

Original article

An Evaluation of Iatrogenic Damage to the Adjacent Teeth During Crown and Bridge Preparation: An *In-Vitro* Study

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The proper tooth preparation should not damage the neighboring tooth surfaces. Accidental damage during teeth preparation is considered an important concern that dentists often face throughout restorative procedures. The purpose of the following study is to evaluate the amount and frequency of accidental injury to the interproximal surface of nearby teeth, subsequent teeth preparation, Setting: among dental practitioner in private dental laboratories in west of Libya. An example (n=80) of a working cast list used for crown and bridgework was sampled from Alzindah and Hi-Tech dental commercial laboratories in west of Tripoli Libya. Tooth surfaces were examined on master casts by direct vision by one observer. Statistics were investigated by using SPSS. A high incidence of iatrogenic injury to the mesial and distal surfaces of adjoining teeth where mesial 78% and 73% on distal surface, (p<0.044) was detected, more common in molar teeth (67%) than anterior teeth (45%). The most common accidental damage was abrasion and nick, then abrasion. The prevalence of injury was established to be higher in general dental practitioners and was significantly associated with mainly mesial surface, mostly in the middle third of the proximal surface (45%). More injuries were observed in the maxilla in comparison to the mandible. A high rate of accidental damage to the neighboring teeth has been present through crown and restorative work, middle-third of the tooth with mild abrasions more risk location and surfaces. The present research work places of interest the need for dentists to exercise more with preparations and casts making.

Introduction

The indirect way of constructing crowns and bridges allows the manufacture of a restoration from the chairperson's side by replacing a gypsum cast for the normal tooth. However, the working cast on which it's made must nearly copy the tooth or teeth preparation and associated areas of surrounding soft tissue if the prosthesis is to fit the mouth accurately. Iatrogenic damage that occurs during teeth preparation and operation constitutes a crucial issue where dentists may need to be more cautious throughout restorative procedures [1]. Any dental treatment during any phase can come accidental and endanger the tooth surfaces. The perfect tooth/teeth preparation should save the adjoining teeth from iatrogenic damage [2,3]. The literature had established a higher chance of accidental damage to adjacent dental hard and soft tissue during the work preparation [4,5], orthodontic stripping [6-9], and crown preparation [3,10]. This results in a scratching and rough enamel surface, therefore making it prone to plaque growth, which gives more chance for caries to start or spread [4,11].

Iatrogenic damage to adjoining teeth after work preparation was one of the problems of this procedure [3]. In a study by Long and Smith [12], dentists were asked to prepare extracted teeth fixed in the normal contact position and set up 100% damage to the surfaces of neighboring teeth. Moreover, they determined that teeth preparation having easy entry to the contact area was less likely to cause harm to adjacent teeth [12]. Several demonstrations can be practical for the injured enamel following iatrogenic damage as the presence of adequate scratches, 1 mm wide vertical grooves, expansive damage, and indentations [4, 5]. Following the occurrence of such complications, later, the affected areas can show the risk of increasing dental caries. It was found that taking off the outer parts of enamel and might exposure, can be accompanying with more various solubility of water-soluble and acid- suchlike substances that can initiate more complications. Abdul-wahhab et al., [3] conducted a similar study in Saudi dental scholars and established that about 98% of neighboring teeth were proximally affected. Furthermore, they found that the injury was more common in the maxilla, however, there was no major difference between the right and left sides [3].

Advanced danger of iatrogenic damage to upper posterior teeth was because of difficult physical and visual accessibility for those teeth [3]. These complications might be reduced by using matrix bands and other

teeth separation helping devices [4,13]. Many studies have inspected working dental casts and used them as a guide for perfect impressions [1]. The good dental casts should have few requirements, such as: necessity free of bubble, more along the finish lines of the prepared teeth, must be distortion free, and they can be easily trimmed with clear borders. The British Society for Restorative Dentistry has indicated that the purpose of the “master impression is to gain an accurate, dimensionally stable, completely supported impression of the teeth set and its associated soft tissues” [3]. Many studies showed that an important amount of the impressions from which the dental casts used for indirect restorations are made, that demonstrate defects in these casts which might influence the outcome restorative work.

This current research work was aimed to determine the quality of dental casts of types, degree, and position of iatrogenic damage to the adjoining tooth during teeth preparation by collecting dental casts from private dental laboratories.

