

Impact of implant insertion torque on success of implant-an evidence based review

Ajay Mahajan^{1*}, Kanwarjit Singh Asi², Shivanjli Bansal³, Deepa Rayast⁴

¹Professor, ²Professor and Head, ^{3,4}Junior Resident, Dept. of Periodontology, Himachal Pradesh Government Dental College and Hospital, Shimla, Himachal Pradesh, India

***Corresponding Author:**

Email: drajdent@yahoo.co.in

Abstract

Introduction: Insertion torque imposes a direct effect on the stability of implants. Some studies suggest that high torque has resulted in bone necrosis while some suggest no impact on bone with high torque, the literature regarding insertion torque relationship to changes in bone is sparse.

Purpose: The rationale of this article is to critically evaluate the available scientific data on influence of insertion torque on implant success.

Materials and Methods: A Medline and manual search was done to recognize studies that are concerned with insertion torque related implant success rates from 1970 to 2017. The articles taken in this study includes data on insertion torque such as primary stability, bone quality and quantity, implant design and changes in bone related to high or low torque.

Results: The 28 included studies contains one randomized controlled trial, 12 prospective studies and 10 retrospective studies.

Conclusion: Insertion torque leads to primary stability of implants which ultimately contributes to implant success.

Keywords: Insertion torque, Primary stability, Bone density, Implant success.

Introduction

Nowdays, use of dental implants have turn out to be a popular treatment modality to replace missing tooth and have shown success rates beyond 90% in long term.¹⁻² Development in implant techniques have reduced the required healing time after implant loading.³ A dental implant is an alloplastic material used to anchor prosthetic replacement teeth in the edentulous jaw.⁴ The aim of implant therapy in dentistry is to restore tissue contour, function, comfort, esthetics and speech.⁵ The bone crest level around implant is of great importance to conclude osseointegrated implant success.⁶ Certain stresses on the repairing tissue in early or immediate loading of implants can promote fibrointegration during healing period and lead to implant failure so, protection of bone tissue from forces of occlusion is necessary. This helpful protection can be attained by reduction in micromovements at bone implant interface.⁷ Micromovements up to 150 um are not harmful and has no effect on healing pattern of bone.⁸ For minimal micromovements splinted implants are good but splinting on more than one implant causes equal distribution of force on each implant. So, the minimum cut off value of micromovement shall not be achieved.³

Primary implant stability refers to a function of local bone characteristics, the design of an implant, the position and surgical procedure used, and the accurate fit in the bone.⁹ The objective to achieve primary stability during implant placement is to reduce undue micromotion at bone implant surface, which can interfere osseointegration.¹⁰ Methods to measure primary stability includes non-invasive methods such as periotest, Resonance Frequency Analysis (RFA) and the insertion torque.¹¹

The force required to introduce a dental implant is called insertion torque (IT). It is the requisite torque to place the implant into the prepared osteotomy site.¹² Oftenly a possible relationship between primary stability and implant insertion torque has been found in the dental literature. Several studies have used a common insertion torque as a marker of primary stability.¹⁰⁻¹⁵ The more the value of an insertion torque, the more the primary stability of the implant.³ Some clinicians prefer higher insertion torque whereas some suggest low. Few studies have indicated insertion torque near the range of 35 Ncm to be satisfactory while some found no bone damage up to 176 Ncm.^{3,10,16,17} However, impact of high and low insertion torque depends on various parameters.¹⁸ In this review article we will discuss the effect of high insertion torque and bone related changes which ultimately decide the success and failure of an implant.

Materials and Methods

An investigation of the electronic database of PUBMED, up to and including 2017 was done. Studies included were randomized control trials, case series, case reports, review articles and systematic reviews.

The flow chart depicting the selection criteria and studies included is shown in Fig. 1.

