Causes of denture fracture : A survey

Ali M. El-Sheikh, BDS, MSD, MSc, PhD
Saied B. Al-Zahrani, BDS, MS

تحدث الكسور عادةً في أجهزة الإستعاضة الصناعية المتحركة و المصنوعة من مادة الأكريل نتيجة لقوى إطباقية شديدة أو حوادث عارضة، تهدف هذه الدراسه إلى تحديد عدد و نوع الأجهزة المكسورة التي إستقبلها مركز طب الأسنان بالدمام خلال ستة أشهر، حيث تم توزيع إستبيان على ثلاثة أطباء لتعبئته عند مراجعة أي مريض لديه جهاز مكسور، و قد تبين بعد التحليل الإحصائي أن أكثر الأجهزة التي تعرضت للكسر هي أجهزة الفك السفلي الجزئيه بنسبة ٤٦,٤٪ كما أوضحت النتائج أن ٥٣,٦٪ من الأجهزة المكسورة قد تم إستخدامها لأكثر من سنة و أقل من ٣سنوات، أن السبب الرئيسي للكسور كان الأرتطام المفاجئ بنسبة ٨٠,٤٪ كما و أن انهيار قاعدة الأجهزه كان أكثر أنواع الكسور شيوعاً بنسبة ٧١,٤٪، يوصي الباحثون بأن يتم تقوية أجهزة الإستعاضة الصناعية المتحركه ببعض المواد لزيادة متانتها و تحملها للقوى المختلفة كما أن الفحص المنتظم للمريض و حالته الفموية مهم جدا للحد من هذه المشاكل.

Fracture of acrylic resin removable dentures occurs frequently during service through heavy occlusal force or accidental damage. **OBJECTIVES:** The purpose of this survey was to determine the number and type of damaged removable dentures at Dammam Dental Center, Dammam, Saudi Arabia and to ascertain the statistical relationship between certain variables and damage to dentures. **MATERIALS and METHODS:** Three operators were instructed to complete the questionnaires for each denture received for repairs at the center over a period of 6 months. Eleven variables were examined for each damaged denture. **RESULTS:** Results obtained showed that the type of dentures most commonly needing repair was the lower partial denture (46.4%). Results also showed that 53.6% of the damaged dentures had been in use more than 1 year and less than 3 years. Impact failure (80.4%) was the most common cause of damage. The most frequent type of damage was breakdown of the acrylic base (71.4%). The Chi-square test showed a statistical dependence (P<0.05) between damaged dentures and some of tested variables namely, Kennedy classification of partial denture, age of the denture, causes of fracture, type of fracture, retention of the denture, type of antagonist and strengthener of the denture. **CONCLUSIONS:** It could be concluded that damage to removable dentures is quite frequent and provides much distress and cost for patients. These difficulties can best be prevented by regular examinations of the mouth and dentures. A new, more suitable method of reinforcing the base of dentures during preparation is also needed.

INTRODUCTION

The material most commonly used for the fabrication of dentures is the acrylic resin, poly methyl methacrylate (PMMA). This material is not ideal in every respect and it is the combination of properties rather than one single desirable property that accounts for its popularity and usage. Despite its popularity in satisfying aesthetic demands whereby, with an appropriate degree of clinical expertise and with the careful selection and arrangement of artificial acrylic teeth, it is possible to produce a prosthesis which defies detection, it is still far from ideal in fulfilling the mechanical requirements of a prosthesis.[1] This is reflected in the unresolved problem of denture fracture and the accompanying costs to effect repair.[2]

Fractures in dentures result from two different types of forces, namely, flexural fatigue and impact. Flexural fatigue occurs after repeated flexing of a material and is a mode of fracture whereby a structure eventually fails after being repeatedly subjected to loads that are so small that one application apparently does nothing detrimental to the component. This type of failure can be explained by the development of microscopic cracks in areas of stress concentration. With continued loading, these cracks fuse to an ever growing fissure that insidiously weakens the material. Catastrophic failure results from a final loading cycle that exceeds the mechanical capacity of the remaining sound portion of the material.[3] The midline fracture in a denture is

