ISSN No:-2456-2165

A Systematic Review on Designing the Implant Surface Affecting the Stability of Implant in Maxillary and Mandibular Arches

Elakiya S[1]; Rajmohan M[2]; Bharathwaj V V[3]; Sindhu R[3]; Dinesh Dhamodhar[2]; Sathiyapriya S[3]; Prabu D[4]*

[1]Postgraduate student, Department of Public Health Dentistry, SRM dental college, Ramapuram, Chennai, India
[2]Reader, Department of Public Health Dentistry, SRM dental college, Ramapuram, Chennai, India
[3]Senior Lecturer, Department of Public Health Dentistry, SRM dental college, Ramapuram, Chennai, India
[4]Professor and Head of the Department, Department of Public Health Dentistry, SRM dental college, Ramapuram, Chennai, India
Corresponding Author*

Abstract:- The aim of the study is to evaluate the implant surface or implant design affects the stability of dental implant in maxillary and mandibular arches. A systematic review was conducted based on a literature search in the databases PubMed, Cochrane library, Elsevier science direct, Wiley online library, grey literature, using the search keywords (implant surface) OR (implant design) AND (implant stability). Randomised controlled trials investigating the effect of implant design or surface and further followed by Cochrane database bias assessment was done. Four randomised controlled trials were included, and after discussed, the result of the p-value is statistically significant but in one study the p- value is found that there is no statistically significant in implant surface or implant design affects implant stability. The study concludes that there is less evidence of affecting implant stability of implant surface or design.

Keywords: *Dental Implants, Implant Stability, Implant Surface.*

I. INTRODUCTION

Use of dental implants has become a widespread and predictable treatment modality for the restoration of missing teeth and various edentulous cases (1). In compromised bone sites, the choice of implants with modified surfaces has directly influenced implant survival rates (2). Previous studies have shown that the bone quality is directly affected by the surface roughness of the implants. The development of new implant surfaces and techniques will consider reduction in the initial healing process (3). The implant variation of the technique is to reduce the function of osteointegration time, by altering the texture of titanium implant surface (4).

Dental implants are used for replacing the teeth in lost area (5). For the placement of screw- type implants, the healing time takes place at 3 to 4 months. In the posterior mandible and maxilla, the healing time of 5 to 6 months may take due to the more cancellous bone structure (6). According to Lekholm and Zarb classification, the bone for the implant placement in type 4, the healing time in the mandible increase from 1 or 2 months. The advances in materials and designs of dental implants, the treatment protocols for patients demand with very short recovery time and few surgical procedures needed (7).

The adequate primary stability of implant at the time of placement is the prerequisite for implant loading (8). The implant stability is defined as no mobility after placement and depends on mechanical involvement of implant in fresh bone socket; implant stability increases by new bone formation at the bone implant interface and its gradual remodelling over time (9). The factors affecting the primary stability of dental implants includes bone quality and quantity, morphology of implant, rough surface, surface topography and surgical technique (10,11).

Dental implant and surgical technique are the properties of secondary stability. At the time of implant loading, it can resist masticatory forces due to secondary stability. In many cases, the sites don't have the quality and quantity of bone. For the quality and quantity of bone, there is a need to induce bone regeneration around implants (12). The significance of stability in long-term success of dental implants in areas with low quality of bone to increase stability (13). The resonance frequency analysis is used to assess the primary stability for 10 years. It is used to monitor and follow up the implant stability (14). The aim of the study is to evaluate the implant surface or implant design affects the implant stability.

II. MATERIALS AND METHOD

A total of 60 articles were searched among those four articles are included in this study, and this systematic review was done using implant surface or implant design affects implant stability.

- *Eligibility Criteria:*

- *Inclusion Criteria:*
- ✓ Studies published in English

✓ Articles on the effect on implant surface or implant design
✓ Full text articles

- *Exclusion Criteria:*

✓ Only abstracts available
✓ Unrelated articles
✓ Animal studies
✓ Invitro studies
✓ Non-experimental study

➢ Search engines:
✓ PubMed
✓ Cochrane library
✓ Elsevier science direct
✓ Wiley online library
✓ Grey literature

After the search using the appropriate mesh terms, a total of 60 articles were found from the online databases. After duplicates removal of 30 articles were screened, and 15 full-text articles were available. Inclusion-exclusion criteria were applied, and finally, four related articles were selected for further assessment.

