

Intervention for replacing missing teeth: Different types of implants - evidence summary of updated Cochrane review

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Abstract

Around 1300 different types of dental implants are available worldwide and the implant manufacturers are resorting to aggressive marketing strategies; claiming their implants to provide a superior outcome. The clinician is left with a constant dilemma on which implant to choose for better clinical outcome and welfare of the patient. Moreover, in India, economical consideration is a concern too. The dentist has to select an implant that provides a good result and is economical. Cochrane systematic reviews provide the gold standard evidence for intervention, diagnosis, etc., and follow a strict quality control. A Cochrane systematic review was done to shed light on whether the different implant surface modifications, shapes or materials significantly influence clinical outcomes. All randomized controlled trials (RCTs) till January 17, 2014 were searched and out of the 81 trials, only 27 met the inclusion criteria. This evidence summary from the review concludes that based on the available literature; there is no evidence of any one type of implant being superior to another. There is weak evidence showing roughened dental implants are more prone to bone loss due to periimplantitis. This review indicated that there is a need for well-designed RCTs, with long-term follow-up and low bias. Moreover, none of the included studies was from India, which also points out the need for improving the quality of RCTs conducted in India.

Key Words: Cochrane database of systematic review, level of evidence, meta-analysis, prosthodontics, randomized controlled trial, systematic review

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INTRODUCTION

Cochrane database of systematic reviews, published by the Cochrane Library provides the gold standard evidence for intervention, diagnosis, etc., The standard of systematic review is maintained by uniform criteria of the research question, selection of studies, and data analysis including interpretation. After publishing in the database, each systematic review has

to be updated every 2 years to include studies if followed the inclusion and exclusion criteria.

Although the prevalence of tooth loss is decreasing,^[1,2] a large proportion of patients visiting the dentists consist of partially or completely edentulous patients. Osseointegrated dental implants have revolutionized the treatment of these

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patients. They can be used to treat a variety of patients ranging from single tooth loss to complete oral rehabilitation. Dental implants have shown promising success rate and have now become a routine treatment when dealing with the replacement of teeth. However, as the use of dental implants is increasing, so is the research. Around 1300^[3] different types of dental implants are available worldwide, with their manufacturers claiming their implants to be more successful than others. The clinicians are put in a perplexing situation to decide the ideal body shape of the implant, the ideal platform design, the ideal surface of the implant or the ideal material of the implant.

It is important for the clinician to understand the difference between the facts and the marketing gimmicks by various implant manufacturers. This updated Cochrane review^[4] presents evidence-based guidelines regarding different types of implants and their comparison in terms of various surface preparations, different shapes, and different materials. It attends to the question “whether the different surface modifications or coatings or different shapes of implants or different implant materials lead to better clinical outcomes?”^[4]

METHODOLOGY

The Cochrane handbook for systematic reviews of interventions is used as a guide to form the methodology of this review. Randomized controlled trials (RCTs) of the parallel group and split-mouth design in participants who received osseointegrated root form dental implants with at least 1-year of follow-up were included in this review. Comparison was done between identical implants placed following the same protocol, but differing only in terms of (1) surface modification or (2) implant shape or (3) implant material or (4) any combination of these. Nonrandomized/quasi-randomized trials were excluded. The primary outcome was described in terms of biological or mechanical failure, and the occurrence of periimplantitis was the secondary outcome.

Electronic search was conducted in the Cochrane Oral Health Group’s Trial Register, the Cochrane Central Register of Controlled Trials, MEDLINE through Ovid and EMBASE via Ovid; without any language filter, until January 17, 2014. A hand search of selected journals was also conducted. The titles and abstracts of the reports identified through electronic and hand search were scanned by two independent reviewers and full report to check if they met the inclusion criteria. Any disagreement was resolved by discussion and contacting a third reviewer. Data extraction forms were modified as needed and used to collect data. The risk of bias assessment was done using the recommended approach for Cochrane reviews. Risk ratio and 95% confidence interval (CI) were used to describe the

measurement of treatment effect for dichotomous data and mean difference along with 95% CI was used for continuous outcomes. Heterogeneity assessment and sensitivity analyses were performed as per the Cochrane handbook for systematic reviews of interventions.

