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CRITICAL FACTORS FOR FAILURE OF ORTHODONTIC MINI IMPLANT: A REVIEW

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ABSTRACT Anchorage in orthodontics is of prime importance for effective results. With the introduction of temporary anchorage devices (TADs) as skeletal anchorage method its use has been popularised. Although all anchorage systems have their own merits but they are often associated with certain demerits too. Since, literature is flooded with articles documenting the success rate but, as there are always two facets to everything, an insight to the failures of TADs should also be unravelled. So, review was done with the objective to evaluate the factors responsible for the failure of mini implants.Strategic and through search of the literature in four major databases was undertaken for data extraction and conclusion was drawn that mini implant failure is a multifactorial problem which includes mini implant related factors, clinician related factors and patient related factors.

KEYWORDS : TADs, mini-implant, failure-rate, success-rate, orthodontics.

INTRODUCTION

TADs are recent development in skeletal anchorage system, which when anchored to the alveolar bone provide direct or indirect anchorage. Its advantages include simpler treatment mechanics, shorter treatment time alongwith minimising orthognathic surgeries in borderline cases, greater patient comfort, ease of insertion and removal, reasonable cost, biocompatibility, and capability to withstand orthodontic forces.

Use of mini-implant have increased tremendously in orthodontic due to above mentioned factors but its success or failure largely depends upon its ability to resist forces and to provide sufficient healing at the bone-implant interface. Factors contributing to the success or failure of mini-implant can be categorized as[1]:

Mini-implant - related factors comprising of screw-diameter, length, material and insertion method. Clinician related factors has been reported to have main impact on success they comprises of root proximity, insertion- torque, angle, besides amount of orthodontic load, direction of load, time of loading (Immediate vs delayed), primary or secondary (re) insertion as well as placement site and clinician expertise. Other important and ignored aspect are the patient-related factors which comprises of oral hygiene, smoking, cortical bone thickness and patients age. Foremost requirement for the success of mini-implant as an anchorage device is its stability.[2] Several studies reported them as being unstable, since they depend only oan mechanical locking of threads into the bony tissues without any osseointegration. Hence, the present review will discuss the responsible risk factors for the failure of mini-implants.

DETERMINANTS RESPONSIBLE FOR TAD FAILURE

AGE :-

TADs failure was observed in younger and adolescent patients there are studies of wide range of age reported on the database and failure rates were reported even at age of 15 years hence age as an factor for failure rates of TADs should not be considered[3]. There is no firm conclusion related to failure rate and age consideration. Tsai et al[1] have reported that after 20 years there will be 2.6% and 30 years onwards for every 1-year 5% failure was observed. The possible explanation for this was that aging alters the distribution of organic and non-organic constituents in bone, because TADs implantation is regarded as form of alveolar bone trauma, and healing is slower in older patients than in younger patients. Thereby stating higher failure rate in adolescents compared to adults. This result is potentially due to difference in the buccal plate thickness which increases in density with age.

IMPLANT PLACEMENT:-

Ashley et al[4] reported that the primary cause of implant failure is incorrect insertion technique also most common mistakes are inadequate irrigation at surgical site, excessive drilling speed, unstable movements of screwdriver, and insufficient placement torque, supporting this Melsen and Costa[5] stated that overheating during pilot drill causes bone damage and increases failure rate. Further Chen[6] and Motoyoshi[7] stated that self-drilling mini-implants are not recommended in area of thinner cortical bone as they have high placement-torque therefore more breakage while placement.

Kim et al[8] in study found that patient failure rate (PFR) is generally higher than implant failure rate because of multiple insertion.Therefore, its suggested while inserting multiple mini implants in a patient, clinicians should consider inserting additional mini implants at the same site of local anesthesia for use in the event of failure, keeping in mind the high PFR for cases of multiple insertions.

IMPLANT LENGTH AND DIAMETER:-

Chen et al[9] conducted study and concluded that minimum length of the TAD should be atleast 6 mm this was supported by Lim [10] and Sarul et al[11] where they compared 6mm and 8mm long implant and found that longer TAD showed more success, supporting this Kau et al[12] reported that alveolar bone contacted the total surface area with TAD's by almost 71.2%

thus its assumed that smaller the contact surface area of greater will be the chance of failure.

Mini-implant diameter is associated with failure as use of large-diameter (1.4-1.5 mm) increases risk of surface damage to the adjacent root, which decreases primary stability[1]. Whereas Miyawaki et al[13] found that diameter of 1mm or less leads to failure. Supporting this Wiechmann[14] concluded that decreased diameter decreases survival of implant irrespective of length.

Further, impact of diameter in relation to jaw was done by Wu[15] and found that lower failure rate in maxilla when diameter was equal to or <1.4 mm, reason for this is biological adaptation mechanisms of jaw bone during or after mini-implant insertion as heat is always generated during the predrilling process for the smaller diameter implant, which may lead to osteonecrosis.