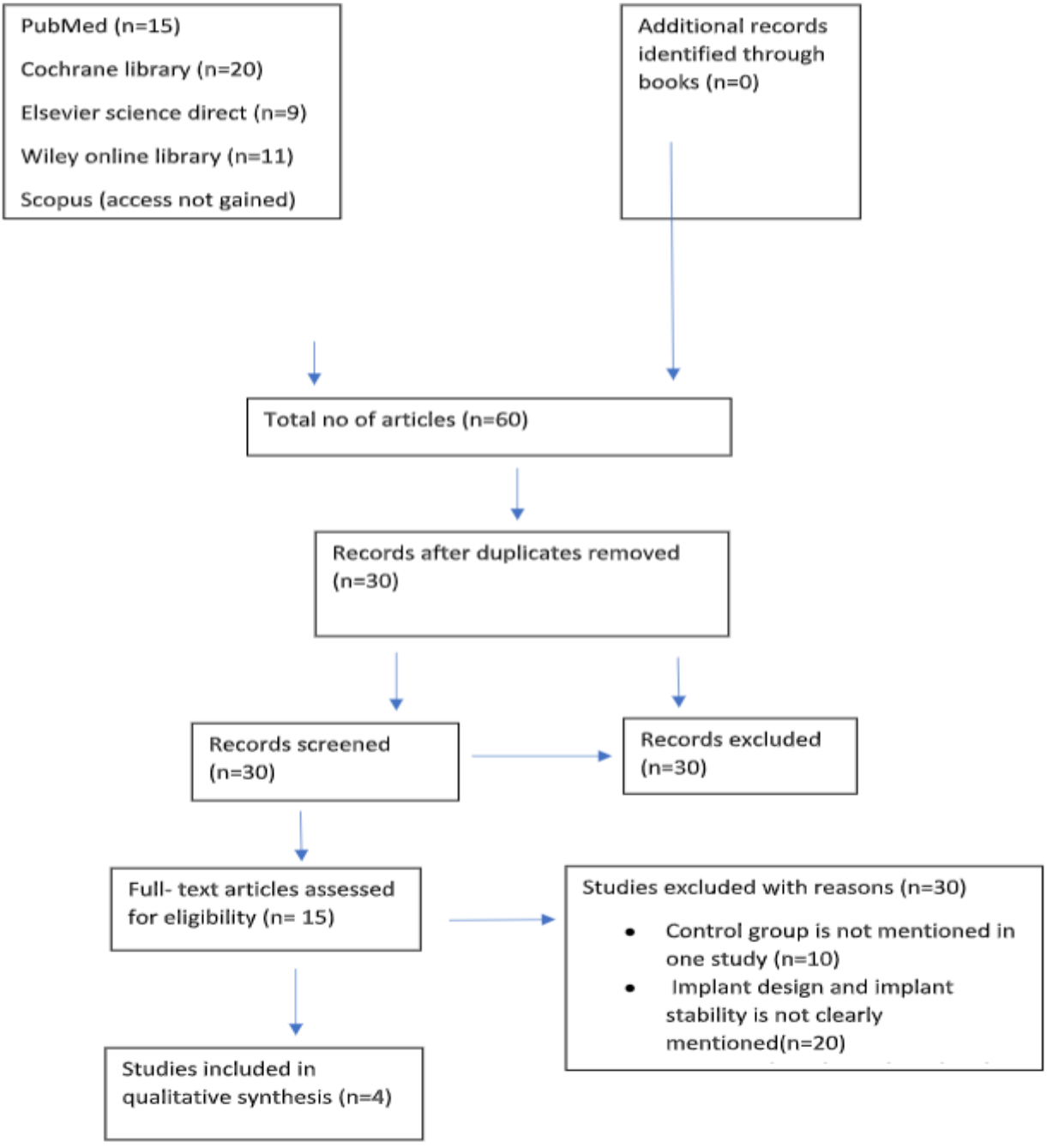

Fig 1 Flow diagram showing the number of studies identified, screened, assessed for eligibility, excluded, and included in the systematic

