Tikrit Journal
for
Dental Sciences
https://tjo-ds.com

Implant Fixture Fracture (5-10 years clinical study)

Nagham H. Ali [1]
Emad H. Abdulla [2]

Department of oral and maxillofacial surgery, College of Dentistry, Ibn Sina University of Medical and Pharmaceutical Sciences.[1,2]

Article Info:
-Article History:
-Received: 10/7/2020
-Accepted: 9/8/2020
-Available Online:
Dec, 2020

Keywords: fixture fracture, fracture implant.

Corresponding Author:
Name:
Nagham Hussein Ali
E-mail:
nagham.h74@gmail.com
Tel: 07707102007
Affiliation:
(1) Asst. Lect., Department of oral and maxillofacial surgery, College of Dentistry, Ibn Sina University of Medical and Pharmaceutical Sciences, Baghdad, Iraq.
(2) Asst. Prof., Department of oral and maxillofacial surgery, College of Dentistry, Ibn Sina University of Medical and Pharmaceutical Sciences, Baghdad, Iraq.

Abstract
Introduction: Osseo integrated dental implant represents an advance management in modern dentistry, with high success rates. Despite that, several complications involve dental implants may still happen and dental surgeons should be attentive to such problem, to prevent implant failures and biomechanical problems. One of the most serious late implant complications is the fracture of implant fixture. It can be a challenge for dentists to determine the etiology of fixture fractures. Aim of study: Evaluate the effect of some implant parameters, such as length, diameter and position, on the occurrence of fixture fracture and to determine the incidence of fractures reported in 5-10 years of fallow up. Materials and methods: Clinical retrospective study included 439 implants made of titanium alloy(Ti-6Al-4V) placed in 192 Iraqi patients; 103 male patients and 89 female patients with partially and completely edentulous areas had consulted the implant department at Al- Elwiya specialized dental center in Iraq. Results: In this study 439 fixtures distributed in 192patients; 53, 6% was male patients; 46.3% female patients.3 fixtures fracture reported in this study represent 1.5% in relation to total number of patients. 0.6% of the 439 fixtures installed. 71 fixtures 16.1% supported prosthesis with Pontics; that reported 3 fixtures fracture 4.2%, while 368 fixtures 83.8% supported prosthesis without Pontics in which no fracture of fixtures were recorded. Discussion &Conclusion: Fracture of Osseo integrated dental implants is a late complication, it has low incidence, the fracture of dental implants fixture are multifactorial, and the most common cause for fracture is the biomechanical or physiologic overload.

Introduction:

Dental Implants are widely used for oral rehabilitation for patients who are completely or partially edentulous [1].

Managements with dental Implant is a well-documented therapy [2]. Osseo integrated dental implant represents an

advance management in modern dentistry; it is an important option for the rehabilitation of missing teeth in totally or partially edentulous patients, with high success rates [3]. Previous studies shows a total 95.3% cumulative success rate of implants placed in partially edentulous areas after 3-7 years of loading [4]. Long-term survival rates for implant treatment modality range from 93.8% to 95.0% for implants fixture and 89.5% for its prostheses after 10 years of follow-up [5, 6]. Despite that, several complications involve dental implants may still happened and dental surgeons should be attentive to such problem, to prevent implant failures and biomechanical problems [7].Failure of implants may be divided into two categories: Early failure, occurs before prosthetic phase of treatment have been taken place and mainly related to problems that may occur in implant placement during surgical phase; and late failure, which may occur due to pathologic problems involving implants that already has been Osseointegrated [3,8]. One of the most serious late implant complication is the fracture of implant fixture(Portion of the implant surgically pl aced into the bone and will act as a "root" it takes a period of 3 to 6 months to be fully supported and surrounded by bone) [9]. Fracture implant is a disappointment not only for the patient but also for the surgeon, because it involves loss of both; the implant fixture and the prosthesis [3]. It can be a challenge for dentists to determine the etiology of fixture fractures. These can be divided into 3 categories: A-defects in the material design.B- nonpassive fitness of prosthetic structure.C- physiological or biomechanical overload [10]. In microscopic analysis for fractured fixtures showed no porosity or any other defects in the titanium structure, this finding eliminated failure due to manufacturing process [10,11].On the trail of screw loosening, fatigue of metals occurred, which may result in fracture of implant [12]. The managements of a fractured implant are a challenge for the clinician because of surgical, rehabilitative and emotional effect [13].Most of these cases, required implant removal [14,15]. The implant itself, the durability of abutment type, the abutment- implant connection, and the abutment material have to be considered. Fracture strength or the load-bearing capacity is considered to be one of the most important features for implant components [16].Fixtures fracture is an uncommon complication that affects two out of every 1,000 implants [14, 17]. This study aimed to evaluate the effect of some implant parameters, such as length, diameter and position, on the occurrence of fracture and to determine the incidence of fractures reported in 5-10 years of fallow up.

Materials and Methods

This clinical study included 439 implants made of titanium alloy (Ti-6Al-4V) placed in 192 patients; 103 male patients and 89 female patients with partially or completely edentulous areas had consulted the implant department at Al- Elwiya specialized dental center in Iraq in the period from January 2009 to November 2012. Patient well asked and examined according to a specially prepared questionnaire form Fig. (1) About:

-Age, residence, occupation.

-The history of missing tooth: Where? Why? And How?

-The medical history? To evaluate the patient general health and if it interferes with surgery.

The patients carefully examined clinically and radiographically to estimate the possibility for implantation.