Eighty-one trials were identified in the search; however, most of them were nonrandomized or quasi-randomized studies, and many studies had a short follow-up, or the data were presented in an unusable way. Twenty-seven RCTs with either parallel group design or split mouth design, which met the inclusion criteria, were included in the review [Tables 1 and 2].

Critical analysis of included trials

Critical analysis of the included trials revealed that most of the studies were at unclear risk of bias for allocation concealment and low-risk of bias for sequence generation while a considerable number of studies were at high-risk of bias for blinding. Meta-analysis was performed among studies of similar comparisons reporting the same outcome measures. However, a sensitivity analyses could not be performed due to the lack of a sufficient number of trials in the meta-analyses. The severity of the risk of bias on the final results could not be assessed due to the lack of sensitivity analyses.

SUMMARY OF FINDINGS

Based on the data from the included trials, this Cochrane review failed to show any superiority of a particular implant surface, shape or material over others in terms of implant failure and bone level changes. The review found 81 trials during the search but, only 27 fulfilled the inclusion criteria which clearly indicates a lack of properly designed and reported RCTs. Even after an extensive review and a meta-analysis, a definitive guideline on which implant system should be chosen by the clinician could not be established. Nonetheless, it did become clear from the review that clinical outcomes are not significantly altered by various modifications put forth by different manufacturers. However, a strong evidence to support this statement is still missing [Table 3]. The review did fulfill its secondary objective and found weak evidence that roughened dental implants are more susceptible to periimplantitis than turned implants [Tables 4 and 5].

Future implications and research

A very prominent fact that came to light in the review was that only one-third of the searched trials (27/81) met the inclusion criteria. Those that did meet the inclusion criteria were at unclear or high-risk of bias. The number of

Table 1: Available evidence from the included trials comparing implant surfaces and implant shapes

Study	Design	Implants compared	Prosthesis	Follow-up period	Outcome	Risk ratio	Finding
Trials comparing different implant surfaces*							
Froberg 2006	Randomized mouth study	Brånemark Mark III implants: Turned versus oxidized surface (TiUnite)	Screw retained cross arch fixed prosthesis	1.5 years	Implant failure (1-year)	-	No implant failures
Schincaglia 2007	Randomized mouth study	Brånemark Mark IV implants: Turned versus oxidized surface (TiUnite)	Immediately loaded, screw retained partially fixed prosthesis	3 years	Implant failure Bone level (1-year) Bone level (3 years)	RR=0.33 (0.82-7.32) P=0.49 MD=0.11 (-0.38-0.60) P=0.66 MD=-0.15 (-0.56-0.26) P=0.48	Turned=0/10 Oxidised=1/10 Turned=1.06±0.618 mm Oxidised=0.92±0.649 mm
Heberer 2011	Randomized split-mouth design	ITI regular neck: SLA standard versus SLActive surface	Early loaded at 6 weeks in mandibles and at 10 weeks in maxillas with 16 bar-supported overdentures and 4 fixed prostheses	14 months	Implant failure (1-year)	RR=5.00 (0.26-98.00) P=0.29	SLA standard=2/20 SLActive=0/20
Esposito 2012	Randomized parallel group study	MegaGen EZ Plus implants with blasted surface: Standard versus calcium-incorporated (Xpeed) surface	Early loaded screw-retained fixed prosthesis	1-year	Implant failure (1-year) Bone level (1-year)	MD=0.04 (-0.13-0.21) P=0.64	No failures Xpeed Mean=-0.58, SD=0.31, 30 participants Standard Mean=-0.62, SD=0.36, 30 participants No failures
Esposito 2013a	Randomized split-mouth design	SPI element implants with SLA surface: Standard versus SurfLink-modified surface	Conventionally loaded cemented single implant crowns	1-year	Implant failure (1-year) Bone level (1-year)	- SurfLink Mean=-1.09, SD=0.76, 21 participants Element Mean=-1.36, SD=0.86, 21 participants	MD=0.27 (-0.01-0.55) P=0.0.057 No failures
Trials comparing different implant shapes							
Lee 2007	Randomized split-mouth design	Astra cylindrical versus Astra conical implants	Placed adjacent to each other and restored as a 2 unit fixed prosthesis	3 years	Implant failure	-	No failures
Song 2009	Randomized split-mouth design	Implantium microthreads at the top versus Implantium microthreads 0.5 mm below the top	Implants were placed adjacent to each other restored as a 2 unit fixed prosthesis	1-year	Implant failure	-	No failures
Gatti 2002	Randomized parallel group study	Brånemark Mark II type versus Brånemark conical transmucosal implants	Overdentures supported on 4 implants connected with bar	2 years	Implant failure	-	No failures
Lang 2007	Randomized parallel group study	ITI cylindrical versus ITI tapered implants		1-year	Implant failure	-	No failures

Contd

Table 1: Contd....

