



Original Research Article

Stereognostic assessment in natural teeth and dental implants – A comparative study

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ABSTRACT

Background: Proprioception should be an important consideration in occlusal contact designs for implant-supported prosthesis, because overstressing the implants may result in implant failures. The purpose of this study was to explore the difference in the proprioception between the natural teeth and osseointegrated dental implants, as a highly tactile sensitive implant can decrease the rate of overloading the remaining teeth and implants. Active tactile sensibility (ATS) test was used in our study as it effectively represents normal function and more useful in practical dentistry.

Materials and Methods: The ATS of single tooth implants - contralateral teeth and between natural - natural tooth, was measured in 25 patients after they bit on standardized aluminium foils of 10µm – 1mm thick, each for five times, in a random order blinded to patient and assessor, carried out at two sessions. ATS data was analyzed using paired and unpaired t – test and repeated measure of ANOVA.

Results: The mean time taken to detect aluminium foil was more in cases (23.67sec) as compared to controls (14.42sec) and this difference was also statistically significant. Also the time taken to detect different thickness of aluminium foil decreases with increasing thickness. The result of the study showed that there was a statistically significant difference ($p < 0.001$) between the control and the case groups, when the ATS test was conducted

Conclusion: There was a significant difference between that the implant and natural tooth proprioception. Therefore while designing the prosthesis stress distribution must be considered as an important factor so to avoid implant failures due to overloading.

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1. Introduction

The Dental implant therapy has become a popular method of replacing one or more missing teeth. To ensure a long term function, it is important that implant prosthesis harmonize functionally and biologically with the stomatognathic system.¹ In dentate individuals the process of perception as it relates to oral function involves the sensory innervation of the periodontal ligament, the epithelial surfaces of the oral cavity, the muscles of the tongue, the muscles of mastication, and the temporomandibular joints.² A defect or nonintegration of the proprioceptive or perceptive input

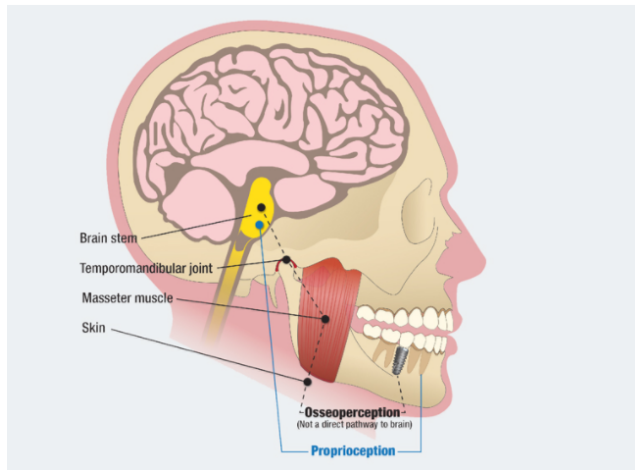
may result in poor function or pathologic changes to parts of the system.³

So the success/failure of any prosthodontic restoration depends on the integration of proper proprioceptive feed back and motor responses. The osseointegrated dental implants lack periodontal ligament while on the other hand natural teeth have PDL which is extremely sensitive tactile sensation. Implant sensation should be an important consideration in occlusal contact designs for implant-supported prostheses, because overstressing the implants may result in implant failures, according to several studies implant overload is the third most common cause of implant failure following infections and impaired wound healing.⁴

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This study is done to find a basic and reliable chairside test to evaluate the proprioception and thus planning an appropriate design of the prosthesis, thereby reducing the chances of overloading.



2. Materials and Methods

A comparative study was designed and it was conducted on both male & female subjects meeting the inclusion and exclusion criteria, reporting to the Department of Periodontics, V.S Dental College and Hospital, Bangalore. The participation was voluntary. Verbal and written informed consent was obtained from those who agreed to participate.

Twenty five subjects fulfilling the inclusion criteria, with single tooth implants with natural opposing teeth (case) and the corresponding natural contralateral teeth (control) with natural opposing teeth were included in this clinical split mouth comparative study.

2.1. Inclusion criteria

Patient who were in the age range of 18-60 years of either gender i.e. male or female who were apparently clinically healthy and with implants supported prosthesis in posterior region of maxilla and mandible.

2.2. Exclusion criteria

Patients with uncontrolled diabetes, immunologic disorders, hepatitis, HIV infection or with any other debilitating disease, failing implants, smokers, periapical lesions and without proper interocclusal contacts.

The method of constant stimuli was used to determine the active tactile sensitivity (ATS).⁵ In this procedure, the subjects compared the various thickness of the standardized foils and the time taken was evaluated for each foil thickness of 10um,20um,40um,1mm were used. Judgments were made to assess whether the test foils were present or absent

and thicker or thinner. Each foil was compared to several thinner or thicker foils which were randomly placed. The patients and the clinician were blind folded regarding the foil thickness. The subjects were asked to occlude his/her teeth to find the presence of the foil and the time taken to discriminate various thicknesses of the foil were noted. At least 2 readings for the same thickness of foils in a random order was performed for each patient in two sessions.