Clinical examination included: A careful Extra-oral examination to estimate the smile line and thorough Intra oral examination to investigate: the Jaw opening; oral hygiene; inter-arch relationship; ridge deficiencies and mesiodistal width of edentulous ridge to be implanted.

A pre-surgical radiograph was taken for each patient to determine bone quality & quantity and the implant position; orientation; length and diameters in relation to vital structures available. This was done mainly by taking an OPG or C.B.C.T or both according to each individual case.

A diagnostic impression was taken for each patient to fabricate a study cast for ridge mapping for the measurement of bone width and thickness of the gingiva and to fabricate a surgical stent to facilitate implants orientation.

KENTRON implant system (product of GEASS Medical Company) was used in this study.

Implant surgery was done using the KENTRON specialized sequential surgical drills arranged in specialized surgical kits. DENTSPLY Friadent implant motor and 20:1 hand piece with external irrigation were used in implant surgery.

Most of the implants placed traditionally fallowing a two-stage protocol established by Branemark et. al. [18] .That's includes: positioning of implant below crestal bone to allow for healing and maintained for 3-6 months without loading then a 2nd stage surgery is necessary to uncover these implants to placed prosthetic abutment [19]. Abutments fabrication began with direct or indirect impression techniques to transfer the axial relationship of the implant from the patient mouth to a prosthetic cast, then (cement retained abutment) was fabricated. Evaluations and fallow-up schedule designed to examine the patients clinically and radiographically every six months.

Results:

In this study 439 fixtures installed in 192patients with different ages and according to patients gender; 53, 6% was male patients; while the percentage of female patients was 46.3%.3. Fixtures fracture reported in this study represent 1.5% in relation to total number of the implant patients. 2(1.9%) fractures in male patient and 1 (1.1%) fracture were in female patient as shown in Table (1) and (2).The fixture lengths installed in patients were (9, 10,11,12,13 and 15 mm); 25.5% of the implants length used were 11mm. 0.6% of the 439 fixtures installed in this study reported with fracture and they related mainly to length 12mm which represent a percentage of 3.1% from this length. The fractured fixtures reported mainly after 7-10 years of fallow-up as shown in Table (3) and (4). Fixtures diameters used in this study included (3.25, 3.8, 4.5, 5.5 mm); 84.2% of implant diameters used was 3.8mm that reported a 3 fixtures fracture 0.8% from this diameter, as shown in Table(5). From 439 fixture; 215 fixture 48.9% installed in the maxilla that reported 1 fixture fracture 0.4%, and 224 fixtures 51 % installed in the mandible that reported 2 fixtures fracture 8 % the as shown in Table (6) .From the total of the implants installed, 71 fixtures 16.1% supported prosthesis with Pontics; that reported 3 fixtures fracture 4.2%, while 368 fixtures 83.8% supported prosthesis without Pontics in which no fracture of fixtures were recorded as shown in Table (7).

Discussion:

From the beginning of implant dentistry, the implant-based prostheses considered a highly predictable rehabilitation for partially or totally edentulous patients [20, 21]. For decades, the implants have been used were made of titanium [7].The complications that related to dental implants could be classified as biological and mechanical. Mechanical complications although they are rare, they may lead to serious complications clinically [22]. Prosthetic screw, abutment screw Loosening or fracture, and implant body/ fixture fracture are among of these mechanical complications [21]. Fracture implant considered the most frustrating and might occur after a period in function [23].This clinical study evaluates the effect of some implant parameters, such as length, diameter and position, on the occurrence of fixture fracture and determines the incidence of fractures reported during 5-10 years of fallowing up 439 implants made of titanium alloy (Ti-6Al-4V) placed in 192 patients; 103male and 89 female patients. During this period only 3 fixtures fracture 0.6% were reported 2 fixtures fracture 0.4% of them were reported in male and 1 fracture 0.2% in female patients. Literatures reported a large variation (0% to 3.45%) in the incidence of implant fractures [7, 22, and 24]. Studies that reported 0% in the incidence of fracture usually exhibit relatively short periods of follow-up and small sizes of

