

Assessment of Incidence, Causes and Types of Removable Denture Fractures: A Cross-sectional Clinical Survey from Northern Karnataka, India

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ABSTRACT

Introduction: Removable dentures are subjected to fracture due to many causes and reasons. Due to sudden fracture of denture, the individual's social and mental well-being is affected. As Prosthodontists, we must investigate and solve the problems pertaining to removable dentures.

Aim: To investigate the incidence, causes and types of removable denture fractures and to determine the association between different variables and fractured removable dentures.

Materials and Methods: A cross-sectional clinical survey was carried out in Department of Prosthodontics in PMNM Dental College and Hospital, Bagalkot, North Karnataka, India. A total of 214 adult patients within the age group of 25-80 years were included in the study and assessed over a period from August 2018 to February 2020, by four clinicians with the help of questionnaire. Ten parameters namely gender, age of wearer, type of denture, Kennedy's classification, age of denture, cause of fracture, type of fracture, number of previous fracture, retention and type of antagonist were evaluated. The participants responded to all the questions and the data obtained was organised in a tabular form and statistically analysed by Chi-square test.

Results: Amongst a total of 214 adult patients (142 males and 72 females), the results showed that the incidence of removable denture fracture was seen higher in male patients (66.36%) than in female patients (33.64%). Age group greater than 60 years showed higher incidence 108 (50.47%) of denture fractures. The lower complete dentures were the most commonly fractured removable dentures 96 (44.86%). Acrylic denture base resin fracture was most frequent denture fracture type 144 (67.29%). Fractures for the first time were higher in number compared to previous 1, 2 or 3 fractures. Higher incidence of fracture was seen in poorly retained dentures 111 (51.87%) and in dentures with complete denture as antagonist 163 (76.17%). The variables like gender of wearer (p-value=0.001), age of wearer (p-value=0.014), age of denture (p-value=0.019), retention quality of denture (p-value=0.017) and type of antagonist (p-value=0.001) showed a statistically significant relation with denture fracture.

Conclusion: Improvement in the processing techniques and type of resin used along with innovative methods of increasing the fracture toughness of removable dentures is of great importance to reduce the incidence of denture fracture.

Keywords: Acrylic resin, Denture repair, Flexural fatigue, Impact

INTRODUCTION

The mental and social well-being of an individual is negatively influenced by teeth loss. Successful restoration with artificial substitutes such as dentures can be done with plenty of contemporary and conventional treatment planning [1]. Though fixed substitutes are desirable, removable partial denture is the treatment of choice in patients with less number of teeth or several edentulous areas, in patients with serious periodontal problems and extreme alveolar bone loss. Often removable complete denture is indicated instead of implant supported fixed complete denture because of predictable injury to maxillary sinuses, nerves, and vessels; in patients where surgery is contraindicated due to medically compromised condition and due to financial constraints of the patient. Dentures are considered to be a treatment modality since many years. Through the years improving the quality of the denture materials to meet the patients' demand for better aesthetics, function and comfort; is always under research process [1].

Wood, ivory, bone, precious and semi-precious metals and alloys, porcelain and vulcanite rubber were used as artificial teeth and denture base materials in earlier days [1]. Heat cure acrylic resin polymethyl methacrylate, which came in the market in 1950s, is now universally used for the fabrication of dentures because of its combination of various desirable properties [2]. The mechanical

requirements of a prosthetic appliance are not satisfied despite its better aesthetic qualities. Unexpected fracture of the denture causes a set back in the daily routine of the denture wearer [2].

Flexural fatigue and impact force are the causes of fractures in removable dentures. Repetitive flexing of a material with small loads over a period of time results in flexural fatigue. Stress cycles due to chewing, thermal change and acidity due to certain foods gradually lead to wear of the denture developing minute gaps in areas where stress is more concentrated like large frenal notch and thin flanges [3,4]. With repeated small loads, the smaller cracks merge to form a larger fissure that reduces the material strength. The failure or fracture results from an ultimate loading cycle that surpasses the mechanical capability of the remaining intact portion of the material [5]. Midline fracture is caused by flexural fatigue. Denture fracture due to sudden blow to the denture or accidental dropping of the denture to the hard ground due to patient's negligence during insertion, removal and cleaning is considered as impact failure. Most frequent cause of maxillary denture fractures was ill fit of the dentures while mandibular denture fractures mostly occurred due to accidental dropping [6-8].