III. RESULTS

Table 1 Characteristics of the interventions in the included studies

AUTHOR & YEAR	NO. OF PATIENTS	NUMBER OF IMPLANTS	IMPLANT DIMENSION AND SURFACE OR DESIGN	REGION OF PLACEMENT	IMPLANT PLACEMENT	IMPLANT STABILITY
Clark M. Stanford et al 2016(15)	120	59	Diameter:3.6,4.2 and 4.8 mm Length:9,11and 13 mm Design: biomechanical	Premolar and molar region of both in maxilla and mandible	5 to 6 weeks	Osteotomy inserted at the apical portion of the implant to engage unprepared bone
Gerard Torroella-Saura et al 2014(16)	10	40	Diameter:3.75 and 4.2 mm Length:11.5 and 13 mm surface: rough surfaced microthread and sandblasted large-grid acid-etched surface.	Anterior region of the mandible	24 hours	Resonance frequency analysis
Jeffrey J. McCullough et al 2016(17)	7	4	Diameter:4 mm Length:10 mm surface: sand-blasted, large-grit, acid-etched surface	Posterior region	8 weeks	Resonance frequency analysis
Luiz Carlos do Carmo Filho et al 2018(18)	19	80	Diameter:4.0-4.1 mm Length:8.0-11.5mm surface: double acid-etching	Posterior region of mandible	12 weeks	Resonance frequency analysis

Table 1 shows the characteristics of the intervention in the included studies. In all above, the effect of implant surface or design affects implant stability was reviewed.

Table 2 Outcome data as reported in included studies

AUTHOR NAME	YEAR	STUDY DESIGN	OUTCOME	RESULT
Clark M. Stanford et al(15)	2016	Multicentre randomized controlled clinical trial	All implants are placed with a calibrated surgical handpiece fitted with a force feedback transducer and linked to a computer recorder for the insertion torque curve. Peak maximal ITVs are recorded up to a maximum of 45 Ncm for the test system and 35 Ncm for the predictor system.	The result shows the p value is p=.00 there is statistically significant difference between the peak value and ITVs
Gerard Torroella-Saura et al(16)	2014	randomized controlled clinical trial	The ITVs were evaluated by a surgical micromotor at the time of implant placement. The implant placement began with initial IT of 25 N/cm, and 5 N/cm was increased until the surgical micromotor stopped, thus obtaining the ultimate ITV	The result shows the p value is (P = 0.0210), there is statistically significant difference between the tapered implants presented higher primary stability than the cylindrical implants measured with the ITV
Jeffrey J. McCullough et al(17)	2016	randomized controlled clinical trial	The Smart Peg was inserted into the implant at 5 N/cm, and the ISQ measurements were taken. The peg was then removed, and the healing abutment replaced at 5 N/cm	The result shows p value is (p < 0.01) there is statistically significant between Primary nonparametric analysis of the mean ISQ values for the test and control implants across baseline and the four combined follow-up intervals indicated due to implant type
Luiz Carlos do Carmo Filho et al(18)	2018	randomized controlled split- mouth clinical study	The insertion torque (IT) values were determined as the maximum torque value (Ncm) reached at the end of the implant insertion.	The result shows p value is (p > 0.05) there is no significant differences was observed between the insertion torque values according to the implant type

Table 2 shows an outcome and result of the effect of implant surface or design affects implant stability in the above-mentioned studies.

Table 3 Bias analysis of included studies

AUTHOR NAME	YEAR	RANDOM SEQUENCE GENERATION	ALLOCATION CONCEALMENT	SELECTIVE REPORTING	INCOMPLETE OUTCOME DATA	BLINDING OF OUTCOME ASSESSMENT	BLINDING PARTICIPANTS AND PERSONALS
Clark M. Stanford et al(15)	2016	-	-	++	++	?	-
Gerard Torroella-Saura et al(16)	2014	++	-	-	-	-	-
Jeffrey J. McCullough et al(17)	2016	-	++	-	?	-	-
Luiz Carlos do Carmo Filho et al(18)	2018	-	-	-	-	?	-

Table 3 shows the bias analysis of all the included studies. It is categorized as high-risk bias "-", low risk bias "++" and unclear "?".