samples [25, 26]. In this study 368 fixtures installed 83.8%, supported prosthesis without poetics or cantilevers this group reported 0% fixture fracture. This rehabilitation type is more preferable because the using of one implant for one missing tooth provided less values of stress/strain in all parts [27]. 71(16.1%) fixtures supported prosthesis with pontics and/or cantilevers that reported unfortunately 3 (4.2%) fixture fractures. Reduction in number of implants may provide an unfavorable biomechanical behavior [27]. Due to the distribution of stresses that generated by occlusion and masticatory forces [28]. Overload identified as the main cause [18,22].And being first leaded to a progressive fatigue until the implants lose the appropriate strengths that maintain the appropriate integrity[7] .In addition to the absence of periodontal space and ligaments that is present in natural teeth and the direct opposition of bone to the implant surfaces this will do not allow movement of implants when there is occlusal loads and excessive stresses may result in, this may lead to multiple mechanical failures; the most frustrating of these failures is the implant fracture [19]. Dental implants localization also influenced directly on the distribution of biomechanical forces. If the axis of implant placed at a certain distance from the prosthetic crown center, the forces created from the occlusal contact point to the implant axis by this distance may cause loosening of screw or component fracture [3]. Other Factors such as design of the implants, any defects in manufacturing and lack of passive fitness of the prosthesis can be associated with fractures [29]. Some studies considered implants with lengths of ≥10 mm as standard-length implants [30]. In this study, the most widely implant length used was 11mm that represent 25.5% from the total implants fallowed by 13mm length 21.8% and 12 mm21.4% ,all the fractured fixtures reported in this study was related mainly to the implant length 12mm that represent 3.1% in relation to the total implant number of the same length, while longer implants 13mm and 15 mm and shorter ones 9mm,10mm and 11mm presented 0% of fracture these result have shown that fixture fracture are independent of implant length, with no clear relationship between the implant length and its survival. According to the diameter installed; the highest incidence of fractures occurred in standard implants 3.8 mm in diameter that represent 0.8% in relation to the total number of the same diameter that represent the most widely used diameter(84.2%)in this study. Small diameter Implants tend to fracture more easily than implants with large diameter, especially when used in posterior regions [31]. According to Krogh standard implants used in the molar region are among the causes of implant fracture [32]. In several cases analyzed, fracture taken place in reduced 3.5 mm or standard 3.75 mm diameters implants (7, 10, 11, and 33). Therefore, Eckert, Rangert et al, Krogh,Graves, and Beaty describe large diameter dental implants advantages and advise using it whenever possible ,especially in maxillary and mandibular posterior regions, where most of the fractures may occurred[3]. In this study smaller diameters 3.2mm and larger ones 4.5mm and 5.5 mm reported 0% fracture rate. Long survival period could be expected for reduced implants diameter, as long as sufficient implants number are used to support a well-planned prostheses [23]. These findings support the 0% of fixture fracture in 83.8%of implants that supported prosthesis without pontics or cantilevers. In this clinical study, fractures were reported more frequently in the mandibular posterior region 0.8% as shown in Fig. (3) and (4), while the maxilla recorded only one fixture fracture 0.4%, in the anterior region as shown in Fig.(2).This is mostly due to load factors that related to the direction and magnitude of the occlusal forces, dental implant fracture cases most commonly located in the posterior regions of the mouth due to forces chewing of and lateral movements with inclination of cusps that lead to generate undesirable forces [34]. These forces may lead to fatigue of metal which may resulted in fracture of implant. Especially if these forces associated with parafunctional habits such as clenching or pruxism which may increase the overload on the dental implant prosthesis [35].

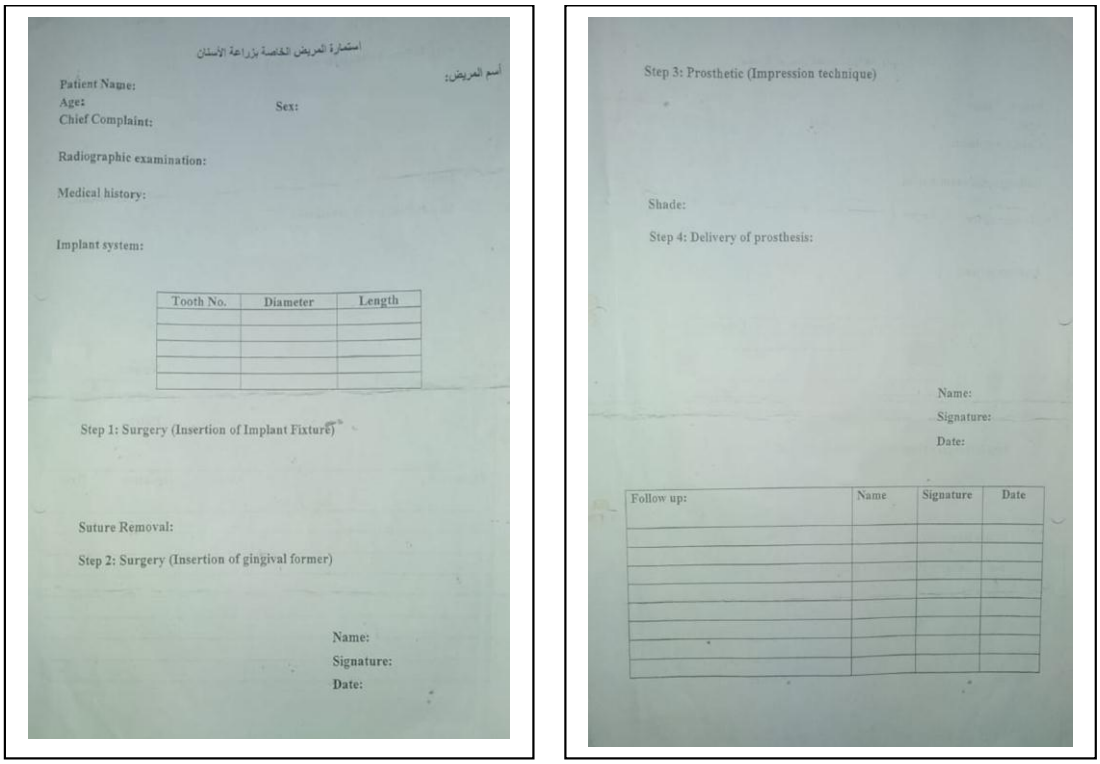
This study reported a fixture fracture rate of 0.6 % from a total of 439 fixtures installed after 7 years of clinical function; although this incidence of implant fractures is relatively low, but this failure can be avoided taking into consideration, the selection of right implant length, diameter, number of implants that supported prosthesis and to avoid pontics and cantilevers as much as possible.

Conclusion

The fracture of a well osseointegrated dental implant fixture is a late disappointed complication, it has low incidence. The fracture of dental implants fixture are multifactorial, the most common cause for the fracture is the biomechanical or physiologic overload especially where it is not possible to install one implant for each missing tooth that provides lower values of stress/strain in all structures of the dental implant. The use of pontics and cantilever (especially distal cantilever) should be avoided as much as possible due to unfavorable biomechanical behavior, which could increase the chances of implant fixture fracture.