2.3. Statistical analysis

Statistical Software Package SPSS version 22 (IBM SPSS Statistics for Windows, Version 2.0, IBM Corp., released in 2013) was used to perform statistical analyses.

Descriptive Statistics: Descriptive analysis of all study parameters was done using Mean, SD & Range.

Inferential Statistics: Chi Square test was used to compare the presence of proprioception for different aluminium foil thickness by case & control sites. Student paired t test was used to compare the mean time taken (in secs) to detect different thickness of Aluminium foil by case & control sites. Repeated measures of ANOVA was used to compare the mean time taken (in secs) to detect the different thickness of aluminium foil within case as well as control sites. The level of significance [P-Value] was set at $P < 0.05$

3. Results

It was observed that more controls than cases could proprioceptively detect 10 μm aluminium foil, only 24% of the case group were able to detect the 10um foil and this difference was found to be statistically significant ($p \text{ value} \leq 0.05$). Detection of 20um foil was made by 76% of the cases. While all the subjects in control group could detect 10um, 20um, 40um and 1mm and in cases 40um and 1mm were detected by all the participants.

The mean time taken to detect 10um aluminium foil was more in cases (23.67sec) as compared to controls (14.42sec) and this difference was also statistically significant. Also the time taken to detect different thickness of aluminium foil decreases with increasing thickness in case group. This difference was found to be statistically significant. ($p \text{ value} \leq 0.05$). The mean time taken to detect 10um to 1mm foil varies from 23.67sec to 2.76sec which was

4. Discussion

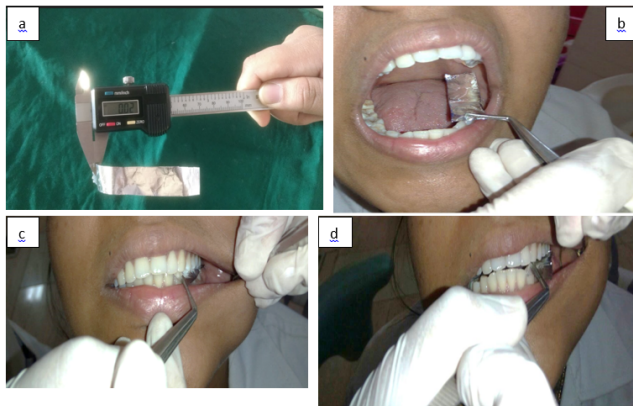
The periodontal ligament of natural teeth provides the central nerve system with feedback for sensory perception and motor control. Conversely, the lack of such proprioception causes lower tactile sensitivity and less coordinated masticatory muscle activity in implant-borne restorations and makes them more prone to occlusal overload and possible subsequent failure.⁵ The success or failure of a prosthodontic restoration or replacement is also dependent upon the integration of proper pro-prioception

Table 1: Comparison of the presence of proprioception for different aluminium foil thickness by case & control sites using Chi Square test

Thickness	Proprioception	Case		Control		χ^2 value	P-Value
		n	%	n	%		
10 \square m	Present	6	24%	25	100%	30.645	<0.001*
	Absent	19	76%	0	0%		
20 \square m	Present	25	100%	25	100%
	Absent	0	0%	0	0%		
40 \square m	Present	19	76%	25	100%	6.818	0.009*
	Absent	6	24%	0	0%		
1mm	Present	25	100%	25	100%
	Absent	0	0%	0	0%		

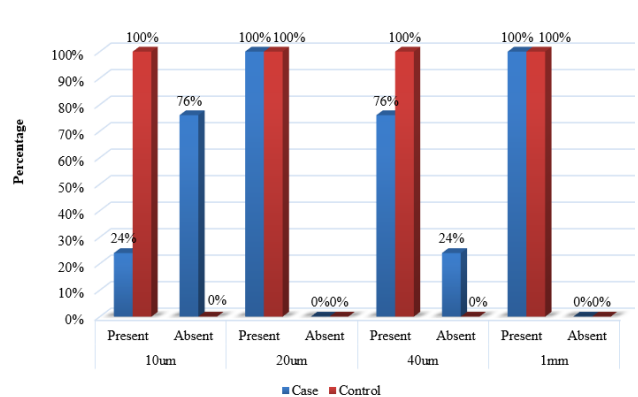
Table 2: Comparison of mean time taken (in secs) to detect different thickness of Aluminium foil by case & control sites using Student paired t test

Thickness	Tooth	N	Mean	SD	S.E.M	Mean Diff	t	P-Value
10 \square m	Case	6	23.67	2.80	1.15	9.25	4.007	0.01*
	Control	6	14.42	4.78	1.95			
20 \square m	Case	25	21.92	1.94	0.39	11.42	18.907	<0.001*
	Control	25	10.50	2.24	0.45			
40 \square m	Case	25	17.28	5.65	1.13	8.00	8.251	<0.001*
	Control	25	9.28	3.57	0.71			
1mm	Case	25	2.76	0.78	0.16	1.16	6.820	<0.001*
	Control	25	1.60	0.50	0.10			

**Fig. 1:** a): Standardization of the foil with digital vernier; b): Insertion of the standardized foil at the intraoral site with the help of tweezers; C): Patient occluding on the standardized foil; d): Final occlusion and lateral movements made while the foil is still there in occlusion

feedback and motor responses.