Various studies [7,9-16] were conducted related to incidence, types, causes, frequency of removable dentures. Till date no such study is conducted in the North Karnataka region of India.

So, this study was conducted to investigate the incidence, causes and types of removable denture fractures and to determine the statistical relationship between different variables and fractured removable dentures in North Karnataka region, India. This might help to improve the process of fabrication of dentures. Advanced materials and techniques for processing and maintenance can be incorporated for increasing the fracture resistance.

MATERIALS AND METHODS

A cross-sectional study was conducted in the Department of Prosthodontics and Crown and Bridge in P.M. Nadagouda Memorial Dental College and Hospital, Bagalkot, Karnataka, India over a period of one year and six months, initiated in August 2018 and completed in February 2020. Information about the purpose and procedure of the study was explained to the patients in local language and informed consent of the patient, in English and Kannada, was obtained for willingness to contribute in the study. Approval was taken from the Institutional Ethical Committee of PMNM Dental College and Hospital, Bagalkot, Karnataka, India.

Inclusion criteria: Dentures fabricated with Polymethyl methacrylate resin only and patients without history of neuromuscular disorders were included.

Exclusion criteria: Dentures fabricated with reinforcements like fibres and metal mesh or wires, use of soft liners and patients with habitual eccentric movements and bruxism were excluded from the study.

Study Procedure

A modified questionnaire consisting of 10 different variables was designed as per the study done by El-Sheikh AM and Al-Zahrani SB [9]. One variable, that is, strengthener (metal wire) was removed from the original questionnaire because any form of denture reinforcements were excluded from this study. Four clinicians recorded the responses of 214 patients who reported for repair of fractured removable dentures during the period of one year and six months. The patients were grouped according to age as less than 30 years, 30-60 years and more than 60 years. The clinician asked the patient his/her name, age, cause of fracture, age of denture, any previous fractures and then checked the denture visually for type of fracture, type of antagonist within approximately half hour. The retention of the dentures was evaluated by using subjective method with clinical scoring system as suggested by Kapur KK [17]. The types of dentures evaluated were categorised into Upper Acrylic Complete Denture, (UCD) Lower Acrylic Complete Denture (LCD), Upper Acrylic Partial Denture (UPD) and Lower Acrylic Partial Denture (LPD). The partial dentures were classified according to Kennedy's classification as Class I, II, III and IV [18].

STATISTICAL ANALYSIS

Statistical analysis was done with International Business Management (IBM) Statistical Package for Social Sciences (SPSS) version 25.0. To determine the statistical relationship between the selected variables and fractured dentures, Chi-square test was implemented. Gender of the wearer, age of the wearer, type of denture, Kennedy classification, age of denture, cause of fracture, number of previous fracture, retention and type of antagonist were the independent variables; whereas type of fracture was dependent variable. When probability was less than 0.05, the result was considered statistically significant.

RESULTS

The frequency of denture fracture was higher in male denture wearers (66.36%) than female denture wearers (33.64%). The most common type of denture fracture was seen in LCD (44.86%) followed by UCD (36.92%), UPD (9.81%) and the least in LPD (8.41%). When removable partial dentures were considered, then Kennedy's class I partial denture showed higher incidence of denture fracture (38.46%)

followed by Kennedy's class IV (33.34%), Kennedy's class III (15.38%) and least is Kennedy's class II (12.82%) classification [Table/Fig-1]. The Chi-square test showed a statistical significant relationship between fractured dentures and gender ($p < 0.05$) [Table/Fig-2].