Suggestion

Studying the microscopic analysis for fractured fixtures in relation to the non-fractured implant fixture.


استمارة المريض الخاصة بزراعة الأسنان

اسم المريض:

Patient Name:
Age:
Sex:
Chief Complaint:

Radiographic examination:

Medical history:

Implant system:

Tooth No.	Diameter	Length

Step 1: Surgery (Insertion of Implant Fixture)

Suture Removal:

Step 2: Surgery (Insertion of gingival former)

Name:
Signature:
Date:

Step 3: Prosthetic (Impression technique)

Shade:

Step 4: Delivery of prosthesis:

Name:
Signature:
Date:

Follow up:	Name	Signature	Date

Fig. (1) Case sheet for implant patient

Fig. (2): Implant fracture in anterior maxilla supporting long span prosthesis with multiple pontics.

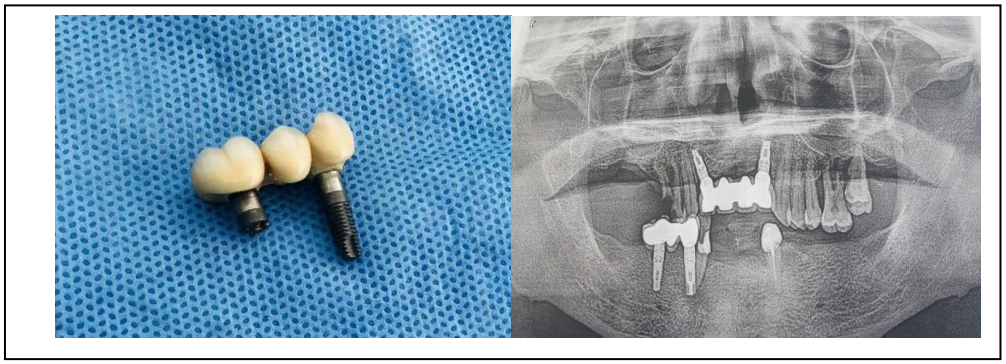


Fig. (3): Implant fracture in posterior mandible, the implant not in the center of the prosthesis, there is distal cantilever action.

Fig.(4): Implant fracture in posterior mandible previously supported Prosthesis with central pontic and distal cantilever.

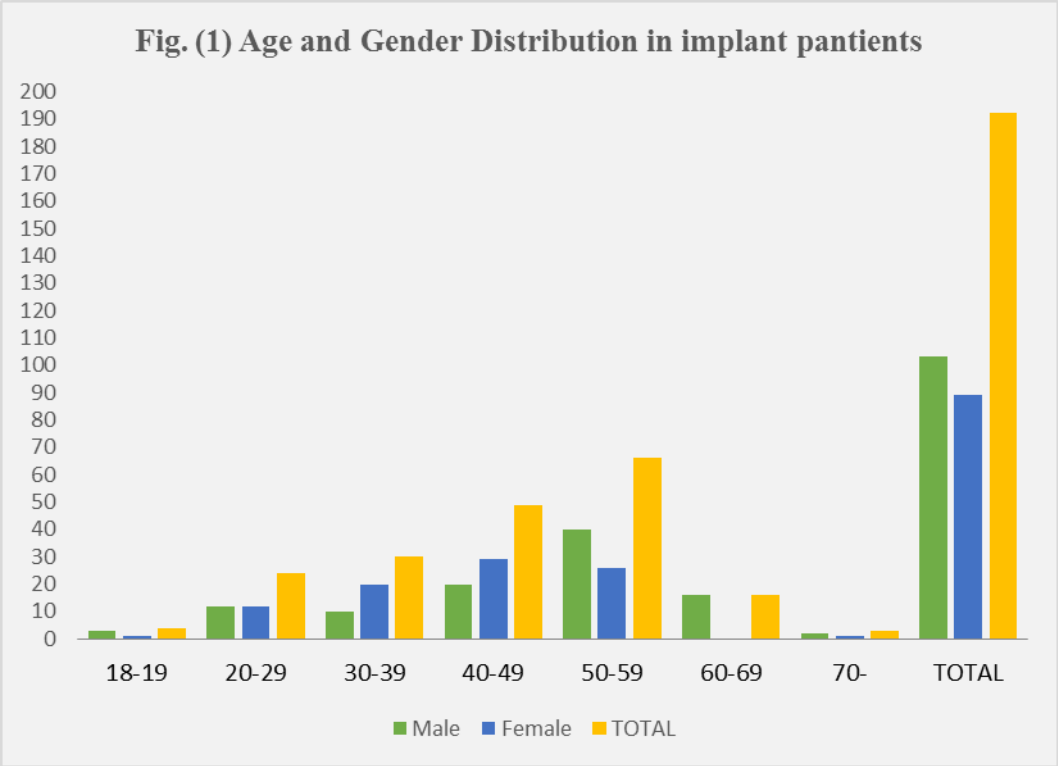


Table (1): Age and Gender distribution in implant patients.

