with matching diameter abutments (control group), slightly increased marginal bone loss in the control group was observed (Pieri et al, 2011; Telleman et al, 2012). In both situations the peri-implant soft tissues were stable. However, evidence of long term results between platform switched and matching diameter abutments are still not available from peer reviewed literature. In the current split mouth study matching diameter implant abutments were used in the experimental and control group, with identical connections in both, eliminating any variation in the implant abutment microgap.

A critical factor in determining the success of implant-supported restorations in the anterior maxilla is the esthetics of the crown and surrounding soft tissues. The PES provides practitioners and researchers a reliable method to objectively evaluate esthetics. However, patients often perceive esthetics differently than trained dental
professionals. Therefore the esthetic outcomes perceived by dental professionals and the patients and their correlation needed to be further investigated. In our experiment of assessing the patients’ overall satisfaction and compare patients’ perception with clinicians’ opinion on the muco-gingival esthetics of single-tooth implants in the esthetic zone when a variation in the abutment design was used, we found a significant correlation between the two groups. Similar observations were made in some other studies (Suphanantachat et al, 2012; Bonde et al, 2013).

Soft tissue parameters of biotype as well as crown dimensions can play a significant role determining the esthetic outcome of surgical procedures (Fu et al, 2011). Visual distinction between thick and thin biotype may be subjected to individual prejudice negating it as an unsuitable analytical tool. Efforts were made to identify parameters that could specifically objectify biotypes based on hard tissue (i.e. crown) dimensions. This cross-culture study encompassed a vast number of subjects and two clinicians for comparing reliability of assessments. Significant differences between Indian and Dutch populations were noted in width-length ratio but not in the crown width-length angle. Further studies need to be done to evaluate the degree of racial differences and their relevance in post restorative gingival esthetics. Thus objective crown dimension assessments may prove to be a valuable parameter in unbiased treatment planning.

Principal findings and clinical implications

The general aim of the study was to evaluate the soft tissue development around the abutments of different geometry. The multidimensional approaches used analyzed the stability of the soft tissue formation, made measurements of the soft tissue around the implant abutment interface with actual/physical models and analyzed the attachment in terms of resistance applied to dislodgement of different geometry of abutments. The similar response to both, the experimental and control abutments suggests that peri-implant tissue morphology is guided by multiple factors and one factor alone i.e. abutment geometry does not have a significant role to demonstrate any change. It reconfirms the multifactorial theory
for implant esthetics (Saadoun & Touati, 2007; Buser et al, 2009).

The factors like bone level, bleeding on probing, PES and gingival recession
have shown no clinical difference across both, the experimental and control
group in a 1 year delayed protocol indicating that in a single tooth implant, with
standard protocols followed and with proper case selection, an abutment shape
does not noticeably change the clinical outcome of the case. In a study comparing
radiographic bone levels for bone platform switch using Nobel Active® implants
versus non-bone platform switch Nobel Replace Groovy® implants, no statistically
significant difference in bone levels after one year period was seen (Rokn et al,
2014).

Interestingly, the interproximal bone and the black triangle space, both
seem to be similar in terms of soft tissue formation in the interdental papillary
area. The interdental papilla showed a spontaneous improvement one year post
operatively in both the experimental and control group, which is in agreement with
few other studies (Jemt, 1997; Grunder, 2000; Cardaropoli et al, 2006; Cooper
et al, 2007). It can be hypothesized that the concept of ‘form following function’
in this case can be reflected by the papillary growth without inflammation due to
the function of oral tissues. This suggests that post-procedure follow up is not only
essential for disease control but also for checking functional balance in a restoration.

Patient satisfaction and the professional’s observation related to muco-
gingival esthetics around a single tooth implant correlated at crown cementation
and one year later generally showed a low, though statistically significant correlation.
No statistically significant difference was found between the abutment designs, both
for PES and Visual Analogue Scale (VAS) scores. Again, the experimental abutment
performed no better than the control.

On visual examination, the shape of the tooth seems to be squarish in
thick biotype as compared to a tapered shape tooth with thin biotype. However,
for assessment of gingival biotype, a more objective measure could be derived to
establish the diagnosis of thick or thin biotype. The crown width-length angle could
be used as the new measure to determine the gingival biotype. Since subjective
analysis shows variation in terms of interpretation, measurement of the crown
width-length angle and a new index based on natural crown morphology would
be a more predictable indicator for assessing biotypes, especially across various sections of population in the world.

It is interesting that the patient's understanding and expectation correlate linearly, but that does not mean that they interpret the end result as critically. Usually the dentist sees more room for improvement, although authors have recorded patient satisfaction by asking specific questions (Furze et al, 2012; de Lima et al, 2012; Hartlev et al, 2014). It is not well documented in literature whether the patients really understand without provocation the soft tissue esthetic essentials around implants.

Future research

Based on our findings and that of other studies, a concave geometry of an abutment does not enhance the peri-implant soft tissue. Stability of the mucosal margins, bone levels, PES was similar in both groups indicating no direct correlation between geometry of abutment and soft tissue development. So improvement has to be found in other areas. This leads us to some interesting future areas for innovation like reinforcing the epithelial attachment around the abutments, possibility of change in material for implant abutments or use of nano coatings or chemical surface treatment for abutment to improve soft tissue adherence (Teughels et al, 2006; Rompen et al, 2006; Linkevicius & Apse, 2008; Zigdon & Machtei, 2008; van Brakel et al, 2012).

The placement of the implants subcrestal should be compared with the ones placed at the crest both, with a platform switch of the abutment and also to evaluate the soft tissue formation around them.

The newer generation CAD/CAM based techniques are allowing tissue customization with provisional restorations followed by customizing the abutment contour (Furze et al, 2012). CAD/CAM based abutments which are customized for every situation will present significant challenges as factors to assess the superiority of a curvature both-convergent or divergent in abutment design have not been able to show conclusively different results and many trials will be necessary as
dentistry progresses rapidly in the direction of design based computer solutions. The propagators however need to carefully document the process they followed, so as to allow easy and accurate comparison of advantages of this new technology (Kapos & Evans, 2014). As the quest to find out the ideal permucosal configuration continues, one cannot ignore the need to think in terms of long term stability and peri-implant soft tissue health.

So, what is the ideal permucosal configuration? The traditional option of using a broader base of the abutment to help manage the emergence profile to produce an esthetic crown may need re-thinking. In future we will be looking at options to minimize the surface area around the peri-implant abutment interface by using narrower customized abutments as they emerge out of the soft tissue and flaring thereafter to allow a good base for adequate emergence profile of the crown. It will reduce the vulnerable soft tissue wound. This will be in sync with our ultimate goal and that is, to minimize the possibility of bacterial invasion and allow a stronger epithelial attachment in the peri-implant region.

The study design of split mouth, randomized, blinded recorded over longer period of time with large sample size seems necessary to resolve the dilemma of validating clinical outcomes. These studies should follow standardized protocols for case selection and eliminate operator variability. This will also ease comparison of studies.

In addition, investigating the predictive value of pre-operative biotype on the esthetic result after implant replacement by using a reliable measuring tool, for instance the crown width-length angle, and compare it with the PES of the final restoration may help to substantiate often heard statements about its relevance.
References


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