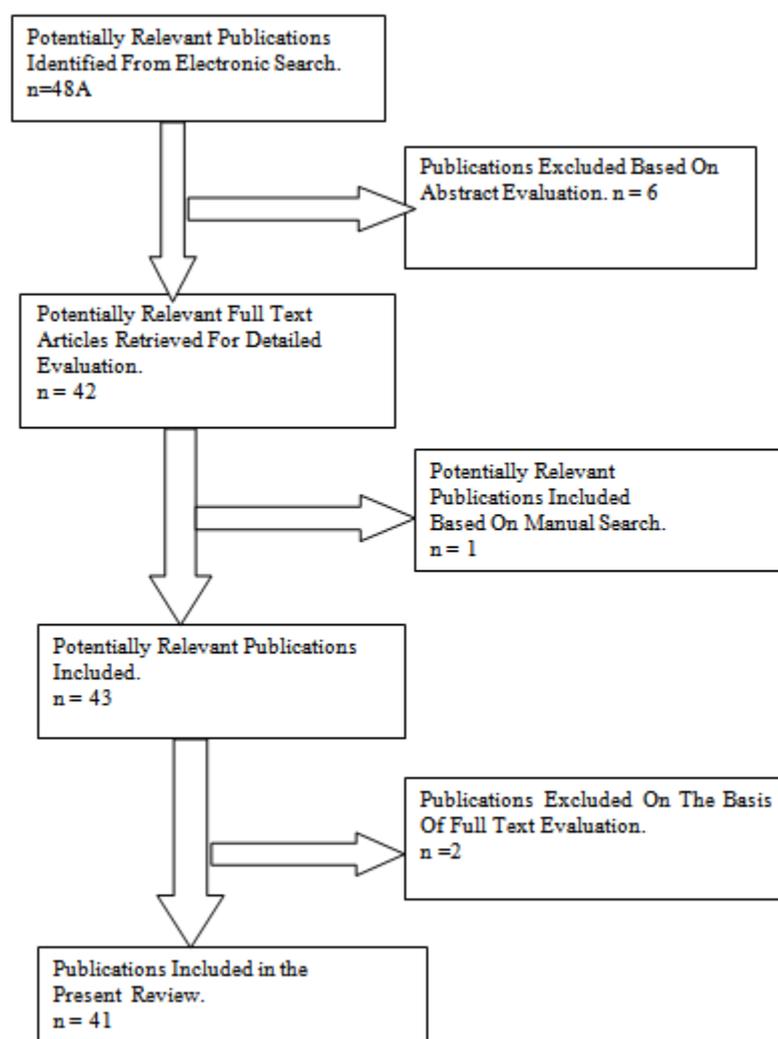


Fig. 1: Flow chart showing selection process of the studies included in the systematic review

Studies on insertion torque related to osseointegrated implant success included 23 RCT, 6 retrospective studies, 8 prospective studies, 8 review article, 2 meta-analysis and 1 literature review.

What are the key factors affecting insertion torque?

The factors affecting the insertion torque are - bone density, quality and quantity and hardness, using under-sized drills and tapered designed implants.¹⁹ Primary stability of implants is influenced by two main factors which include residual bone at implant interface and the function of compressive stresses at the interface of implant-tissue. These stresses may prove useful to enhance implant's primary stability, but they can attain a elevated level that may cause necrosis and localised ischemia of the bone at the surface of implant-tissue.⁹ Torque has a direct relationship with the density of the bone.¹⁹ At the time of placement of an implant the insertion torque plays a prime role to determine the initial stability, which serves as an essential factor for

osseointegration of implants and immediate loading.²⁰ The level of torque is generally expressed in Newton

centimeters (Ncm).³ Implant insertion torque can be assessed by electronic devices integrated with physiodispenser or with torque gauge incorporated with manual ratchets.¹¹

Insertion torque not only describe the bone quality, rather it is an essential factor for the implant's primary stability and to decide the loading protocol, which in turn is an important factor which decides whether an implant will be successful or not. More value of insertion torque leads to more primary stability.^{11,15} Lower ranges have been associated with failures.²¹ Studies have indicated insertion torque near the range of 35 Ncm to be satisfactory.²²⁻²⁴ Some authors demonstrated that higher insertion torque of an implant had no effect on hard and soft tissue while some reported necrosis and marginal bone resorption with higher torque.^{10,21,25-29} Some implant manufacturers suggest an insertion torque value that should not be

exceeded or a minimum torque level to be attained for immediate implant loading still it is not clarified

what is that appropriate insertion torque value and if a threshold level of insertion torque does exist that could, eventually, induce bone resorption.^{11,30}

Thus, several studies have been done to determine the association between insertion torque and bone related changes and have concluded a positive correlation between the two.¹⁰⁻²⁰

The relation between insertion torque, osseointegration and implant success-an evidence based overview:

Successful osseointegration is an outcome of good quality of primary stability which in turn depends on insertion torque.³¹⁻³³ Osseointegration is a structural and functional association between living bone and the loading implant interface, is crucial for implant stability, and is well thought-out a requirement for implant loading and clinical success of end osseous dental implants in long run.³⁴ The success of an implant depends on interrelationship of various components which includes-implant surface and design, biocompatibility, surgical technique used, undisturbed healing phase and the most important by the quality and quantity of bone available.³⁴ Although quantity of bone is definitely a crucial structure the quality of bone seems to be even more important criterion in implant success.²⁰ Lekholm and Zarb first described 4 types of bone quality namely type I-IV, where type I is the most dense and type IV is the poorest quality. The type I bone present in the anterior mandible has the best

insertion torque values and implant stability and thus has highest success rates. Type III and type IV bone present in the posterior maxilla, has good primary stability but with high insertion torque values is not predictable, and the success rates cannot compare with those of the anterior mandible.³⁵ Numerous studies support this association between quality of bone and long-term success.^{20,34,35}

In recent years, modifications in implant design and surface have caused more success rates in all bone types.⁴⁶⁻⁴⁷ However, type IV bone has less long term success rates when compared with type I bone.⁴⁸⁻⁴⁹

A brief summary of the studies related to insertion torque and implant success is given in (Table 1). Success of an implant is attributed to osseointegration which takes place when micro movements are minimal. To keep micro movements minimal primary stability should be attained and to achieve primary stability insertion torque plays a vital role.

Insertion torque and primary stability both determines the osseointegrated implant success. According to various research papers, different torque values have been indicated as minimal and optimal, but there is no definitive torque value that lead to primary stability and above which bone necrosis resulting in peri implant bone resorption can occur. Further studies should be carried out to understand the impact of insertion torque on bone resorption.

Table 1:

Author	Type of Study	Result
Ottoni et al (2005) ^[21]	Controlled randomized: in vivo (humans)	Average insertion torque in their study was 38 Ncm and successful osseointegration was achieved.
Neugebauer et al (2006) ^[16]	Prospective: in vivo (minipig)	Successful osseointegration observed when average insertion torque was kept higher than 35 Ncm.
Duyck et al (2010) ^[36]	Controlled randomized: in vivo (rabbits)	Higher peri implant bone loss observed when insertion torque was kept above 50 Ncm.
Makary et al (2011) ^[37]	Controlled randomized: in vivo (humans)	The range of insertion torque was kept between 15 to 150 Ncm and found successful outcomes in D1 to D4 type of bone.
Trisi et al (2011) ^[38]	Controlled randomized: in vivo (sheep)	Studied that higher IT (mean 110Ncm) caused no bone necrosis however increased primary stability observed.
Khayat et al (2011) ^[10]	Prospective: in vivo (humans)	With use of high (upto 176 Ncm) no deleterious effects insertion torque observed on osseointegration.
Campos et al (2012) ^[39]	Controlled randomized: in vivo (dog)	Range of IT was 130-160 Ncm and different healing patterns of bone observed.
Chai John et al (2012) ^[40]	Controlled randomized: in vivo (humans)	Concluded IT as viable mean to assess mandibular bone quality in patient with compromised bone density.
Cannizzaro et al (2012) ^[25]	Controlled randomized: in vivo (humans)	At high insertion torque(>80 Ncm) there was less implant failures.
Consolo et al (2013) ^[41]	Controlled randomized: in vivo (sheep)	No significant differences in histological evaluation, resonance frequency analysis, removal torque.

Hof et al (2014) ^[42]	Controlled randomized: in vivo (humans)	No clinically significant differences in marginal bone resorption after 1yr observed.
Rea et al (2015) ^[28]	Controlled randomized: in vivo (dogs)	The success rate of implants was more with lower insertion torque as compared to higher insertion torque.
Rea et al (2015) ^[29]	Controlled randomized: in vivo (dogs)	Similar type of osseointegration was observed with high and low insertion torque.
M. Wada et al (2016) ^[43]	Review article	Revealed bone density as a useful indicator of implant success, preoperative CT may help to predict the initial implant stability.
Gehrke et al (2016) ^[17]	Controlled randomized: in vivo(humans)	Their results proved 35 Ncm as best IT value for Conical internal connection.
Venkatakrishnan et al (2017) ^[44]	Short review	40 N load in normal bone and 32 N load in osteoporotic bone had same stress-strain value.
Gary Greenstein et al (2017) ^[45]	Literature review	Minimum torque to attain primary stability not defined. With increasing IT(>50) no bone damage observed and Implant micromotion reduced.
Grandi et al ^[3]	Controlled Randomized: In vivo(humans)	When insertion torque used between 30 Ncm and 100 Ncm, there was no difference in peri implant bone resorption.

Conclusion

At the end of the study it was found that most of the studies used an insertion torque ranging 20-45 Ncm. A specific insertion torque value is still difficult to determine as the current evidence suggests the role of various other factors affecting insertion torque while implant placement.

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