Gender / Age	Male		Female		Total	
	NO.	%	NO.	%	NO.	%
18-19	3	2.9%	1	1.1%	4	2%
20-29	12	11.6%	12	13.4%	24	12.5%
30-39	10	9.7%	20	22.4%	30	15.6%
40-49	20	19.4%	29	32.5%	49	25.5%
50-59	40	38.8%	26	29.2%	66	34.3%
60-69	16	15.5%	0	0%	16	8.3%
70-	2	1.9%	1	1.1%	3	1.5%
Total	103	53,6%	89	46.3%	192	100%

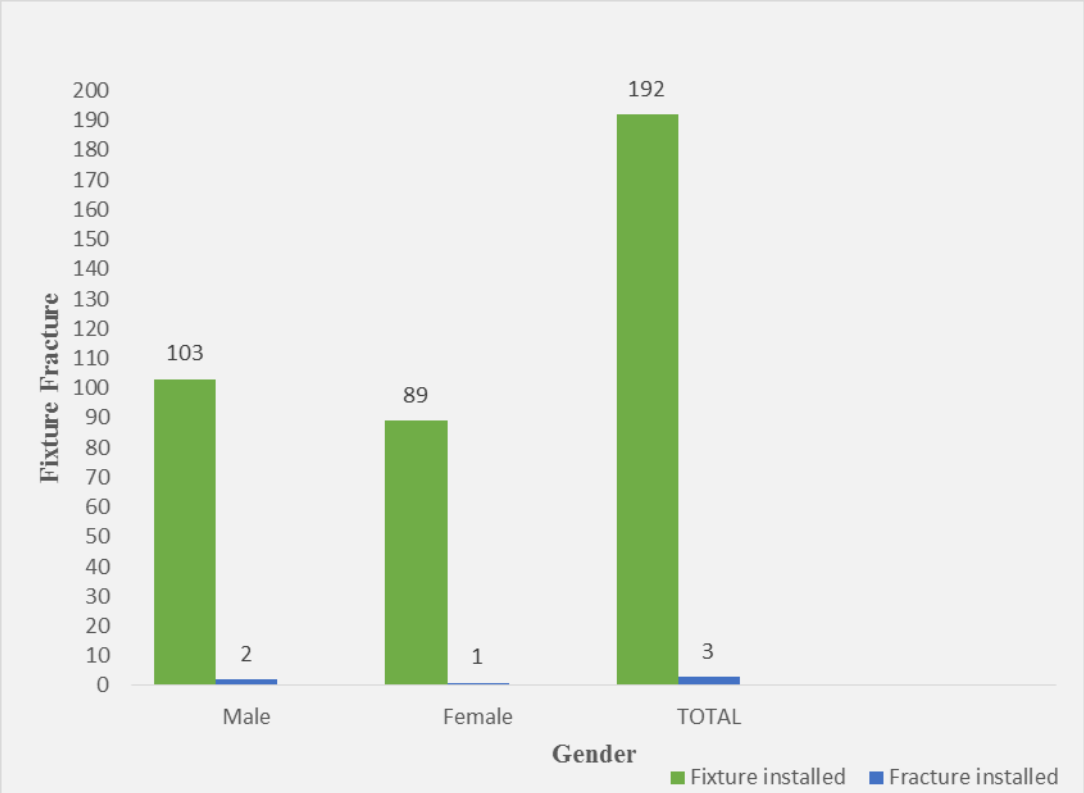


Fig.(2) : Fixture fracture according to the Gender of patient

Table (2): Fixture fracture according to the Gender of patient.

Gender	Fixture installed		Fracture fractured	
	NO.	%	NO.	%
Male	103	53,6%	2	1.9%
Female	89	46.3%	1	1.1%
Total	192	100%	3	1.5%

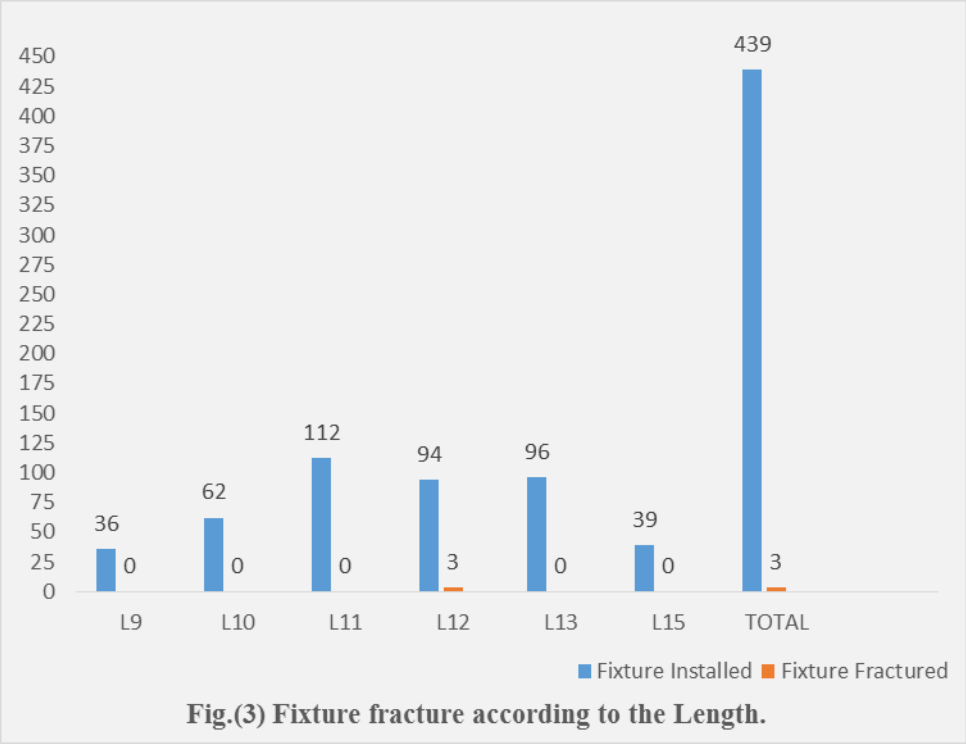


Fig.(3) Fixture fracture according to the Length.