Methods

Sample selection

A sample of 80 sets of working casts were obtained randomly from different dental laboratory sources from west of Tripoli of Libya, they were analyzed by one observer. All casts had been poured using the double mix putty wash impression technique (Zetaplus, Zermack clinic, Italy), heavy and light body impression (Zetaplus, Zermack clinic, Italy). After finding and examining the location of the prepared tooth/teeth (upper-lower, posterior-anterior, right -left), intact teeth and adjacent teeth were included in this study. Casts that showed damage because of wrong handling, casts with clear porosities, and casts from alginate impressions were excluded.

Measuring

Master dental casts that had inclusion criteria were inspected using direct vision. Surfaces of tooth/teeth neighboring the prepared tooth were inspected for the amount and the location of the tooth damage and then classified, agreeing to the criteria described by researchers (10) as follows: 0: no damage, 1: slight damage (depth <0.05mm) can be seen by the naked eye, and 2: obvious damage (depth >0.05-<1.0 mm) location of injury

Location of damage

A: Incisal or occlusal third of the mesial or distal surface. B: Middle one-third of the mesial or distal surface C: Cervical third of the mesial or distal surface. Mixed damage of mire surface giving a mixture of letters above (AB, BC, AC, and ABC).

Type of damage

Nick: grooves in the long axis of the enamel of the tooth injured by the tip of the bur. Abrasion: An Area where a large surface has been removed without causing grooves. Both: nicks and abrasion

The values of each dental cast were noted on specifically designed forms. Eighty (80) working casts were chosen for assessment by the observer. To ensure intra-examiner reliability, the scores of the iatrogenic damaged casts on 20 randomly selected from a total 80 casts was checked by making the examiner repeat the measurement on the same casts after 3 weeks and was determined using kappa statistics that showed the total agreement.

Statistical analysis

SPSS version 22 was used to analyze the data (IBM Corp, Armonk, N.Y., USA). A descriptive investigation was designed for the category of practitioner, type of the prostheses, number of teeth, position, amount (type), and degree of damage to adjacent teeth.

Results

A total of 64 casts with several surfaces, 137 adjacent to prepared teeth done by general dental dentists (107) and specialists (30), were included in this study and were assessed for iatrogenic damage. Evidence of iatrogenic damage of proximal surfaces of adjacent teeth (121/137) 89% with $p < 0.392$ (78% on distal tooth and 75.7% on mesial surfaces) statistically non significance was observed.

The results in Table 1 indicate that Level 1 damage occurred in 51.2% (n = 42) of cases, with an important difference between mesial (17.1%) and distal (34.1%) surfaces ($p = 0.044$). Level 2 damage was observed in 48.8% (n = 40) of cases, showing no significant difference between mesial (20.8%) and distal (28.0%) surfaces ($p = 0.430$). Regarding damage location, the majority of cases presented damage in either the AB region (47.6%, n = 39) or the ABC region (45.1%, n = 37), with no statistically significant differences between

proximal surfaces ($p > 0.05$). Isolated damage in regions A (3.7%), B (2.4%), and C (1.2%) was less common. The predominant type of damage was classified as "N" (63.4%, $n = 52$), with no significant difference between mesial (25.6%) and distal (37.8%) surfaces ($p = 0.212$). Combined damage types ("Both") occurred in 36.6% ($n = 37$) of cases, showing similar distribution between proximal surfaces (24.4% each, $p = 0.743$). Overall, chi-square analysis revealed no significant associations between damage patterns and surface location ($\chi^2 = 0.732$ for degree, $\chi^2 = 4.120$ for location, $\chi^2 = 0.402$ for type; all $p > 0.05$).

Table 1. Degree, Location, and Type of damage in mesial and distal surface

Level of damage		Total n (%)	Mesial n (%)	Distal n (%)	P-value	Chi square	P-value
Degree	0	-	-	-		0.732	0.392
	1	42 (51.2)	14 (17.1)	28 (34.1)	0.044		
	2	40 (48.8)	17 (20.8)	23 (28.0)	0.430		
Location	A	3 (3.7)	0 (0.0)	3 (3.7)	0.250	4.120	0.390
	B	2 (2.4)	0 (0.0)	2 (2.4)	0.500		
	C	1 (1.2)	0 (0.0)	1 (1.2)	0.999		
	AB	39 (47.6)	15 (18.3)	24 (29.3)	0.200		
	ABC	37 (45.1)	16 (19.5)	21 (25.6)	0.511		
Type of damage	N	52 (63.4)	21 (25.6)	31 (37.8)	0.212	0.402	0.526
	A	-	-	-			
	Both	37 (36.6)	17 (24.4)	20 (24.4)	0.743		