Sl. No.	Variable	Cases (n)	Percentage (%)
1.	Gender of the wearer		
	Male	142	66.36
	Female	72	33.64
2.	Age of wearer		
	<30 years	3	1.40
	30-60 years	103	48.13
	>60 years	108	50.47
3.	Type of denture		
	Upper Acrylic Complete Denture (UCD)	79	36.92
	Lower Acrylic Complete Denture (LCD)	96	44.86
	Upper Acrylic Partial Denture (UPD)	21	9.81
	Lower Acrylic Partial Denture (LPD)	18	8.41
4.	Kennedy classification (Partial dentures) (n=39)		
	Class I	15	38.46
	Class II	5	12.82
	Class III	6	15.38
	Class IV	13	33.34
5.	Age of denture		
	<1 year	11	5.14
	1-3 years	84	39.25
	>3 years	119	55.61
6.	Cause of fracture		
	Trauma	14	6.54
	Impact/Accidental dropping	162	75.70
	Mastication	38	17.76
7.	Type of fracture		
	Hairline	26	12.15
	Breakage in acrylic base	144	67.29
	Loosening of teeth	41	19.16
	Damaged clasp	3	1.40
8.	No. of previous fracture		
	0	148	69.16
	1	53	24.77
	2	10	4.67
	3	3	1.40
9.	Retention quality of the denture		
	Poor	111	51.87
	Moderate	81	37.85
	Good	22	10.28
10.	Type of antagonist		
	Natural teeth/fixed prosthesis	48	22.43
	Complete denture	163	76.17
	Partial denture	3	1.40

[Table/Fig-1]: Incidence of fractures in relation to different variables (Total=214).

DISCUSSION

In the present study, the incidence of fractured dentures was significantly higher (p -value < 0.05) in males than in females. This result was in agreement with the study conducted by El-Sheikh AM and Al-Zahrani SB and Puranik S et al., where it was noted that the incidence of fractured dentures in males was higher than in females, that is, 65.2% vs 34.8% and 60% vs 40%, respectively [9,19]. This may be attributed to the fact that even though the electromyographic activity levels of men and women were alike, men had considerably

Sl. No.	Variables		Fractured denture					p-value
			UCD	LCD	UPD	LPD	Total	
1.	Gender of wearer	Male	59	63	15	5	142	0.001
		Female	20	33	6	13	72	
2.	Age of wearer	<30 years	1	0	1	1	3	0.014
		30-60 years	31	46	12	14	103	
		>60 years	47	50	8	3	108	
3.	Type of denture		79	96	21	18		0.294
4.	Kennedy classification (Partial denture)	Class I	-	-	9	6	15	0.211
		Class II			1	4	5	
		Class III			4	2	6	
		Class IV			7	6	13	
5.	Age of denture	<1 year	7	2	1	1	11	0.019
		1-3 years	28	32	14	10	84	
		>3 years	44	62	6	7	119	
6.	Cause of fracture	Trauma	4	6	1	3	14	0.504
		Impact/Accidental dropping	60	74	18	10	162	
		Mastication	15	16	2	5	38	
7.	Type of fracture	Hairline	16	4	4	2	26	0.058
		Breakage in acrylic base	43	74	13	14	144	
		Loosening of teeth	20	18	3	0	41	
		Damaged clasp	0	0	1	2	3	
8.	No. of previous fractures	0	49	68	15	16	148	0.294
		1	21	26	3	2	53	
		2	7	3	0	0	10	
		3	2	1	0	0	3	
9.	Retention	Poor	43	45	12	11	111	0.017
		Moderate	29	41	7	4	81	
		Good	7	10	2	3	22	
10.	Type of antagonist	Natural teeth/FPD	18	2	16	12	48	0.001
		Complete denture	61	94	3	5	163	
		Partial denture	0	0	2	1	3	

[Table/Fig-2]: Number of types of fractured dentures by different variables and their significance. p-value determined by the Chi-square test. N=214; UCD: Upper acrylic Complete Denture; LCD: Lower acrylic Complete Denture; UPD: Upper acrylic Partial Denture; LPD: Lower acrylic Partial Denture

more masticatory force and smaller chewing cycles with faster velocities compared to women [20].