Table (3): Fixture fracture according to the Length.

Fixture length	Fixture installed		Fixture fractured	
	NO.	%	NO.	%
L9	36	8.2%	O	0%
L10	62	14.1%	O	0%
L11	112	25.5%	O	0%
L12	94	21.4%	3	3.1%
L13	96	21.8%	O	0%
L15	39	8.8%	O	0%
Total	439	100%	3	0.6%

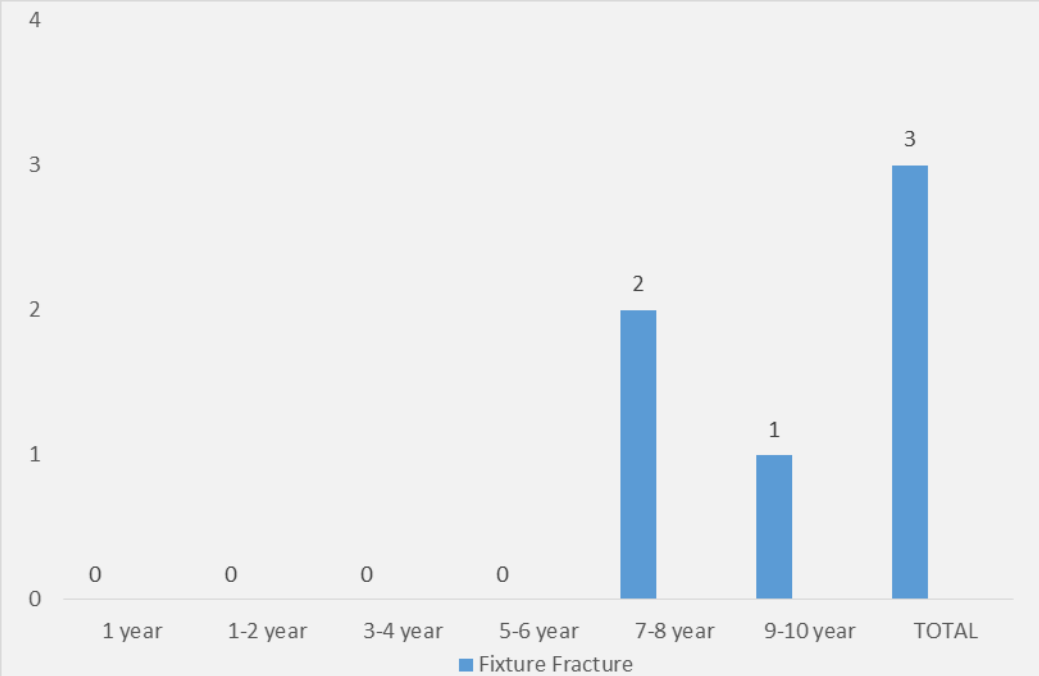


Fig.(4) : Fixture fracture in relation to the loading periods

Table (4): Fixture fracture in relation to the loading periods.

Loading period	Fixture fracture
1 year	O
1-2 year	O
3-4 year	O
5-6 year	O
7-8 year	2
9-10 year	1
Total	3

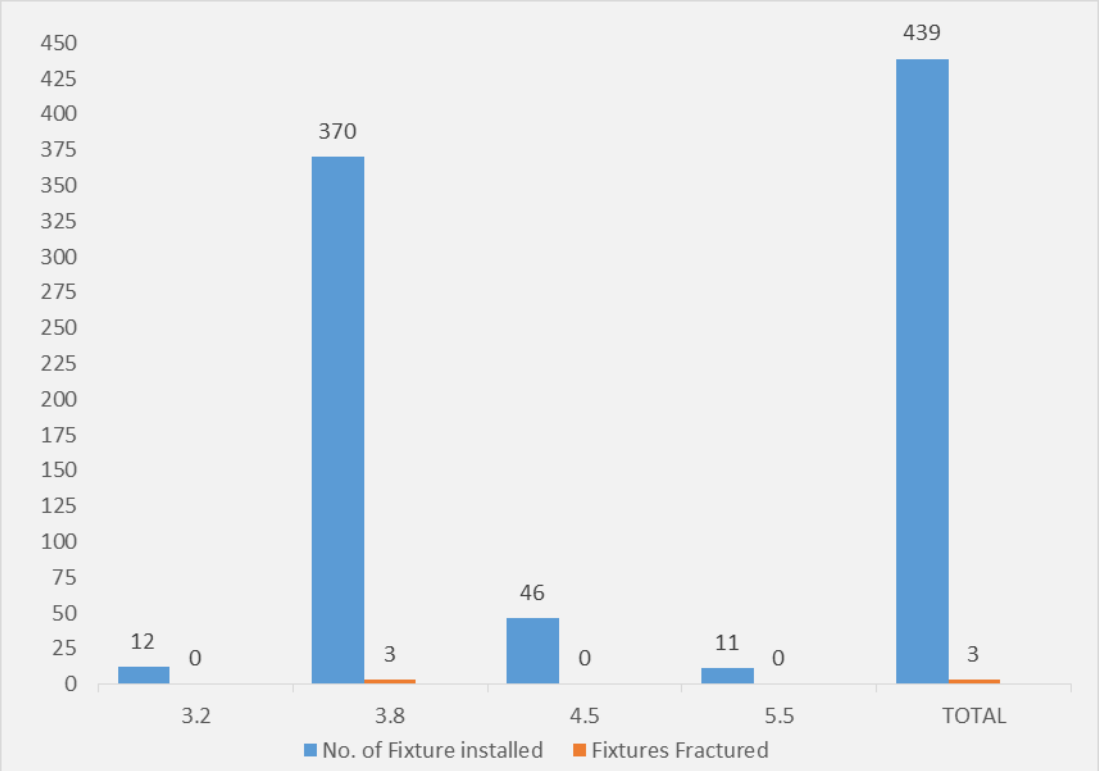


Fig. (5) Fixture fracture in relation to the Diameter installed

Table (5): Fixture fracture in relation to the Diameter installed.