The analysis reveals that Level 1 damage was more prevalent in the lower jaw (61.9%, $n = 26$) compared to the upper jaw (38.1%, $n = 16$), although this difference was not statistically significant ($p = 0.164$). Level 2 damage showed a more balanced distribution between upper (51.3%, $n = 20$) and lower (48.7%, $n = 19$) jaws ($p = 0.999$). Regarding damage location, the AB and ABC regions demonstrated similar distribution patterns. The AB region showed 44.7% ($n = 17$) occurrence in the upper jaw and 55.3% ($n = 21$) in the lower jaw ($p = 0.627$), while the ABC region displayed 45.9% ($n = 17$) in the upper jaw and 54.1% ($n = 20$) in the lower jaw ($p = 0.743$). Isolated damage in regions A, B, and C showed varied distributions but with limited sample sizes. The type of damage classified as "N" occurred in 43.1% ($n = 22$) of upper jaw cases and 56.9% ($n = 29$) of lower jaw cases ($p = 0.401$). Combined damage types ("Both") showed a similar pattern with 46.7% ($n = 14$) in the upper jaw and 53.3% ($n = 16$) in the lower jaw ($p = 0.856$). Chi-square analysis indicated no significant associations between jaw location and damage patterns ($\chi^2 = 1.424$ for degree, $\chi^2 = 3.035$ for location, $\chi^2 = 0.095$ for type; all $p > 0.05$). The frequency of injury was found to be higher in general dentists (74%). Furthermore, an important relationship was established between location of the tooth and site of tooth surface damage, was more common in mandibular teeth (68%) than in maxillary teeth (32%), in anterior teeth (45%) and posterior teeth (67%) than lower anterior (34%) and the left side (65%) (Table 2).

Table 2. Degree, Location, and Type of damage in upper and lower jaw

Level of damage		Upper Jaw n (%)	Lower Jaw n (%)	P-value	Chi square	P-value
Degree	0	-	-		1.424	0.233
	1	16 (38.1)	26 (61.9)	0.164		
	2	20 (51.3)	19 (48.7)	0.999		
Location	A	1 (33.3)	2 (66.7)	0.999	3.035	0.552
	B	0 (0.0)	2 (100.0)	0.500		
	C	1 (100.0)	0 (0.0)	0.999		
	AB	17 (44.7)	21 (55.3)	0.627		
	ABC	17 (45.9)	20 (54.1)	0.743		
Type of damage	N	22 (43.1%)	29 (56.9)	0.401	0.095	0.758
	A	-	-			
	Both	14 (46.7)	16 (53.3)	0.856		

Discussion

The injury/damage to the adjoining tooth is regularly unavoidable when working on proximal areas for mechanical tooth preparation to get a crown and bridge. They conducted studies to assess the predominance and degree of iatrogenic damage that happened during tooth preparation. With this purposeful, the result of this consider support the theories of previous authors. It affirmed that tooth preparation of abutments for prosthetic work is an extraordinary hazard for the proposed abutment. This was in agreement with

Abdulwahhab *et al.*, [2014], who detailed that about 98% of the inspected surfaces of neighboring teeth appeared to have some injury because of tooth preparation. However, Moopnar and Faulkner [1991] evaluated the damage to the tooth surface of adjoining teeth to the prepared tooth and found that 74% of the inspected surfaces.

Materials science has made enormous signs of progress over last few years; however, the essential strategy of preparation, the utilization of tall speed burs, has still unchanged. Moopnar and Faulkner [1991] hypothesized that the utilization of high-speed water coolant rotating drills needs consideration during use. It's also be noted that visibility during utilize, due to persistent water splash. Moreover, they appeared that 49% of the surfaces had clear iatrogenic damage which is obvious by the exposed eye. Comparative finding appeared in the present study, where (25 %) of our observed surfaces were extremely damaged. The design of the area of damage was too vital where the damage occurred in many areas and for the most part including the mid third of the tooth surface, single or in mixture with other surfaces as showed in the present study. The possible reason behind this is that the nearness of the bulbous portion of the tooth at the contact region in this area was the most helpless area for iatrogenic damage. Moopnar and Faulkner [1991]. Moreover, it showed the comparative trend of the area of harm and stated that 65.7% of the injury was at several sites, including the occlusal, center, and cervical third of the proximal surface. One of the findings of this study was that even though most of the casts examined had signs of damage, around half of them had injuries of more than a mid-third of the tooth surface. Some creators have recommended that whereas minor harm to the adjoining tooth has the potential to demineralize [23, 21], the deformity may be misdiagnosed as caries on the x-ray [2, 21]. A significant affiliation in our study was established between location of the tooth and position of tooth surface damage, with more serious damages happening in mandible preparations as compared to maxilla preparations, in any case, this finding geos against the studies have appeared essentially lower rate of damage in mandibular teeth than in maxillary teeth [1, 21]. The frequency of injury was established to be higher in general dental practitioners (74%) in comparison to specialists in our study. Moopnar and Faulkner [1991] did not discover a critical distinction among distinctive clinician groups for the rate of surface harm to the adjoining teeth amid crown arrangement. Be that as it may, the current study did not appear any critical distinction in the recurrence of iatrogenic damage on proximal surfaces of prepared tooth. The suggestion in the distribution of iatrogenic damage and the overwhelming hand of the operator were examined by numerous analysts.

