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Research Article

To Investigate the Influence of Conventional and Non-Conventional Drill on Implant Stability During Bone Bed Preparation- A Systematic Review

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Abstract

Background: There are multiple surgical techniques proposed for implant bone bed preparation to enhance the stability of implants. However, there is no adequate amount of scientific evidence to support the association between the surgical techniques and implant stability.

Purpose: This systematic review aims to investigate the influence of laser/piezoelectric or conventional drill on its surgical outcome during bone bed preparation.

Materials and Methods: The studies included were from January 2007 to December 2017 An electronic search was done of PubMed, Google Scholar, Institutional Library and manual search of various journals. The inclusion criteria composed of all randomized control trials and observational studies evaluating the implant stability after bone bed preparation conventionally or using a piezo electric system or laser. All studies selected were in ENGLISH language only and included *in vitro* and *in vivo* studies conducted in animals.

Results: 6 articles were selected which met the criteria of comparative evaluation of conventional versus non conventional drilling methods. There is very weak evidence suggesting that the use of piezo electric or laser methods compared to conventional method of the bone bed preparation could influence the implant stability.

Limitation: Total number of articles screened for full text is limited in number i.e. only 6 articles are screened in this systematic review.

Conclusion: There is still a lack of evidence about the better surgical outcome about the influence of laser or piezoelectric technique compared to the conventional drilling method on implant stability.

Keywords: Dental Implants; Implant Stability; Instrumentation; Implant Site Preparation; Piezo Surgery; Laser Surgery; Osteotomy

Introduction

The placement of dental implants has been revolutionized and is the most predictable treatment option for restoration in edentulous patients. Progression of implant materials and designs over decades has led to treatment of patients in less time and surgery. Hence, popularity of immediate loading has gained much more importance in implant dentistry. The fundamental requirement for immediate loading in dental implants is primary stability during its insertion [1]. Primary stability is defined as the absence of mobility in the bone bed after the implant has been placed while secondary stability is achieved after Osseo integration [2]. It mainly depends on the mechanical engagement of an implant and the

fresh bone socket; however, its stability decreases throughout time in early stages of healing, due to the remodeling of the surrounding bone. However, the secondary stability is increased progressively due to biologic events at the implant- bone interface, such as the formation of new bone and remodeling. This is initially absent when the implant is just placed and it increases eventually in time. Primary stability is among the important requisites for achieving and maintaining osseo integration [3,4]. Apart from the quality and quantity of the bone, the morphology of the implant body, like its surface roughness, and topography and its surgical procedure has a great influence on the primary stability [5-7]. Likewise, secondary stability is mainly depending on the implant characteristics and surgical technique [8].

The surgical technique used for implant bed preparation has a major impact of implant stability. In one of the techniques, implant stability can is increased in a low-density bone by the preparation of the receptor site smaller in diameter of the implant to be placed, so there will be an osteo compressive fit between the bone bed and the surface of the implant [9]. However, the shortcoming of all drilling techniques is that the bone tis- sue is lost during the process of drilling. This flaw is exacerbated in conditions where limited bone or bone of lesser density is available. Due to this, the technique of osteotomy has been introduced [10]. In this method preparation is with a smaller-sized pilot hole, and then the bone tissue is compressed laterally and apical with a spreader or implant shaped instrument. The main aim in this technique is replacing the implant with greater stability without removing additional bone, which aids in final bone healing [11].

With the addition to the conventional surgical bone bed preparation, piezoelectric bed preparation gives an alternative technique to the placement of implants that overcomes the shortcomings of conventional system using an ultrasonic surgical system [12]. Piezoelectric surgery unit states to be a much superior technique than the conventional method in a number of ways: like, selective cutting action, improved precision, least damage to soft tissues such as nerves or blood vessels, decreases bleeding leading to an improved visibility in the surgical area, and the absence of overheating. The effect is been re- searched widely in various fields such as medicine. In orthopedics, it is used to increase the speed of bone healing in fractures and ligament damage by cell proliferation and bone matrix synthesis [13]. Clinical reports on multidisciplinary approach on ultrasounds in bone surgery provided promising results [14].