Received 3 September 2005; Accepted 3 July 2006
*Consultants
Department of Prosthetic Dentistry
Dammam Central Hospital, Dammam Dental Center

Address reprint requests to:
Dr. Ali M. El-Sheikh
Department of Prosthetic Dentistry
Dammam Central Hospital, Dammam Dental Center
P.O. Box 188, Dammam 31411, Saudi Arabia
Telephone: (+966) 0508107757
E-mail: ali1993@hotmail.com

often a result of flexural fatigue. Impact failures usually occur out of the mouth as a result of a sudden blow to the denture or accidental dropping whilst cleaning, coughing or sneezing.[1]

Fracture may be due to a multiplicity of factors rather than the denture base material itself and these factors have been discussed in detail.[4] For example, any factor which increases the deformation of a denture base;[5,6] additional factors which form areas of stress concentration such as a large frenal notch;[7] dentures with thin or under-extended flanges; poorly fitting dentures or a lack of adequate relief; dentures with a wedged or locked occlusion; poor clinical design and dentures which have been previously repaired.[8]

Despite the high frequency of denture fracture, there is surprisingly little discussion of the subject in the literature. Therefore, the purpose of this survey was to determine the number and type of damaged removable dentures seen at Dammam Dental Center, Dammam, Eastern Province, Saudi Arabia and to ascertain the statistical relationships between certain variables and damage to dentures.

MATERIALS AND METHODS

Types of damaged removable dentures, complete and partial acrylic resin dentures were studied. Three operators were instructed to complete the questionnaires (Table 1) for each damaged denture received for repairs at Dammam Dental Center over a period of 6 months. One hundred and twelve questionnaires were completed. The questionnaire consisted of eleven variables, and the damaged dentures were evaluated on a nominal scale. The denture types were classified into four categories: upper complete dentures, lower complete dentures, upper partial dentures and lower partial dentures. The study hypothesis was that the damaged dentures were related with many factors including age of denture, gender, age of wearer and number of previous dentures.

Table 1. Data from questionnaire of dentures repaired and the list of variables and the frequency distribution of responses (n = 112, total)

Variable	No. of Cases	%
Type of denture:		
Upper acrylic complete denture	25	22.3
Lower acrylic complete denture	20	17.9
Upper acrylic partial denture	15	13.4
Lower acrylic partial denture	52	46.4
Kennedy class (Partial dentures):		
Class I	52	77.6
Class II	7	10.4
Class III	3	4.5
Class IV	5	7.5
Age of denture:		
< 1 year	18	16.1
1-3 years	60	53.6
> 3 years	34	30.4
Wearer of denture:		
Male	73	65.2
Female	39	34.8
Age of wearers:		
≤ 59 years	67	60.0
≥ 60 years	45	40.0
Causes of fracture:		
Accident, trauma	4	3.6
Impact	90	80.4
Mastication	18	16.1
Type of fracture:		
Hairline fracture	16	14.3
Breakage in acrylic base	80	71.4
Loosening of tooth	8	7.1
Damaged clasp	8	7.1
Number of previous fracture:		
0	63	56.3
1	15	13.4
2	25	22.3
3	9	8.0
Retention:		
Poor	6	5.4
Moderate	39	34.8
Good	67	59.8
Type of antagonist:		
Natural teeth or fixed prostheses	40	35.7
Complete denture	49	43.8
Partial denture	23	20.5
Strengthener:		
No	107	95.5
Metal wire	5	4.5

DATA ANALYSIS

To fulfill the purpose of this study, the analysis was primarily descriptive in nature, and involved calculating frequency tabulations, and cross-classifications for categorical data. Chi-square test was carried out to establish the statistical independence between the selected variables and damaged dentures. Significance level was set at 5%.