Conclusion

This present study has demonstrated differences in the quality of working casts used in the construction of indirect restorations for crown and bridge work. Inside the limitation of this study, a high recurrence of iatrogenic damage to the adjacent teeth had been found during teeth preparation with the half-third as the affected tooth surface. An advance recommendation of the present study to include clinical follow-up of the patients will clearly shed more light on what shows up as a serious issue during tooth preparation by general dental specialists and specialists.

Limitations

Some restrictions of this study are that the patients were not followed-up for complaints of affectability or conceivable caries injury. Any follow-up of these cases may allow more views on the nature of tooth damage and repair following iatrogenic damage. Every effort should be made to anticipate these unavoidable occasions from occurring, which includes the cautious use of interproximal matrix or other metal protections that are made to avoid such iatrogenic harms. Other strategies that can be used to lock it include the use of thin-diameter tapering burs and separation of the small finish fin at the proximal contact area and the use of hand instruments to break down the contact area, utilize of separators, and keeping up a high level of care.

References

1. Lussi A, Gygax M. Iatrogenic damage to adjacent teeth during classical approximal box preparation. *J Dent.* 1998;26(5-6):435-41.
2. Lussi A, Kronenberg O, Megert B. The effect of magnification on the iatrogenic damage to adjacent tooth surfaces during class II preparation. *J Dent.* May;31(4):291-6.
3. Long TD, Smith BG. The effect of contact area morphology on operative dental procedures. *J Oral Rehab.* 1988;15(6):593-8.
4. Medeiros VA, Seddon RP. Iatrogenic damage to approximal surfaces in contact with Class II restorations. *J Dent.* 2000;28(2):103-10.

