Chapter 1

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With increasing emphasis on esthetics and patient satisfaction, implant dentistry has attained greater horizons. Single tooth implants are not only a good option for replacement of both anterior and posterior teeth, they also help in preserving the remaining dental and osseous structures, fulfilling the high esthetic expectations of the patients. The survival rate of implant supported single tooth restorations is reported to be 96.5%\(^1\) and 95.9%\(^2\) after five years. In another study, a survival rate of 89.4% was reported for implant supported single crowns after 10 years of function.\(^3\) Several studies were carried out using different systems and different techniques for single tooth implants and the studies concluded that single tooth implants gave good clinical, esthetic and functional results and predictable outcomes.\(^4\)\(-11\)

Inspite of the high success rate of single tooth implant restorations incidence of complications associated with this treatment modality have been reported in literature.\(^12\)\(-14\) These complications have been categorized as biological, esthetic and mechanical/technical.\(^14\) Several studies \(^5,6,15,16\) stated that most common technical complication was abutment- or screw-loosening. It may be noted that the biological and the mechanical failures are inter-related, therefore, may be considered as the biomechanical failures. The biomechanical rationale of endosseous implants has been investigated and researchers have established considerations such as number, distribution, and cantilever forces on implants. Even with the knowledge base available, clinicians and patients experience problems. Numerous reports have and continue to reveal technical problems such as screw and abutment loosening. According to McGlumphy, screw loosening occurs when external forces trying to separate the parts exceed the forces keeping them together.\(^17\)

There are a numbers of publications on the effects of implant diameters, platform switching design, ridge diameters and inclination of load applied to an implant on stress/strain patterns in the surrounding bone.\(^18,19,20\)

However, information regarding stress patterns within an implant and the effects of various types of connections on load transfer are rare. A load is applied to
the superstructure part of an implant, and transferred to the abutment. The abutment carries the load to the fixture and bone through the implant-abutment and implant-bone connection. This load is finally applied to the surrounding bone. Therefore, the implant-abutment connection area has an important role in modifying this load. The difference between external and internal types of abutment connection has been studied previously, although there is no information regarding biomechanical comparison of different types of internal connections. A precise and well-designed connection leads to high rotational stability. Finally, a stable interlocking fit between implant and abutment reduces the occurrence of micro-movements and guarantees that the retaining screw will remain in place without being exposed to the risk of screw loosening or screw breakage. There are different kinds of internal connections on the market, although the most reliable one has not been recognized.

Biomechanical failures can be avoided with proper treatment planning, a good understanding of screw joint mechanics and knowledge of the implant system used.¹³ The biomechanical complications may range from a normal screw loosening leading to peri-implantitis, crestal bone loss and even breakage of implant components. One of the causes for screw loosening is when the external load (occlusal forces) is of sufficient magnitude or duration and exceeds the screw preload (clamping force to maintain unity of components) resulting in vibration, micro-movement, and opening of the joint interface leading to screw loosening and joint failure.²¹ Steinebrunner et al., (2008) hypothesized that the reason for the fatigue failure of an implant abutment connection is a lack of force fitting or form-closure of the connection design which leads to loss of preload at the abutment screw and the resulting unscrewing or fatigue failure of the screw material.²²

Currently, there are many geometric variations of the implant abutment interface available. These variations in geometric designs to Impant abutment interphase (IAI) with various rotational resistance and indexing features and/or lateral stabilizing geometry, have been incorporated as it is one of the primary determinants of joint strength, joint stability, and locational /rotational stability.²³ It has been a challenge and a constant effort to study and to reduce the mechanical failures by improving and developing the implant – abutment connection designs. ¹² The primary function of implant systems is to transfer and distribute the force generated
by functional activities to the surrounding bone. Numerous earlier studies emphasized on the influence of implant abutment type on stress distribution in bone. \(^{24-26}\) However, there is little evidence in literature on the relationship between the IAI and the stress distribution pattern on the implant, as well as its components and surrounding bone. Therefore, this study has been taken up to evaluate the stress distribution, on the implant surface, the screw, on the bone surrounding implants and at the IAI of existing 4 different connection designs using finite element analysis. Based on these findings a novel implant abutment connection will be designed and the stress distribution pattern around 2 modifications of this design compared.
1.1 AIM

To design and develop an Implant Abutment connection / interface that will aid in preservation of residual bone and soft tissue ensuring predictable aesthetic and functional outcome of Implant treatment.

1.2 OBJECTIVES

1. To compare and analyze the influence of four different Implant abutment interface on the stress distribution using finite element analysis

2. To analyze the amount of stress dissipated to the bone surrounding the implant on axial or vertical loading and non-axial or oblique loading of the implant abutment assembly.

3. To understand the role of the implant abutment interface in the mechanism of stress transfer to the implant bone interface.

4. To analyze the magnitude of stress generated on the Implant, abutment screw, Implant abutment interface and the bone on change of location of the vertical loads.

5. To design a novel Implant abutment connection that will improve longevity of the implant and the supporting prosthesis.