Schulte w et al⁶ suggested that the touch sensitivity of natural teeth are at lower biting and chewing loads, that is in the phase of natural tooth mobility, during which only the soft parts of the periodontium are deformed, cannot be substituted by ankyrotic retained implants. Thus proprioception measurement is very important factor that should be considered.

**Fig. 2:** Comparison of presence of different aluminium foil thickness by case and control sites

Thiel tested 150 subjects and found that the sensory threshold was between 20 and 100 μ m when using thin pieces of platinum foil. Similar results were found by Hollstein, Tryde, Frydenberg, and Brill who used silver strips in thicknesses ranging from 0.1 mm. to 0.01 mm. The results showed 50 per cent sensitivity thresholds ranging from less than 0.01 mm. to 0.035 mm.

Shiila and Laine tested 36 patients to find the smallest thickness which could be detected between natural dentitions in the incisal and molar areas. They found that one third of the subjects were aware of the presence of foil 8 and 10 μ m thick, which was similar to our study as all the

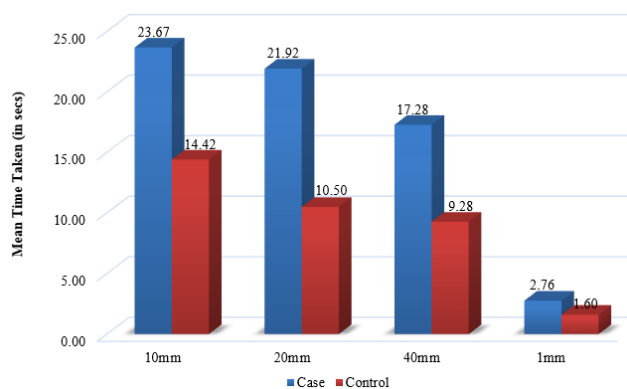


Fig. 3: Comparison of mean time taken (in secs) to detect different thickness of Aluminium foil by case and control

subjects in control group were able to discriminate 10um foil thickness.

In our study, among the test group with 10um foil, only 24% of the participants were able to distinguish the presence of the foil. Thus it was observed that the 10um thickness of foil is difficult to distinguish by implant supported teeth. There was a gradual increase in perception of the foils with the increase in the thickness. It was observed that 1mm foil was discriminated by 100% of the study population. Similarly the time taken in the test group varied from 23.67sec to 2.26sec and in the control group varied from 14.42sec to 1.60sec, when the foil thickness varies from 10um to 1mm. A mean time of 23.67 sec was observed with 10um foil, while only 2.33 sec was noted in 1mm foil in cases. It was observed that the cases took almost double the time than control to detect the foil thickness. In studies done by Grieznis L et al in 29 patients using a computer-controlled custom-made pressure sensitive device. The differences in mean values for osseointegrated dental implants and for natural teeth were statistically significant ($p < 0.001$) and it was concluded that the implants threshold levels were about 3.8 times higher than those of natural teeth.¹

Other studies were done to evaluate proprioception with different set ups like Kazemi M et al, in a split mouth double blinded RCT in 25 patients, the ATS(active tactile sensibility) was measured after the patients bit on gold and placebo foils 0- to 70-mm thick and it was concluded that there was a slight(1.3times higher threshold of implants) but statistically significant difference between implant and tooth tactile sensitivity.⁷ Enkling N et al in their computer-assisted and randomized way study used copper foils of varying thickness (0–100 mm) which were placed interocclusally and reported that the implant threshold was about 1.2 times higher than that of natural teeth.⁵ In a study done by Hämmerle CH et al in 24 subject, a strain gauge attached to the shaft of amalgam plugger was used as a force sensor and it was concluded that more than 8 fold higher

threshold value of for tactile perception exists for implants than natural teeth.⁸

5. Conclusion

Implant sensation should be an important consideration in occlusal contact designs for implant-supported prostheses, because overstressing the implants may result in implant failures. The foil tests performed in the present study can be used as a chairside diagnostic tool for evaluation of proprioception as it is economical and convenient, though further studies are required with large participation groups to know the sensitivity and specificity of the same.

6. Conflicts of Interest

All contributing authors declare no conflicts of interest.

7. Source of Funding

None.

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