IMPLANT MATERIAL:-

Commonly used implant material in practice are stainless steel, titanium and pure titanium. Most of the studies done using titanium implant showed successful results because of its good biocompatibility but even when no failures were seen when the other materials were used for anchorage control[1].

ANGULATION OF PLACEMENT:-

Suzuki et al[16] reported that placing TADs at a different angulation changes the amount of bone contact length and significantly affect stress distribution which may affect failure rate.

Woodall[17] conducted a study by placing an implant at different angulations as 30°, 45°, 50°, 60°, 70°, 80°, 90° and concluded angles <90° created more stress to alveolar bone surface leading to failure supported by Perillo et al[18]. Further Wilmes et al[19] found that highest insertion torque were measured at angles between 60 and 70°.

Zhang et al[20] conducted a study and analysed influence of different angles on biomechanical characteristics and concluded that decreasing tilt angle can lead to failure in implant's ability of bearing mesio-distal orthodontic force.

PLACEMENT SITE, SIDE AND ARCH:-

Mohammed et al [21] conducted review and stated that TADs inserted between the first molars and second premolars show failure rate of 9.2% in maxilla and 13.5% in mandible, whereas in regard to palate Kim et al[22] stated that failure rate for paramedian was 4.8% and parapalatal area 5.5% the possible reason that contact of the roots in parapalatal is higher.

Also, according to Tezel et al[23] better hygiene is seen on left side of the oral cavity in right-handed patients therefore high success rate of TADs.

When considering arch Luzi et al[24] stated maxilla showed a more failure compared to mandible, which could be related to lower bone density and thinner cortex. But this does not hold true for every case, in mandible factors like higher density of bone may be conducive to primary stability, but negative factors such as mastication forces and surgical difficulties related to the anatomical structure of the mandible may overcome the advantages, especially in the posterior segments.

CORTICAL BONE THICKNESS:-

Cortical bone density and thickness are important factors in success of an TADs as primarily depends on the mechanical lock between the alveolar bone[24] this was supported by Motoyoshi[7] stating that if bone thickness is <1 mm primary stability is not satisfactory. Further, its found that patients with high mandibular plane angles are associated with failure because of thin cortical bones[13].

PROXIMITY TO ROOT:-

Distance between mini-implant and root was most significantly correlated with mini-implant failure as when in contact with root, occlusal forces are transmitted through teeth to mini-implant, causing its mobilization supported by Luzi et al[25]. Further Albogha et al[26] stated if there is small interradicular width implant is placed closer to root opposing the force direction and therefore 1 mm should always be reserved between the implant and root.

LOADING OF IMPLANT:-

Immediate loading could cause failure of a mini-implant and failure rate was found to be highest if loaded first week after insertion and 75% of failed mini-implants occurred during the 16 weeks after insertion specifically, when the loading time after insertion was <12 weeks[27].

INFECTION / INFLAMMATION AT SITE OF IMPLANT PLACEMENT:-

Luzi et al[24] stated that insufficient hygiene and consequent soft-tissue inflammation around the head of the mini-implants is a potential risk factor for failure, supported by Miyawaki et al[28]. Another study by Becker et al[29] stated that bacterial contamination of the peri-implant tissues is frequently associated with dental implant failure.

MUCOSA THIKNESS:-

Increased mucosal thickness resulted in minor implant-bone surface contact area thus reducing the primary stability and leading to implant failure. When mini-implants were inserted in mobile non-keratinised gingiva as movable mucosa have a higher risk of food impaction, which result in inflammation and loosening of the mini-implant. However they identified anatomic locations and peri-implant soft tissue character as two independent prognostic indicators irrespective of the arch[9,24].

IMPLANT INSERTION AND RE-INSERTION:-

Failure rate increases with increase in the frequency of reinsertions because the host related factors such as age, craniofacial skeletal pattern, degree of bone remodelling, bone density and thickness of the bone in adjacent area in same side of implant reinstallation[8].

OTHER FACTORS:-

Numerous studies have confirmed smoking as risk factor for occurrence and progression of periodontal diseases, therefore delaying postoperative wound healing disorders and hence more failure. When compared to non-smoker a significantly higher rate of peri-implantitis and bone loss was seen. Thus, smoking is generally recognized as a major risk factor,this was supported by Bayat[30]. Also systemic diseases are associated with increased bone metabolism, such as osteoporosis and uncontrolled diabetes which increase the implant failure rate[24].

CONCLUSIONS

Failure of orthodontic mini-implant is multifactorial, so following inferences can be drawn from this review-

- Higher failure rates are associated with younger age groups and males alongwith Insertion technique, high placement torque and multiple attempts of implant insertion on same site lead to failure.
- Mini-implant size, is inversely associated with its success.
- Placement at 90° angulation shows poor stability.
- More implant failure were seen in mandible when placed between the first molars and second premolars also when placed in non-keratinized gingiva.
- Reduced cortical bone thickness and distance between the mini-implant and root results in more failures.

- Immediate loading of the mini-implants after insertion or during the first week after insertion causes failure.
- Poor Oral hygiene and smoking are associated with failure of mini implant.

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