RESULTS

The commonest type of damage was that of lower partial dentures (46.4%). As illustrated in Table 2, 84.6% of the damaged lower partial denture was Class I Kennedy classification. As illustrated in Table 1, 53.6% of the damaged dentures had been in use more than 1 year and less than 3 years. The Chi-square test showed a statistical dependence between

Table 2. Number and percentage of types of damaged dentures by different variables

Variable		Damaged Denture				Total	*P*-value
		UCD	LCD	UPD	LPD		
Kennedy Class	Class 1	-----	-----	8 (15.4)	44 (84.6)	52 (77.6)	<0.0001
	Class 2	-----	-----	2 (28.6)	5 (71.4)	7 (10.4)	
	Class 3	-----	-----	0 (0.0)	3 (100.0)	3 (4.5)	
	Class 4	-----	-----	5 (100.0)	0 (0.0)	5 (7.5)	
Age of denture	< 1 year	5 (27.8)	4 (22.2)	3 (16.7)	6 (33.3)	18 (16.1)	0.024
	1-3 years	10 (16.7)	12 (20.0)	3 (5.0)	35 (58.3)	60 (53.6)	
	> 3 years	10 (29.4)	4 (11.8)	9 (26.5)	11 (32.4)	34 (30.4)	
Wearer of denture	Male	18 (24.7)	12 (16.4)	10 (13.7)	33 (45.2)	73 (65.2)	0.842
	Female	7 (17.9)	8 (20.5)	5 (12.8)	19 (48.7)	39 (34.8)	
Age of wearers	≤ 59 years	14 (20.9)	9 (13.4)	10 (14.9)	34 (50.7)	67 (59.8)	0.401
	≥ 60 years	11 (24.4)	11 (24.4)	5 (11.1)	18 (40.0)	45 (40.2)	
Causes of fracture	Accident	1 (25.0)	0 (0.0)	3 (75.0)	0 (0.0)	4 (3.6)	0.022
	Impact	19 (21.1)	17 (18.9)	10 (11.1)	44 (48.9)	90 (80.4)	
	Mastication	5 (27.8)	3 (16.7)	2 (11.1)	8 (44.4)	18 (16.1)	
Type of fracture	Hairline	5 (31.3)	5 (31.3)	3 (18.8)	3 (18.8)	16 (14.3)	0.004
	Breakage	17 (21.3)	12 (15.0)	7 (8.8)	44 (55.0)	80 (71.4)	
	Loosening of tooth	3 (37.5)	3 (37.5)	1 (12.5)	1 (12.5)	8 (7.1)	
	Damaged clasp	0 (0.0)	0 (0.0)	4 (50.0)	4 (50.0)	8 (7.1)	
Number of previous fracture	0	18 (28.6)	12 (19.0)	8 (12.7)	25 (39.7)	63 (56.3)	0.777
	1	2 (13.3)	3 (20.0)	2 (13.3)	8 (53.3)	15 (13.4)	
	2	4 (16.0)	3 (12.0)	3 (12.0)	15 (60.0)	25 (22.3)	
	3	1 (11.1)	2 (22.2)	2 (22.2)	4 (44.4)	9 (8.0)	
Retention	Poor	0 (0.0)	4 (66.7)	1 (16.7)	1 (16.7)	6 (5.4)	0.005
	Moderate	4 (10.3)	9 (23.1)	6 (15.4)	20 (51.3)	39 (34.8)	
	Good	21 (31.3)	7 (10.4)	8 (11.9)	31 (46.3)	67 (59.8)	
Type of antagonist	Natural	6 (15.0)	3 (7.5)	10 (25.0)	21 (52.5)	40 (35.7)	<0.0001
	CD	19 (38.8)	17 (34.7)	0 (0.0)	13 (26.5)	49 (43.8)	
	PD	0 (0.0)	0 (0.0)	5 (21.7)	18 (78.3)	23 (20.5)	
Strengthener	No	22 (20.6)	18 (16.8)	15 (14.0)	52 (48.6)	107 (95.5)	0.048
	Metal	3 (60.0)	2 (40.0)	0 (0.0)	0 (0.0)	5 (4.5)	