The application of low-level lasers is also another method of acceleration and improvisation of the bone tissue healing [15]. Laser light irradiation is applied in the medical field and has shown bio stimulatory effect on healing of injuries, collagen synthesis, and fibroblast proliferation. Also, it is seen that bone irradiated mostly with infrared wave- lengths displays an increased osteoblastic proliferation, collagen deposition, and bone formation when compared to a nonirradiated bone

However, very minimal material is available concerning the effect of laser on the Osseo integration process of implants. Therefore, in this review we determine if any scientific- based evidence is present to support the influence on implant stability by laser bone bed preparation.

Numerous clinical methods for determining implant stability at different stages have been proposed, such as Periotest (Siemens AG, Bensheim, Germany), Dental Fine Tester(Kyocera, Kyoto, Japan), Osstell Mentor (Osstell AB, Stampgatan, G¨oteborg, Sweden), and the cutting-torque or insertiontorque (IT)measurement.

Periotest and Dental Fine Tester used to check the stability of implant have shown to have poor sensitivity and their measurements are highly influenced with multiple reasons such vertical measuring point on implant abutment or the hand piece angulations, and distance horizontally of the hand piece from the implant [16,17].

Osstell resonance frequency analysis (RFA) system involves placing of a Smart Peg into the implant, which is then screwed into the implant itself, the use of a transducer and held close to and perpendicular to the Smart Peg without actually making contact. Osstell gives the implant stability quotient (ISQ) through resonance frequency analysis on a scale from 1 to 100. Higher ISQ number, higher the stability [7]. Recent studies show that ISQ to be an accurate, noninvasive means of determining implant stability, and it is become most used instrument to monitor changes instability at the implant-tissue interface helping to differentiate between successful implants and clinical failures. The surgical techniques highly influence the surgical outcome of dental implants.

Aim of the Study

The aim of this systematic review was to investigate the influence of different surgical techniques conventional or laser and

piezoelectric on the primary and/or secondary stability of dental implants.

Materials and Methods

Eligibility criteria: Inclusion and exclusion criteria were fixed and the studies were screened based on the criteria mentioned below.

Inclusion criteria

- All randomized control trials and observational studies evaluating the implant stability after bone bed preparation conventionally or using a piezo electric system or laser.
- All studies evaluating implant bed preparation technique and stability of implants.
- All studies selected were in ENGLISH language only.
- All studies were conducted in animals.
- All studies included were from 2007 to 2016.

Exclusion criteria:

- All narrative reviews.
- All the letters to editor.
- Studies that reported surgical techniques and implant stability but did not verify their association were excluded from the systematic review.

Information sources

Literature search strategy was developed using key words- implants, implant stability, implant bone bed preparation, laser, conventional drill, resonance frequency analysis, osteotomy. Data was searched from PubMed and google scholar from January 2007 to December 2016. Cross references were checked from relevant articles. Hand searching was done for articles when full text of articles was not available through electronic database.

Search strategy

The comprehensive data search was done on PubMed and Google scholar. While carrying out the search filters were put for the dates of publication from January 2007 to December 2016. Language restriction was put to English language only. No filters for filters for full text and for study designs were kept. The keywords for search strategy used for searching articles in PubMed is given in table 1. Google search was carried out for the articles not published on PubMed. Searching on google yielded 1 article relevant to the eligibility criteria.

Sr no	Search Strategy	Articles in hits	Selected
1	Titanium implants AND implant stability AND osteotomy	24	1
2	Implants AND primary stability AND implant bed preparation	11	3
3	Implants AND implant stability quotient AND resonance frequency analysis AND osteotomy	19	5
4	Dental implant AND implant bone bed preparation AND laser AND con- ventional drill	1	1
5	Implants AND implant stability AND osteotomy AND implant bone bed preparation	6	4
6	Implants AND implant stability AND implant bone bed preparation AND laser AND conventional drill	0	0

Table 1

Data collection process

A standardized data extraction form was prepared in Microsoft Excel with the help of an expert. Initially 3-4 entries were made in the Excel and it was reviewed by an expert. Any dis- agreement between the authors was resolved by discussion. The following criteria were pre- determined for extracting the data:

- The year of publishing, country of conducting the study, sample size and the number of implants
- Implant surgical technique used.
- Implant stability quotient or Implant Torque values and its association between the surgical techniques.