5. Qvist V, Johannessen L, Bruun M. Progression of approximal caries about iatrogenic preparation damage. J Dent Res. 1992;71(7):1370-3.
6. Kuhar M, Cevc P, Schara M, Funduk N. Enhanced permeability of acid-etched or ground dental enamel. J Prosthet Dent. 1997;77(6):578-82.
7. Cevc P, Schara M, Ravnik C, Skaleric U. Study of the arrangement of crystallites in gamma-irradiated human enamel by electron paramagnetic resonance. J Dent Res. 1976;55(4):691-5.
8. Kuhar M, Cevc P, Schara M, Funduk N. In vitro permeability and scanning electron microscopy study of acid-etched and ground enamel surfaces protected with dental adhesive coating. J Oral Rehabil. 1999;26(9):722-30.
9. Twesme DA, Firestone AR, Heaven TJ, Feagin FF, Jacobson A. Air-rotor stripping and enamel demineralization in vitro. Am J Orthod Dentofacial Orthop. 1994;105(2):142-52.
10. Sirajuddin S, Narasappa KM, Gundapaneni V, Chungkham S, Walikar AS. Iatrogenic damage to periodontium by restorative treatment procedures: an overview. Open Dent J. 2015;9:217-22.
11. Almahrog A, Graf Y, Jbireal JM. Enamel Hypoplasia and Dental Caries in Children: A Review Study. AlQalam Journal of Medical and Applied Sciences. 2025 Mar 3:373-9.
12. Hashan MR, Ghozy S, El-Qushayri AE, Pial RH, Hossain MA, AlKibria GM. Association of dengue disease severity and blood group: A systematic review and meta-analysis. Rev Med Virol. 2021;31(1):1-9.
13. El-Qushayri AE, Ghozy S, Abbas AS, Dibas M, Dahy A, Mahmoud AR, et al. Hyperimmunoglobulin therapy for the prevention and treatment of congenital cytomegalovirus: a systematic review and meta-analysis. Expert Rev Anti Infect Ther. 2021;19(5):661-9.
14. Moopnar M, Faulkner KD. Accidental damage to teeth adjacent to crown-prepared abutment teeth. Aust Dent J. 1991;36(2):136-40.
15. Mitchell CA, Pintado MR, Douglas WH. Iatrogenic tooth abrasion comparisons among composite materials and finishing techniques. J Prosthet Dent. 2002;88(3):320-8.
16. Jeffrey IW, Woolford MJ. An investigation of possible iatrogenic damage caused by metal rubber dam clamps. Int Endodont J. 1989;22(2):85-91.
17. Arman A, Cehreli SB, Ozel E, Arhun N, Cetinşahin A, Soyman M. Qualitative and quantitative evaluation of enamel after various stripping methods. American J Orthodont Dentofac Orthoped. 2006;130(2):131.
18. Zachrisson BU, Nyøygard L, Mobarak K. Dental health assessed more than 10 years after interproximal enamel reduction of mandibular anterior teeth. American J Orthodont Dentofac Orthoped. 2007;131(2):162-9.
19. Baldissara P, Catapano S, Scotti R. Clinical and histological evaluation of thermal injury thresholds in human teeth: a preliminary study. J Oral Rehabil. 1997;24(11):791-801.
20. Abdulwahahab B, Maram Alhati, Maha Alenzil, Safia Babidan. Assessment of iatrogenic damage to proximal surfaces of adjacent teeth following crown preparation by final year dental students in Saudi Arabia: S J of oral Sci. 2014;vol 1(1): 37-40.
21. Mayne RJ, Cochrane NJ, Cai F. In vitro study of the effect of fluorphosphate on iatrogenic damage to enamel: Am J orthod Dentofacial orthop 2011; 139:e543-51.
22. Moopnar M, Faulkner KD: Accidental damage to teeth adjacent to crown prepared abutment teeth. Aust Dent J 1991;36:136-40.
23. Boyed a, Knight PJ. Scanning electron microscop studies of class II cavity margins. Br Dent J 1972;133:331-7

المستخلص

يجب ألا يؤدي التحضير المناسب للأسنان إلى إتلاف أسطح الأسنان المجاورة. يعتبر الضرر العرضي أثناء تحضير الأسنان مصدر قلق مهم يواجهه أطباء الأسنان غالباً أثناء إجراءات الترميم. الغرض من الدراسة التالية هو تقييم كمية وتكرار الإصابة العرضية للسطح بين الأسنان القريبة، وتحضير الأسنان اللاحق، والوضع: بين ممارسي طب الأسنان في مختبرات الأسنان الخاصة في غرب ليبيا. تم أخذ عينة من مثال (ن = 80) لقائمة قالب عمل تستخدم في أعمال التاج والجسور من مختبرات الزندها وهي تيك التجارية لطب الأسنان في غرب طرابلس ليبيا. تم فحص أسطح الأسنان على قوالب رئيسية بالرؤية المباشرة من قبل مراقب واحد. تم التحقيق في الإحصاءات باستخدام برنامج SPSS. تم الكشف عن ارتفاع معدل الإصابة المنشأ طبيًا للسطح الأوسط والبعيد للأسنان المجاورة حيث تم الكشف عن 78% و 73% على السطح البعيد، (ص > 0.044)، وهو أكثر شيوعًا في الأضراس (67%) من الأسنان الأمامية (45%). كان الضرر العرضي الأكثر شيوعًا هو التآكل والخدش، ثم التآكل. وقد ثبت أن انتشار الإصابة أعلى لدى أطباء الأسنان العاميين وكان مرتبطًا بشكل كبير بالسطح الأوسط بشكل أساسي، وخاصة في الثلث الأوسط من السطح القريب (45%). لوحظت إصابات أكثر في الفك العلوي مقارنة بالفك السفلي. كان معدل التلف العرضي للأسنان المجاورة مرتفعًا من خلال أعمال التاج والترميم، حيث كان الثلث الأوسط من السن مع التآكل الخفيف أكثر عرضة للخطر في الموقع والأسطح. يضع عمل البحث الحالي اهتمامًا بالحاجة إلى أن يمارس أطباء الأسنان المزيد من التمارين مع الاستعدادات وصنع القوالب.