The Chi-square test indicated statistically significant relationship with fractured dentures and age of the wearer (p-value <0.05). This finding was in agreement with previous studies done by Singh RK et al., and Bosanceanu DN et al., [7,10]. This may be attributed to accidental falling of dentures due to lack of attention and dexterity in elder people. Also, due to resorbed alveolar ridges and sometimes due to decreased neuromuscular control in the elderly, retention of the dentures is compromised leading to fractures. Denture fracture in middle age group might be due to heavy occlusal contacts, faulty teeth setting outside the ridge, internal defects in denture base like porosities, microscopic cavities, notches, grazes and abrasions which lead to residual stresses and ultimately to denture fracture.

The Chi-square test showed statistically non significant relation between fractured dentures and type of dentures (p=0.294). Bosanceanu DN et al., in their study report that accidental dropping is the most common cause for mandibular denture fracture, followed by instability of the lower denture [10]. The accountable reason might be minimal surface area and less thickness in the central part of the lower complete denture. This is also in accordance to the study conducted by Naik AV where in 1:3 was frequency of fracture of upper denture to lower denture [6]. There are also studies conducted by Singh RK et al., and Prombonas AE and Vlissidis DS concluding that maxillary complete dentures are more prone to fracture than mandibular dentures [7,11]. Darbar UR et al., reported

that fractures in midline were more frequent in upper complete dentures (29%) and the rest 38% were different types like repair to upper partial dentures, separation of acrylic resin from metal-based dentures and failure or breakage of connectors in all acrylic resin partial dentures [12].

The Chi-square test showed statistically non significant relation between fractured dentures and Kennedy's classification of partial dentures (p=0.211). Kennedy's Class I refers to bilateral edentulous area posterior to remaining natural teeth. This denture is tooth and tissue supported and has to withstand vertical, horizontal and torsional forces [17]. A study conducted by Jorge JH et. al., concluded that incidence of failure amongst different types of removable partial dentures was not significant [21].

The Chi-square test presented statistically significant association with fractured dentures and age of dentures (p=0.019). Hargreaves AS in his study has pointed out that after two to three years of use; dentures are more likely to fracture [13]. He further stated that though the physical properties of the acrylic do not wane over time, stresses may get induced in the denture after prolong use and may weaken the denture material and accelerate fracture. Vermeulen AH et al., have reported fracture frequency after five years and 10 years as 17% and 35% respectively, showing a definite increase in percentage after prolong use [22].

The Chi-square test showed statistically non-significant relation between fractured denture and cause of denture (p=0.504). The present study is in agreement with study conducted by Iqtidar Z

et al., where they had concluded that the most prevalent cause for denture fracture is impact failure subsequently followed by mastication and trauma [23]. Lambrecht JR and Kydd WL have also reported the major cause of denture fracture as impact failure [14]. Naik AV concluded that, the most prevalent cause for lower denture fracture was unintended dropping of the denture while cleaning, insertion and removal [6]. The accountable reason is that majority of denture wearers are elderly individuals in whom adaptation to new neuromuscular abilities is difficult. Elderly patients might have neuromuscular deficits which make it difficult for them to learn to adapt to new dentures especially mandibular denture [10,13]. Load required to cause denture fracture ranges from 180-800 lb, which is more than the functional capacity of the denture wearer; hence denture fracture in only one single bite is impracticable [15]. Hence, succession of recurrent small loads during mastication leads to fatigue failure and ultimately denture fracture. Vallittu PK conducted a study with seven dentures fractured in two pieces [24]. All fractures except one were mid-line fractures. He attributed the cause of fracture mainly to continual flexing during mastication leading to fatigue fracture. The Scanning Electron Microscope (SEM) photomicrographs with higher magnification revealed fine striations at the junction of tooth and base material. The lines were perpendicularly oriented to the direction of fracture propagation.

The Chi-square test showed statistically non-significant relation between fractured denture and type of fracture ($p=0.058$). Study done by Naik AV showed 60% of fracture in denture base in midline [6]. Choudhary S et al., in the new proposed classification on complete denture fracture based on the site and pattern of fractures reported that maxillary midline fractures are the most common [25]. In the upper complete denture, more the depth of the incisal notch more the denture is prone to fracture. This is described as the "notch effect" by Smith DC [26]. It was reported that the thinnest acrylic resin areas are more prone to fracture [27]. However, Tokgoz S et al., found that denture base thickness of 2 mm has better fracture resistance without any reinforcement or strengtheners [28]. Approximately 22% and 30% of repairs in dentures involve tooth detachment frequently in the anterior region [29,30]. The cause of this separation may be the lesser surface area over the ridge lap that is free for bonding and the direction of the load faced during function. Stress is concentrated at certain distance within the tooth and not at the interface of tooth and denture base. Surface adulteration while fabrication causes sizeable interface separation and ultimately progression of the crack [29-32].