Results

Study selection

The tittles and abstracts of all articles were identified through electronic search and were scanned independently. Studies which appeared to meet the inclusion criteria were selected. 6 articles were selected which met the criteria of comparative evaluation of conventional versus non-conventional drilling techniques. Studies which were exactly repeated in the PubMed were excluded. None of the authors were blinded to the journal titles, study authors or the institution were the studies were conducted.

Records were identified through the data search using search strategy in PubMed. Through Google scholar 0 articles were selected based on titles. Total articles number arrived to be 62. Second step was screening through the titles and after screening 52 articles were excluded because they were not related to the objectives of the systematic review. Some articles mentioned study done on animals whereas; some mentioned materials other than surgical implant bone bed preparation. 10 articles which remained were screened for duplicates manually. Out of 10 articles, four articles were found to be duplicates and hence remaining 6 articles were screened through abstracts as a next step. Finally, 6 articles were screened for full text. At the end 6 studies remained which underwent qualitative synthesis.

Prisma Chart (Figure 1) Records of the literature that was identified using the search strategy in pub med, google scholar and manually is journals.

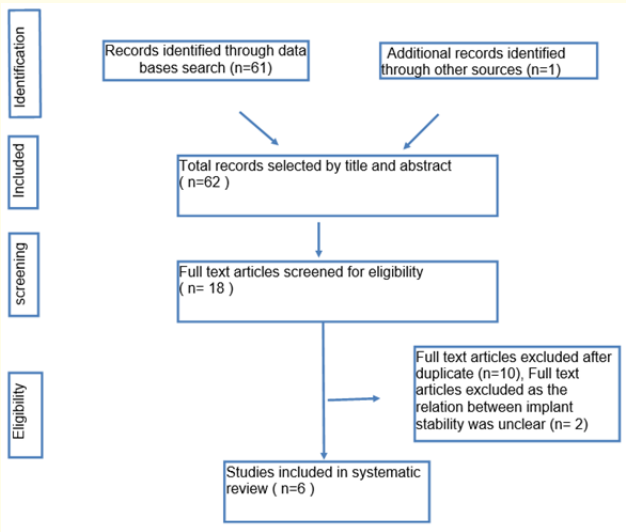

Figure 1: Prisma chart.

Study characteristics

A search conducted using the search strategy retrieved around 62 articles. After screening all the titles and abstracts independently, 6 articles were selected based which fulfilled the focus of implant stability affected during bone bed preparation using laser or piezo electric surgical methods and conventional method of implant bone bed preparation. The studies selected included animal implants, *in vivo* and *in vitro*. The intervention was laser or piezo electric surgical method of implant bed preparation compared to the conventional method of surgical preparation. The outcome was to check the implant stability quotient of dental implants. The articles selected, were carefully scanned and met our inclusion criteria and data extraction.

Discussion

This systematic review was prepared to evaluate the association of different surgical techniques and its outcome on implant stability. Studies have shown the influence implant stability. The osteotome techniques evaluated were the piezo surgery low-level la- ser therapy and the conventional drilling technique. Six randomized controlled trials (RCTs) included. The articles selected were those which confirmed the association be- tween implant stability and surgical bed preparation. Studies which did not report any implant bone bed preparation outcomes were not considered, as they would not provide any necessary information for prognosis of dental implant placement. Since only limited studies investigated influence of different surgical techniques on stability of dental implants, the purpose of this literature review was done to mainly to summarize the pertinent information.

Summary of evidence

Schwarz., *et al*. [18] conducted a study to evaluate the influence of implant bed preparation using Er:YAG laser on the Osseo integration of titanium implants. Osseo integration is the process which is the direct connection of structural and functional relation between the living bone and the surface of the load bearing area of implant. For successful Osseo integration process, a direct connection has to be established between the bone directly to implant body without the interposition of connective tissue or bone interposition. However, the procedure gets compromised when the bone tissue is ex- posed to heat formation during conventional drilling procedures because the threshold level for osteocyte damage has been reported to be around 47^0C, i.e. only about 10^0C above the body temperature. To minimize the risk of temperature, increase in the adjacent alveolar bone, an intermittent drilling technique using sharp burs was used and executed in a sequence of preparation steps under sufficient irrigation with sterile saline. In this study conducted on four beagle dogs were used and were performed in two surgical phases. In the first phase, mandibular and maxillary