UCD : Upper Complete Denture
LCD : Lower Complete Denture
UPD : Upper Partial Denture
LPD : Lower Partial Denture

damaged dentures and age of the denture (P< 0.05). The frequency of male wearers of damaged dentures (65.2%) was higher than female wearers (34.8%). There was no statistically significant difference between damaged dentures and gender of denture wearer (P = 0.842). Impact failure was the most common cause of damage (80.4%). The most frequent type of damage was breakdown of the acrylic base (71.4%). There was a statistical significant relationship between damaged dentures and type of fracture (P = 0.004). More than half the dentures repaired (56.3%) had broken for the first time. There was no statistically significant relationship (P = 0.777) between damaged dentures and number of previous fracture. On the other hand, there was statistical significance (P = 0.005) between damaged dentures and retention of the denture, type of antagonist and strengthener of the denture.

DISCUSSION

Several studies have investigated the incidence and types of fracture of dentures. Darbar et al.[2] in a survey distributed a questionnaire to three laboratories, and reported that 33% of the repairs carried out were due to debonded/ detached teeth and 29% were repairs to midline fractures more commonly seen in upper complete dentures. The remaining 38% were other types of fractures, the majority of which were repair to upper partial dentures, e.g. detachment of acrylic resin saddles from metal-based dentures and fracture of connectors in all acrylic resin partial dentures. The present study reported that 53.6% of the damaged dentures had been in use more than 1 year and less than 3 years and 46.4% of damaged dentures were lower partial dentures. These results agree with that of Hargreaves[9] who in a survey, reported that 63% of dentures had broken within 3 years of their provision, there being a greater proportion of partial than complete denture. Lower partial dentures represented the majority of repairs in the present study. This would be explained by the fewer upper dentures worn and possibly fewer produced by dentists. Such dentures are easily damaged because the structures of partial dentures are quite complex.

Hargreaves[9] and Smith[10] have both indicated that midline fractures in dentures are most likely to occur after 2 to 3 years of use. The present study confirmed that most upper complete dentures (29.4%) were damaged after 3 years of use. The damages after a few years' use may indicate that fatigue of the denture material is somehow linked to denture damage, but dimensional failures in laboratory technique of denture bases also predispose to damage. Chemical degradation of polymer in the oral environment weakens the denture, and this also predisposes it to damage.

Impact failure (80.4%) was the most common cause of damage of the dentures in the present study. This agrees with that of Lambrecht and Kydd[6], and Hargreaves.[9] This could be explained by the lack of attention being paid by the patients towards the care of their dentures.

The most frequent type of damage seen in this study was the breakage in the acrylic base. The problem of acrylic resin fracture can be reduced by the use of the improved high impact resins. There is also need for a new and more suitable method of reinforcing the denture base during preparation. This could be achieved by using continuous electrical-glass (E-glass) partial fiber reinforcement. Reinforcement with glass fibers enhances the mechanical strength characteristics of denture bases such as the transverse strength, ultimate tensile strength, and impact strength.[11] This type of reinforcement is superior

to metal-wire reinforcement in terms of esthetics and bonding to the resin matrix. Continuous, unidirectional E-glass partial fiber reinforcement has been shown to considerably improve the mechanical properties of removable complete and partial dentures in vitro.[12-14] The failure of artificial teeth included fractures and detachments. The type of artificial teeth used influenced the incidence of artificial teeth failure regardless of the type of denture. As plastic teeth have a strong bond to the denture base, the incidence of plastic artificial teeth failure in the present study was low.