In this study, it was seen that 69.16% of the fractured dentures were fractured for the first time followed by one previous fracture in 24.77%, two previous fractures reported in 4.67% and three previous fractures in 1.40%. The Chi-square test showed a statistically non-significant relationship between fractured dentures and number of previous fractures ($p=0.294$). This finding was in agreement with previous studies done by Singh RK et al., Khasawneh SF and Arab JM, Khalid H [7,15,33].

The Chi-square test indicated statistically significant association with denture fracture and retention of denture ($p=0.017$). Diaz-Arnold AM and Faot F et al., in their studies concluded that ill fitted dentures flex during function around the midline and due to cyclic loading during mastication, leading to flexural fatigue fracture [34,35]. Beyli MS and von Fraunhofer JA in a survey of fractured dentures found that the most common cause of denture fracture is poor retention and lack of balanced occlusion [8].

Complete dentures as antagonist showed higher incidence of fracture (76.17%) as compared to natural teeth or fixed prosthesis (22.43%) and removable partial denture (1.40%) as antagonist. The Chi-square test presented a statistical significant relationship with denture fractured and type of antagonist ($p<0.05$). El-Sheikh AM and Al-Zahrani SB reported higher incidence of fracture (43.8%) with complete denture as antagonist compared to 35.7%

and 20.5% natural teeth or fixed prosthesis and partial denture respectively [9]. The present study was not in agreement with studies conducted by Hangreaves AS and Ray SR et al., where they concluded that with natural dentition as antagonist, denture fracture was more frequent [13,16]. The most important cause of denture fracture is unbalanced occlusion and substantial chewing force from the antagonist natural teeth. The incidence of denture fracture with natural teeth as antagonist can be moderated by instituting optimal balanced occlusion and selective grinding of the natural teeth to attain uniform occlusal plane [36].

Presence of notches, diastema, and degradation of polymer lead to stress concentration and initiation of cracks in the denture predisposing it to damage and fracture. Improved high impact resin can be used to reduce the breakage [37,38]. The mechanical strength features of denture base which includes transverse strength, ultimate tensile strength and impact strength are also improved by this aesthetic enhancement [39-41]. Sudan S et al and Dhiman R and Chowdhury SR suggested that to prevent midline fractures in a maxillary single complete denture, flexible denture can be fabricated, as the material is unlikely to fracture [42,43]. As compared to the acrylic resin dentures, the flexible dentures are well accepted by the patients. Following basic prosthodontic principles during denture construction will help in reducing incidence of denture fractures. These include fabricating the denture with even and adequate bulk of fibre reinforced/high impact denture base material, following optimum time and temperature during acrylisation to achieve adequate polymerisation, relieving incompressible tissue in the centre of the hard palate, achieving balanced occlusion, and ensuring good retention and stability of the denture. Patients should be counselled regarding proper handling and maintenance of the denture [43].

Limitation(s)

The fractured dentures were analysed by visual and physical examination. Microscopic analysis of fractures site was not done. Only patients in North Karnataka region were evaluated in this study.

CONCLUSION(S)

Statistically significant relationship with denture fracture was seen in variables like gender of wearer, age of wearer, age of denture, retention quality of denture and type of antagonist. The incidence of removable denture fractures is high and remains as an unresolved problem. Various measures such as applications of prosthodontic principles in constructing and maintaining of the removable dentures reduce the incidence of denture fracture. Increasing of fracture toughness with better strengthened resin and innovative methods of the processing techniques will have far fetching results. Future large multicentre studies with large samples taking microscopic analysis in consideration can be undertaken for better evaluation and to provide detailed insight regarding denture fractures.

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