Fixture diameters	Number of fixture installed		Fixtures fractured	
	NO.	%	NO.	%
3.2	12	2.7%	O	0%
3.8	370	84.2%	3	0.8%
4.5	46	10.4%	O	0%
5.5	11	2.5%	O	0%
Total	439	100%	3	0.6%

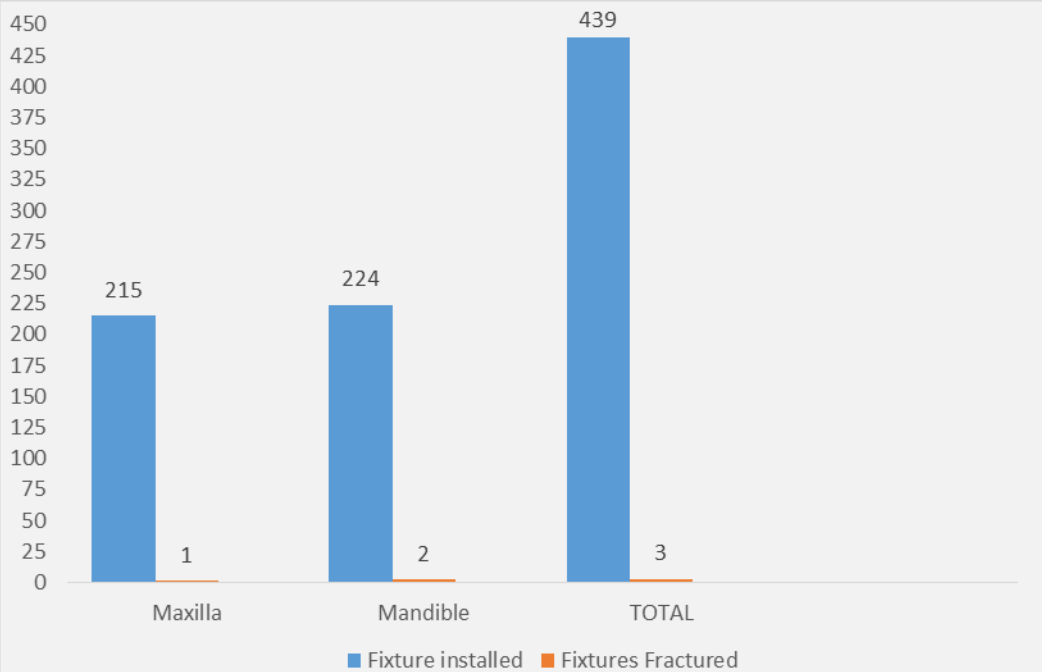


Fig.(6) : Implant fixture fracture in relation to the site of installation

Table (6): Implant fixture fracture in relation to the site of installation.

Region	Fixture installed		Fixtures fractured	
	NO.	%	NO.	%
Maxilla	215	48.9%	1	0.4%
Mandible	224	51 %	2	0.8%
Total	439	100%	3	0.6%