It has been reported that the insertion of metal wire or metal mesh as 'strengtheners' into acrylic resin dentures is not very satisfactory. This could explain why fewer number of dentures (4.5%) in the present study used the metal wire as a strengthener. It is probable that the acrylic resin shrinks away from the 'strengthening' material leaving a material with a network of voids which weakens the structure by creating new points of stress concentration.

Matthews and Wain[15] have shown that under load the maximum tensile stresses are on the palatal aspect of the denture. Factors that contribute to stress concentrations will enable the initiation and propagation of cracks thereby influencing the rate of failure. Both the presence of notches and diastema act as stress concentrators thereby influencing the risk of failure.

A majority of the midline fractures can be avoided by the application of established prosthodontic principles during denture construction. The principles include even and adequate bulk of denture base material cured to achieve optimum polymerization and free of porosity; relief of incompressible tissue in the center of the hard palate; addition of labial flange to increase rigidity of denture base as well as even and balanced occlusion to reduce wedging effect and locking of occlusion. Improvements in denture base resin and the reduction of stress concentrators such as notches and diastema to minimum would also help prevent these fractures.

CONCLUSIONS

Within the limitations of this study, the following conclusions were drawn:

1. Damage to removable dentures is quite frequent causing much distress and cost for patient.
2. Repeated fractures can be reduced by careful attention to the design and construction of dentures particularly during the laboratory stages.
3. Using improved high impact resins can reduce the problem of acrylic resin fracture.
4. There is a need for a new and more suitable method of reinforcing the base of dentures during preparation, e.g. continuous E-glass fiber.

REFERENCES

1. Jagger DC, Harrison A, Jandt KD. The reinforcement of dentures. J Oral Rehabil 1999; 26: 185-194.
2. Darbar UR, Huggett R, Harrison A. Denture fracture – A survey. Br Dent J 1994; 176: 342-345.
3. Wiskott HWA, Nicholls JI, Belser UC. Stress fatigue: Basic principles and prosthodontic implications. Int J Prosthodont 1995; 8: 105-116.
4. Jagger DC, Harrison A. The fractured denture-solving the problem. J Primary Dent Care 1998; 5: 159-162.
5. Kydd WL. Complete base deformation with varied occlusal tooth form. J Prosthet Dent 1956; 6: 714-718.
6. Lambrecht JR, Kydd WL. A functional stress analysis of the maxillary complete denture base. J Prosthet Dent 1962; 12: 865-872.

7. Rees JS, Huggett R, Harrison A. Finite element analysis of the stress concentrating effect of fraenal notches in complete dentures. Int J Prosthodont 1990; 3: 238-240.
8. Yunus N, Harrison A, Huggett R. Effect of microwave irradiation on the flexural strength and residual monomer levels on an acrylic repair material. J Oral Rehabil 1994; 21: 641-648.
9. Hargreaves AS. The prevalence of fractured dentures. Br Dent J 1969; 126: 451-455.
10. Smith DC. The acrylic denture: Mechanical evaluation mid-line fracture. Br Dent J 1961; 110: 257-267.
11. Uzun G, Hersek N, Tincer T. Effect of five woven fiber reinforcements on the impact and transverse strength of a denture base resin. J Prosthet Dent 1999; 81: 616-620.
12. Vallittu PK. Comparison of the in vitro fatigue resistance of an acrylic resin removable partial denture reinforced with continuous glass fibers or metal wires. J Prosthodont 1996; 5: 115-121.
13. Vallittu PK, Lassila VP, Lappalainen R. Transverse strength and fatigue of denture acrylic-glass fiber composite. Dent Mater 1994; 10: 116-121.
14. Kim S-H, Watts DC. The effect of reinforcement with woven E-glass fibers on the impact strength of complete dentures fabricated with high-impact acrylic resin. J Prosthet Dent 2004; 91: 274-280.
15. Matthews E, Wain EA. Stresses in denture bases. Br Dent J 1965; 100: 167-171.