IV. DISSCUSSION

The purpose of this systematic review was to evaluate whether there was scientific evidence to support the association between different surgical techniques and primary and/or secondary implant stability. The surgical techniques that we found in the world literature evaluated by clinical studies whether they have influence on primary and/or secondary implant stability were the undersized drilling, the osteotome technique, the piezo surgery, the flapless, and the low-level laser therapy. Just three randomized controlled trials (RCTs) and five observational clinical studies were included. We selected only clinical studies that verified the association between the surgical techniques and implant stability. Laboratory or animal studies which did not report any clinical implant-related outcomes were not considered of interest since they would not be able to provide reliable clinical information for the prognosis of dental implant rehabilitation. Because only a limited number of studies investigated the influence of different surgical techniques on stability of dental implants, the pattern of the current literature review was customized to primarily summarize the pertinent information.

Clark M. Stanford et al 2016(15), implant placement is for 5 to 6 weeks, and implant stability is done by Osteotomy inserted at the apical portion of the implant to engage unprepared bone. The number of implants used is 59 and the region of implant placed at premolar and molar region of both in maxilla and mandible. It is multi centre randomized controlled clinical trial; the implant dimension of Diameter is 3.6,4.2 and 4.8 mm, Length is 9,11and 13 mm and the implant Design is biomechanical. The outcome of this study reveals that all implants are placed with a calibrated surgical handpiece fitted with a force feedback transducer and linked to a computer recorder for the insertion torque curve. Peak maximal ITVs are recorded up to a maximum of 45 Ncm for the test system and 35 Ncm for the predictor system. The result shows that the p value is p=.00 there is statistically significant difference between the peak value and ITVs.

Gerard Torroella-Saura et al 2014(16), implant placement is for 24 hours, and implant stability is done by Resonance frequency analysis. The number of implants used is 40 and the region of implant placed at anterior region of the mandible. It is randomized controlled clinical trial; the implant dimension of Diameter is 3.75 and 4.2 mm, Length is 11.5 and 13 mm and the implant surface are rough surfaced microthread and sandblasted large-grid acid-etched surface. The outcome of this study reveals that the ITVs were evaluated by a surgical micromotor at the time of implant placement. The implant placement began with initial IT of 25 N/cm, and 5 N/cm was increased until the surgical micromotor stopped, thus obtaining the ultimate ITV. The result shows the p value is (P = 0.0210), there is statistically significant difference between the tapered implants presented higher primary stability than the cylindrical implants measured with the ITV.

Jeffrey J. McCullough et al 2016(17), implant placement is for 8 weeks, and implant stability is done by Resonance frequency analysis. The number of implants used is 4 and the region of implant placed at posterior region. It is randomized controlled clinical trial; the implant dimension of Diameter is 4 mm; Length is 10 mm, and the implant surface are sand-blasted, large-grit, acid-etched surface. The outcome of this study reveals that sand-blasted, large-grit, acid-etched surface. The outcome of this study reveals that the Smart Peg was inserted into the implant at 5 N/cm, and the ISQ measurements were taken. The peg was then

removed, and the healing abutment replaced at 5 N/cm. The result shows p value is ($p < 0.01$) there is statistically significant between Primary nonparametric analysis of the mean ISQ values for the test and control implants across baseline and the four combined follow-up intervals indicated due to implant type.

Luiz Carlos do Carmo Filho et al 2018(18), implant placement is for 12 weeks, and implant stability is done by Resonance frequency analysis. The number of implants used is 80 and the region of implant placed at posterior region of mandible. It is randomized controlled split mouth clinical study; the implant dimension of Diameter is 4.0-4.1 mm; Length is 8.0-11.5mm, and the implant surface are double acid-etching. The outcome of this study reveals that the insertion torque (IT) values were determined as the maximum torque value reached at the end of the implant insertion. The result shows p value is ($p > 0.05$) there is no significant differences was observed between the insertion torque values according to the implant type.

❖ *Limitation of the Study*

Many articles were excluded due to limited accessibility. The other sources should also be considered to get more relevant outcome. Only limited number of studies available and need further studies for research.

V. CONCLUSION

The study concludes that there is less evidence of affecting implant stability of implant surface or design. It is also less evidence about the influence of undersized drilling technique on implant stability.

REFERENCES

[1]. P. I. Branemark, B. Svensson, and D. van Steenberghe. Tenyear survival rates of fixed prostheses on four or six implants ad modum Branemark in full edentulism. Clinical Oral Implants Research, 1995; 6(4): 227–231.