Study	Design	Implants compared	Prosthesis	Follow-up period	Outcome	Risk ratio	Finding
Keilbassa 2009	Randomized, multicenter, parallel group study	NobelActive external connection versus NobelActive internal connection implants	Immediate provisional single crown restorations	3 years	Implant failure (1-year)	RR=1.06 (0.25-4.51) P=0.94	Internal=4/63 External=3/50
		NobelActive external connection versus NobelReplace implants	Immediate provisional single crown restorations	3 years	Implant failure (3 years) Bone level (1-year)	RR=0.66 (0.17-2.58) P=0.55 MD=0.30 (-0.17-0.77) P=0.21	Internal=3/41 External=5/45 Internal Mean=0.89, SD=1.36, 53 participants External Mean=0.59, SD=0.98, 44 participants
Keilbassa 2009	Randomized, multicenter, parallel group study	NobelActive external connection versus NobelReplace implants	Immediate provisional single crown restorations	3 years	Implant failure (1-year)	RR=0.67 (0.17-2.67) P=0.57	External=3/50 NobelReplace=5/56
		NobelActive internal connection versus NobelReplace implants	Immediate provisional single crown restorations	3 years	Implant failure (3 years) Bone level (1-year)	RR=1.00 (0.21-4.67) P=1.00 MD=0.00 (-0.41-0.41) P=1.00	External=3/41 NobelReplace=3/41 External Mean=0.59, SD=0.98, 44 participants NobelReplace Mean=0.59, SD=0.98, 44 participants
Keilbassa 2009	Randomized, multicenter, parallel group study	NobelActive internal connection Implants versus NobelReplace implants	Immediate provisional single crown restorations	3 years	Implant failure (1-year)	RR=0.90 (0.25-3.15) P=0.86	Internal=3/50 NobelReplace=5/56
		NobelActive internal connection Implants versus NobelReplace implants	Immediate provisional single crown restorations	3 years	Implant failure (3 years) Bone level (1-year)	RR=1.00 (0.21-4.67) P=1.00 MD=0.30 (-0.17-0.77) P=0.21	Internal=3/41 NobelReplace=3/41 Internal Mean=0.89, SD=1.36, 53 participants Noble replace Mean=0.59, SD=0.98, 44 participants
Pozzi 2014	Randomized, split mouth study	NobelActive internal connection versus Nobel Speedy Groovy external connection implants	Placed in healed sites loaded after 4 months of healing with single crowns	1-year	Bone level (1-year)	MD=-0.59 (-0.74-0.44) P<0.001	NobelActive Mean=0.51, SD=0.34, 34 participants Nobel Speedy Groovy Mean=1.10, SD=0.52, 34 participants
Prosper 2009	Randomized split mouth study	WINSIX cylindrical versus WINSIX tapered implants	Conventionally loaded single crowns	2 years	Implant failure	RR=2.00 (0.38-10.58) P=0.41	Cylindrical=4/66 Tapered=2/66

*Wennstrom 2004 was not included in the primary outcome measurement as the author did not reply when asked about the removal of the screw retained prosthesis before measuring implant stability.
SD: Standard deviation, RR: Relative risk, MD: Mean difference, SLA: Sand-blasted acid-etched

Table 2: Available evidence from trials comparing different implant materials and combination