2nd, 3rd, 4th premolar and 1st molar were extracted bilaterally in all dogs. After 4 months, once the healing was completed, the implant site was prepared in the lower jaw using the Er:YAG laser device (ERL) on one side and conventional rotating drills (n= 6 implant channels per animal). Three commercially available screw-type titanium implants of different manufacturers were then inserted randomly in both groups. So, in this study, the ERL irradiation did not compromise bone regeneration and subsequently the Osseo integration of common dental titanium implants. Within the limits of the present study, it was concluded that ERL may represent a promising tool for implants site preparation.

Su-Young LEE., *et al.* 2010 [19] studied the comparison of implant bone bed preparation with Er,Cr: YSGG laser and conventional drills. 40 implants which measured 4.1 × 8.5 mm was placed on two different types of pig rib bone. 20 implants were inserted in each type of bone using an Er,Cr: YSGG laser surgical method and the Conventional drilling method for implant site preparation. The maximum insertion torque value was reached at its peak torque at the final stage during implant insertion. With the limitations in this study, the effects of preparation with Er,Cr: YSGG laser on the relationship between implant stability quotient (ISQ) values and implant insertion variables were comparable to those observed in drilling sites and had a comparatively better outcome. Gulin Seymen., *et al.* 2013 [20] conducted a study was to determine the deviations in the position and inclination between the planned and prepared implant beds with Erbium, Chromium doped Yttrium Scandium Gallium Garnet (Er,Cr: YSGG) laser using stereo lithographic (SLA) surgical guides. In this study six sheep lower jaws were used to pre- pared the implant beds with the help of the Er,Cr: YSGG laser and the drill. 2 implant bed sites were used in each half of the jaw. 4 implant beds 3 mm diameter and 8 mm length was then prepared using Er,Cr: YSGG laser and Conventional drill. It was seen that implant bed can be prepared with desired angle, diameter and depth with Er,Cr: YSGG laser system using surgical guide system which guided hand piece enhancing the surgical outcome. Within the limitations of this study, preparing implant beds with Er,Cr: YSGG laser system can be an alternative to conventional drilling method but did not provide any significant evidence to better technique.

Gandhi., *et al.* 2014 [21] studied the comparison implant primary stability in cancellous bone with piezoelectric prepared sites versus conventionally drilled sites for implant placement. The piezoelectric surgical technique claims to provide a better alternative to conventional rotary preparation technique. Four ribs from freshly slaughtered cows stored at 50°C were used. The 2 implant preparation techniques used were: (a) standard drilling technique as recommended by the implant manufacturer and (b) piezo electric implant site preparation as per manufacturer's instruction. irrigation. After implant placement, primary stabilities upon immediate loading were subjected to RFA testing.

Study Id	Author	Location	Year of publication	Study design	Sample size	Population	Surgical technique	Intervention	Comparison	Conclusion	Interpretation
1	F. Schawrz	Germany	2007	Randomised controlled trial	24	4 beagle dogs	Implant bed preparation	Conventional drills	Er: YAG laser device (ERL)	ERL may represent a promising tool for implant bed preparation	Laser device proved to provide a better implant stability
2	Gulin Seymen	Turkey	2013	Randomised controlled trial	6	Sheep lower jaws	Implant bed preparation	Conventional drills	Er: YAG laser device (ERL)	Better stability with ERL using surgical guide	Laser device represented a better stability with surgical guide
3	Su - Young Lee	Korea	2010	Randomised controlled trial	40	Bovine pig bones	Implant bed preparation	Conventional drills	Er: YAG laser device (ERL)	ERL had a better implant stability compared to conventional drill.	Laser device proved to have a better stability compared to conventional method

4	Shweta Gandhi	USA	2014	Randomised controlled trial	4	Bovine ribs	Implant bed preparation	Conventional drills	Piezo electric system	Piezoelectric system has a better implant stability	Piezo electric system represented a better stability compared to conventional method.
5	Justin A. Baker	USA	2011	Randomised controlled trial	4	bovine ribs	Implant bed preparation	Conventional drills	Piezo electric system	Piezo electric system has a similar primary stability compared to conventional bones preparation	No significant difference was seen in the stability of implant, with piezo electric system or conventional method.
6	Rastelli	Italy	2014	Randomised controlled trial	10	pig ribs	Implant bed preparation	Conventional drills	Piezo electric system	No significant difference	No significant difference was seen in the stability of implant, with piezo electric system or conventional method.