[2]. Naves MM, Menezes HH, Magalhaes D, Ferreira JA, Ribeiro SF, Mello JD, et al. Effect of microgeometry on the surface topography of dental implants. International Journal of Oral and Maxillofacial Implants. 2015; 30(4): 789-99.

[3]. Mustafa K, Wroblewski J, Hultenby K, Lopez BS, Arvidson K. Effects of titanium surfaces blasted with TiO2 particles on the initial attachment of cells derived from human mandibular bone. A scanning electron microscopic and histomorphometric analysis. Clinical Oral Implants Research, 2000; 11(2):116–128

[4]. Buser D, Schenk RK, Steinemann S, Fiorellini JP, Fox CH, Stich H. Influence of surface characteristics on bone integration of titanium implants. A histomorphometric study in miniature pigs. Journal of Biomedical Materials Research,1991; 25(7):889–902

[5]. Branemark PI, Svensson B, van Steenberghe D. Ten-year survival rates of fixed prostheses on four or six implants ad modum Brånemark in full edentulism. Clinical Oral Implants Research,1995; 6(4):227–231

[6]. Zarb GA. Clinical application of osseointegration. An introduction. Swedish Dental Journal Supplement, 1985; 28:7–9

[7]. Becker W. Immediate implant placement: diagnosis, treatment planning and treatment steps/or successful outcomes. Journal of the California Dental Association, 2005; 33(4):303–310

[8]. Elias CN, Rocha FA, Nascimento AL, Coelho PG. Influence of implant shape, surface morphology, surgical technique and bone quality on the primary stability of dental implants. Journal of the Mechanical Behavior Biomedical Materials,2012;16:169–180

[9]. Raghavendra S,Wood MC, Taylor TD. Early wound healing around endosseous implants: a review of the literature. The International Journal of Oral and Maxillofacial Implants,2005; 20(3):425–431

[10]. Javed F, Romanos GE. The role of primary stability for successful immediate loading of dental implants. A literature reviews. Journal of Dentistry,2010; 38(8):612–620

[11]. Marquezan M, Osório A, Sant'Anna E, Souza MM, Maia L. Does bone mineral density influence the primary stability of dental implants? A systematic review. Clinical Oral Implants Research,2012; 23(7):767–774

[12]. Atsumi M, Park SH, Wang HL. Methods used to assess implant stability: current status. The International Journal of Oral and Maxillofacial Implants,2007; 22(5):743–754

[13]. Agha-Hosseini F, Moslemi E, Mirzaii-Dizgah I (2012) Comparative evaluation of low-level laser and CO (2) laser in treatment of patients with oral lichen planus. International Journal of Oral and Maxillofacial Surgery, 2012; 41(10):1265–1269

[14]. Gomes FV, Mayer L, Massotti FP, Baraldi CE, Ponzoni D,Webber JB, de Oliveira MG. Low-level laser therapy improves peri- implant bone formation: resonance frequency, electron microscopy, and stereology findings in a rabbit model. International Journal of Oral and Maxillofacial Surgery,2015; 44(2):245–251

[15]. Clark M. Stanford. Chris Barwacz, Stephanie Raes, Hugo De Bruyn, Denis Cecchinato, Nurit Bittner, Jan Brandt. Multicenter Clinical Randomized controlled trial Evaluation of an implant system designed for enhanced primary stability. The international journal of oral and maxillofacial surgery, 2016; 31(4):906-915

[16]. Gerard Torroella-Saura Javier Mareque-Bueno Josep Cabratosa-Termes Federico Hern_andez-Alfaro Eduard Ferr_es-Padr_o Jos_e Luis Calvo-Guirado. Effect of implant design in immediate loading. A randomized, controlled,split-mouth, prospective clinical trial. Journal of clinical oral implants research, 2014:1-5

[17]. Jeffrey J. McCullough, Perry R. Klokkevold. The effect of implant macro-thread design on implant stability in the early post-operative period: a randomized, controlled pilot study. Journal of clinical oral implants research, 2016:1-9

[18]. Luiz Carlos do CARMO FILHO, Raissa Micaella MARCELLOMACHADO, Eduardo Dickie de CASTILHOS, Altair Antoninha DEL BEL CURY, Fernanda FAOT. Can implant surfaces affect implant stability during osseointegration? A randomized clinical trial. Research implantology,2018; 32: e 110-120.