Study	Design	Implants compared	Prosthesis	Follow-up period (years)	Outcome	Risk ratio	Finding
Trials comparing implants with different materials							
Al-nawas 2012	Randomized split-mouth study	ITA SLActive implants: Titanium grade 4 versus titanium-13zirconium (Roxolid) attachments	Overdentures on 2 implants connected with locator attachments	1	Implant failure	RR=2.00 (0.18-21.66) P=0.57	SLActive=2/89 Roxolid=1/89
Trials comparing implants with different surface preparation, shape or different materials							
Akoglu 2011	Randomized parallel group study	Astra TiO ₂ blast versus ITI SLA titanium implants	Overdentures on 2 implants connected with ball attachments	5	Implant failure	-	No failures
Trials comparing implants with different surface preparation, shape or different materials							
Alsaabeeha 2011	Randomized parallel group study	Astra TiO ₂ blast versus SwissPlus (Zimmer) cylindrical implants	Single crowns	1	Implant failure	RR=3.25 (0.15-72.36) P=0.46	Southern regular=1/11 Neoss=0/12
Trials comparing implants with different surface preparation, shape or different materials							
Astrand 1999	Randomized parallel group study	ITI SLA titanium implants versus SwissPlus (Zimmer) cylindrical implants	Fixed prostheses	5	Implant failure (1-year) Implant failure (3 years) Implant failure (5 years) Bone level (1-year)	RR=3.25 (0.15-0.76) P=0.46 RR=0.25 (0.03-2.12) P=0.20 RR=0.40 (0.08-1.92) P=0.25 RR=0.43 (0.09-2.04) P=0.28 MD=-0.09 (-0.33-0.15) P=0.47	Southern regular=1/11 Southern wide=0/12 Astra=1/33 Brånemark=4/33 Astra=2/33 Brånemark=5/33 Astra=2/31 Brånemark=5/33 Astra
Trials comparing implants with different surface preparation, shape or different materials							
Astrand 2002	Randomized split mouth study	Brånemark MKII versus ITI TPS solid screw implants	Maxillary fixed prosthesis	3	Implant failure	RR=0.05 (0.05-5.20) P=0.56	Mean=-0.17, SD=0.60, 32 participants Brånemark
Batenburg 1998	Randomized parallel group study	Brånemark MKII versus ITI TPS hollow screw implants	Overdentures on 2 implants retained with bar	10	Implant failure (1-year) Implant failure (3 years) Implant failure (5 years) Implant failure (10 years)	RR=2.90 (0.12-68.50) P=0.51 RR=2.90 (0.12-68.50) P=0.51 RR=2.71 (0.12-63.84) P=0.54 RR=8.40 (0.47-149.04) P=0.15	Mean=-0.17, SD=0.37, 33 participants Astra Mean=-0.23, SD=0.88, 32 participants Brånemark Mean=-0.17, SD=0.44, 33 participants Astra Mean=-0.23, SD=0.88, 31 participants Brånemark Mean=-0.17, SD=0.44, 33 participants Brånemark=1/28 ITI=2/28 IMZ=1/30 ITI=0/29 IMZ=1/30 ITI=0/29 IMZ=1/30 ITI=0/27 IMZ=4/29 ITI=0/27

Contd

Table 2: Contd...

Study	Design	Implants compared	Prosthesis	Follow-up period (years)	Outcome	Risk ratio	Finding
Crespi 2009	Randomized parallel group study	Ankylos Plus Dentsply versus Seven Sweden and Martina implants	Immediate postextractive and immediately loaded implants supporting single cemented crowns	1	Bone level (1-year)	MD=0.03 (-0.29-0.35) P=0.85	Internal Replace Mean=0.20, SD=0.58, 21 participants
Den Hartog 2011	Randomized parallel group study	NobelReplace Select Tapered versus NobelReplace Groovy implants	Single crowns	1.5	Implant failure	RR=3.00 (0.13-70.92) P=0.50	Mean=0.17, SD=0.54, 27 participants NobelReplace Select=1/31 NobelReplace Groovy=0/31
Heydenrijk 2002	Randomized parallel group	IMZ titanium TPS versus ITI TPS solid implants	Overdentures on 2 implants connected with a bar	5	Bone level	MD=0.29 (-0.06-0.64) P=0.11	Astra Mean=1.19, SD=0.82, 31 participants Brånemark Mean=0.9, SD=0.57, 31 participants RR=3.00 (0.13-69.52) P=0.49
Payne 2003	Randomized parallel group study	ITI SLA versus Southern implants	Overdentures on 2 implants early loaded at 2 weeks	10	Implant failure (10 years)	IMZ=1/20 ITI=0/20 IMZ=1/20 ITI=0/19 IMZ=1/19 ITI=0/18	RR=3.00 (0.13-69.52) P=0.49 RR=2.85 (0.12-65.74) P=0.51 No failure
Payne 2004	Randomized parallel group study	Brånemark MKIV TiUnite versus Southern regular implants	Maxillary overdentures on 3 unsplinted implants early loaded at 12 weeks	1	Bone change (10 years)	MD=-0.02 (-0.18-0.14) P=0.80	ITI TPS Mean=0.26, SD=0.23, 12 participants Southern
Tawse smith 2001, 2002	Randomized parallel group study	Southern regular versus SteriOss implants	Mandibular overdentures on 2 implants conventionally loaded at 12 weeks	10	Bone change (10 years)	MD=0.02 (-0.20-0.24) P=0.86	ITI TPS Mean=0.28, SD=0.15, 12 participants Southern
					Bone change (5 years)	MD=0.17 (-0.19-0.53) P=0.36	Mean=0.24, SD=0.18, 11 participants Mean=0.47, SD=0.46, 10 participants Southern
					Bone change (10 years)	MD=-0.08 (-0.60-0.44) P=0.76	Mean=0.30, SD=0.36, 10 participants ITI TPS Mean=0.33, SD=0.55, 9 participants Southern
					Implant failure (1-year)	RR=0.57 (0.20-1.63) P=0.30	Mean=0.41, SD=0.58, 9 participants Brånemark=4/19 Southern=7/19