Table: Data excel sheet.

Resonance frequency analysis (ISQ) by Method. Independent t test showed significant difference in primary stability by method, t (17). 2.637, P. 0.17, with equal variance assumption satisfied (P. 0.196). A higher mean ISQ value for piezoelectric than for conventional, 58.9 (8.55 SD) versus 49.2 (7.33), respectively was seen. The benefits that associated with noninvasive ultrasonic technique were: precise incision, minimal dam- age to soft tissues, more bone preservation, early increase in bone morphogenetic proteins and growth factors, controlled inflammation, stimulated bone remodeling, and de- creased heating associated with implant preparation [13]. The piezoelectric system functions at a lower frequency (25 - 29 kHz) to create micro vibrations specifically at the lower frequency that cuts mineralized tissue alone. At higher frequencies (.50 kHz) soft tissue is cut. The results of this study indicated that the piezoelectric system implant site preparation gave a higher implant primary stability in cancellous bone. However, variations in quality across bones may have affected results.

Rastelli., *et al.* [22] studied to determine *in vitro*, the stability of implants by the use of the resonance frequency (Osstell mentor), in which, implant site was prepared using the piezo electric surgery, conventional, under-preparation, bone compaction, osteodistraction methods. He was able to improve the stability of type IV cancellous bone. Pig ribs were used for the study and 10 ribs prepared for implant placement. 5 implant sites were prepared, for each rib using one for each technique. For the implant preparation the surgical techniques that were used are the conventional technique and the piezo electric technique. It concluded that piezo electric surgery gave a better outcome than the conventional drilling method.

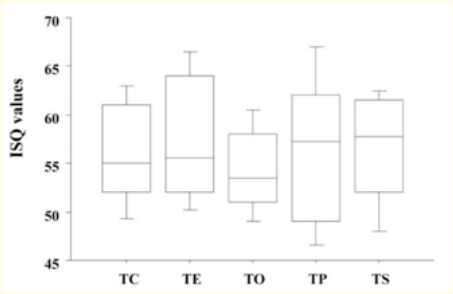

Figure 2: Mean ISQ values of the various techniques.

TO: Osteotomes Technique, TE: Expanders Technique, TC: Conventional Technique, TS: Under Preparation Technique, TP: Piezo Surgery Technique, ISQ: Implant Stability Quotient.

Limitations

Total number of articles screened for full text is limited in number i.e., only 6 articles are screened in this systematic review:

- There is still a lack of evidence about the influence of undersized drilling technique on implant stability.
- There is weak evidence suggesting that using the osteotome technique to prepare implant beds in poor bone density could enhance the primary and secondary implant stability.
- There is weak evidence suggesting that ultrasonic implant site preparation by piezo- electric inserts does not affect the primary mechanical stability but could fasten the bone healing process and increase the secondary implant stability, earlier than the traditional drilling technique.
- There is a weak evidence suggesting that flapless procedure could enhance the implant stability.
- There is insufficient evidence supporting or confuting the efficacy of irradiating bone osteotomies with infrared wavelengths for enhancing the stability of the implants.

Conclusion

Although this systematic review aimed to verify the influence of different surgical techniques on stability of dental implants, it was also possible to extract some data concerning the implant dimensions, implant macro design, and the bone density from the selected articles. This systematic review had several limitations. There is limited literature that proves that laser and piezo electric surgery has a better outcome than conventional method of implant bone bed preparation. However, more studies has to conducted.

Key Message

A systematic review was conducted on 6 articles which met the criteria of comparative evaluation of conventional versus non-conventional drilling techniques to check for implant stability after bone bed preparation and there is very weak evidence suggesting the surgical technique and its influence on implant stability.

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