SD: Standard deviation, RR: Relative risk, MD: Mean difference, TPS: Titanium plasma-sprayed, SLA: Sand-blasted acid-etched

Table 3: Summary of findings

Implant type A compared with implant type B for implant failure and bone loss

Patient or population: Adults with missing teeth

Settings: Dental clinics

Intervention: Implant A

Comparison: Implant B

Outcomes	Illustrative comparative risk (95% CI)		Relative effect (95% CI)	Number of participants (studies)	Quality of the evidence (grade)	Comments
	Assumed risk	Corresponding risk				
	Implant A	Implant B				
Implant failure	-	-	See comments	-	-	There were numerous comparisons between different implants that varied by surface preparation, shape, material, and type, only one of these varying for each comparison. Most of the comparisons were single studies. There were no statistically significant differences for implant failure
Bone level change	-	-	See comments			There were numerous comparisons between different implants that varied by surface preparation, shape, material, and type, only one of these varying for each comparison. Most of the comparisons were single study. There was only one statistically significant difference for bone level change from 1 single study, which indicated more bone loss for Nobel Active than Nobel Speedy Groovy (MD=0.59 mm; 95% CI=0.44-0.74)

The corresponding risk (and its 95% CI) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).
CI: Confidence interval, MD: Mean difference

Table 4: Turned implants compared with roughened implants

Patient or population: Adults with missing teeth

Settings: Dental clinics

Intervention: Turned implants

Comparison: Roughened implant

Outcomes	Illustrative comparative risks (95% CI)		Relative effect	Number of participants (studies)	Quality of evidence (grade)	Comments
	Assumed risk	Corresponding risk				
	Roughened implants	Turned Implants				
Early implant failure	50/100	140/1000	RR=2.79 (0.87-8.90)	285 (6)	Low	-
Periimplantitis	50/100	40/1000	RR=0.80 (0.67-0.96)	144 (4)	Low	-

The corresponding risk (and its 95% CI) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).
CI: Confidence interval, RR: Risk ratio

Table 5: Turned implants compared with roughened implants-individual data

Comparison	Outcome	Data	Effect estimate (95% CI)
			P
Turned versus roughened surfaces 3 parallel group and 2 split-mouth	Implants affected by periimplantitis (3 years)	4 trials	Pooled RR=0.80 (0.67-0.96) P=0.01
	Implants affected by periimplantitis (5 years)	Turned=0/33 Roughened=1/31	RR=0.31 (0.01-7.42) P=0.47
	Implants affected by periimplantitis (10 years)	Turned=0/27 Roughened=3/29	RR=0.15 (0.01-2.83) P=0.21

CI: Confidence interval, RR: Risk ratio

studies included in the meta-analysis was too low to carry out sensitivity analyses which could have been significant. Moreover, the included studies were from European, Australian and, East-Asian countries; while none was an Indian study. Many of the different implant systems that formed the intervention group in these studies are not even available in India; while those that are available and commonly used in India were not presented in the review. This clearly indicates the need for properly designed RCTs

with adequate sample size, a follow-up period of at least 5 years and a low-risk of bias; that are reported according to the consolidated standards of reporting trials guidelines.

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Conflicts of interest

There are no conflicts of interest.

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