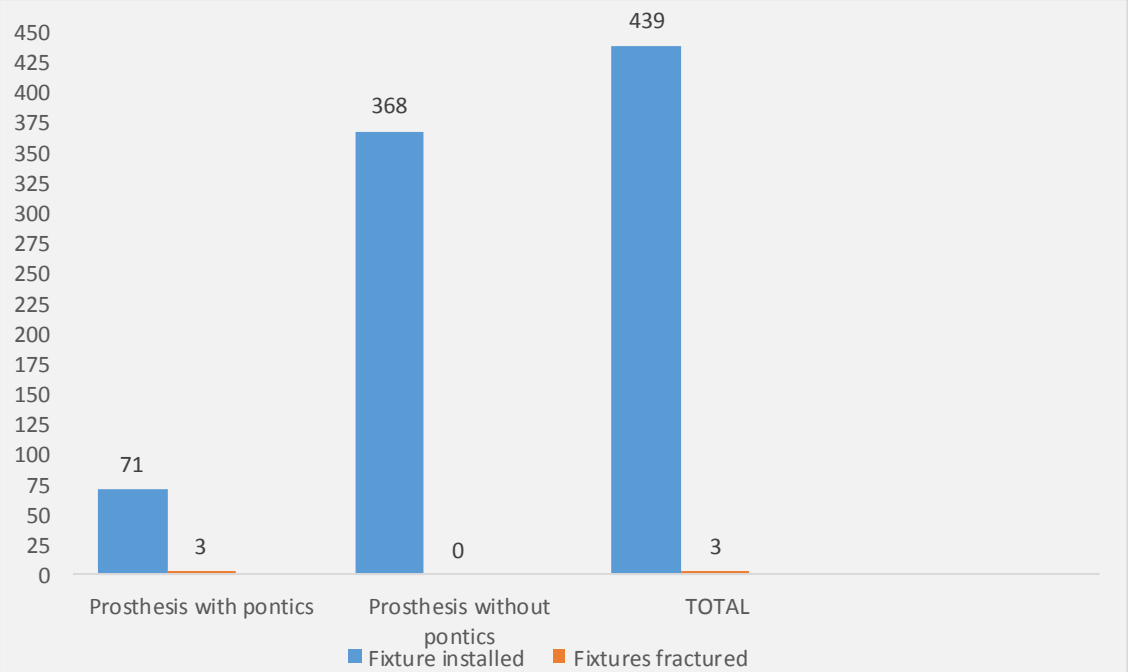


Fig.(7) : implant fixture fracture in relation to the type of prosthesis

Table (7): implant fixture fracture in relation to the type of prosthesis

Type of prosthesis	Fixture installed		Fixture fracture	
	NO.	%	NO.	%
Prosthesis with Pontics	71	16.1%	3	4.2%
Prosthesis without pontics	368	83.8%	0	0%
Total	439	100%	3	0.6%

References

1- Gallucci, G. O., Benic, G. I., Eckert, S. E., Papaspyridakos, P., Schimmel, M., Schrott, A., & Weber, H. P. Consensus statements and clinical recommendations for implant loading protocols. International Journal of Oral and Maxillofacial Implants, 29(Suppl), 287–290; 2014. https:// doi.org/10.11607/jomi.2013.g4.

2-Brugger, O.E., Bornstein, M.M., Kuchler, U., Janner, S.F., Chappuis, V., Buser, D.,. Implant therapy in a surgical specialty clinic: an analysis of patients, indications, surgical procedures, risk factors, and early failures. Int. J. Oral. Maxillofac. Implant. 30, 151–160; 2015.

3-Walter Cristiano Gealh, Vale´riaMazzo, Francisco Barbi, EdevaldoTadeu Camarini, Osseointegrated Implant Fracture: Causes and Treatment; Journal of Oral Implantology: Vol. XXXVII/No. Four/2011:4992.

4-Al Quran FA, Rashan BA, Al-Dwairi ZN. Management of dental implant fractures.A case history. J Oral Implantol. 35:210-14 ;2009.

5-Tonetti MS, Schmid J. Pathogenesis of implant failures. Periodontol 2000. 4:127–138.-:503 ;1994.

6-Hjalmarsson, L., Gheisarifar, M., Jemt, T.,. A systematic review of survival of single implants as presented in longitudinal studies with a follow-up of at least 10 years. Eur. J. Oral. Implantol. 9 (Suppl 1), S155–S162;2016.

7-Eckert SE, Meraw SJ, Cal E, Ow RK. Analysis of incidence and associatedfactors with fractured implants: a retrospective study. Int J Oral MaxillofacImplants. 15:662-67;2000.

8- Tonetti MS, Schmid J. Pathogenesis of implant failures. Periodontol 2000. 4:127–138 ;1994 .

9-The free Dictionary by Farlex ;Medical Dictionary for the Dental Professions ,walter klnewer, Lippincott, Williams and Wilkins© Farlex 2012

10-Balshi TJ. An analysis and management of fractured implants: a clinical report. Int J Oral Maxillofac Implants. 11(5):660-6;1996.

11- Piatelli A, Piatelli M, Scarano A, Montesani L.Light and scanning electron microscopic report of fourfractured implants. Int J Oral Maxillofac Implants.
13:561–564;1998.

12- Schwarz MS. Mechanical complications of dental
implants. Clin Oral Implants Res. 11(suppl):156–158;2000.

13- Singh A, Vivek R, Chaturvedi TP, Chauhan P, Gupta S. SEM
Analysis and Management of Fracture Dental Implant. Case
Rep Dent. 2013:270385;2013.

14-Sánchez-Pérez A, Moya-Villaescusa MJ, Jornet-Garcia A, Gomez S. Etiology, risk factors and management of implant fractures. S.Med Oral Patol Oral Cir Bucal. 1:E504-508;2010.

15-Marcelo Coelho Goiato, Marcela Filié Haddad, HumbertoGennariFilho,Luiz Marcelo Ribeiro Villa, Daniela Micheline dos Santos, AldiérisAlvesPesqueira,; Dental Implant Fractures – Aetiology,Treatment and Case Report ; Journal of Clinical and Diagnostic Research. Mar, Vol-8(3): 300-304; 2014.

16- Coray, Rafaela; Zeltner, Marco; Özcan, Mutlu. Fracture strength of implant abutments after fatigue testing: A systematic review and a meta-analysis. Journal of the Mechanical Behavior of Biomedical Materials, 62:333-346;2016.
DOI: https://doi.org/10.1016/j.jmbbm.2016.05.011-

17-Brägger U, Aeschlimann S, Bürgin W, Hämerle CH, Lang NP. Biological and
technical complications and failures with fixed partial dentures (FPD) on implants and teeth after four to five years of function. Clin Oral Implants Res. 12:26-34; 2001.

18- Manda MG, Psyllaki PP, Tsipas DN, Koidis PT. Observa-tions on an in-vivo failure of a titanium dental implant/abut-ment screw system: a case report. J Biomed Mater Res B Appl Biomater. 89(1):264-73;2009.

19- Quirynen M, Naert I, van Steenberghe D. Fixture design and overload influence marginal bone loss and fixture success in the Branemark system. Clin Oral Implants Res. 3(3):104-11;1992.

20- Jemt T, Linden B, Lekholm U. Failures and complications in127 consecutively placed fixed partial prostheses supportedby Branemark implants: from prosthetic treatment to first annual checkup. Int J Oral Maxillofac Implants. 7(1):40-4;1992.

21- Mendonca G, Mendonca DB, Fernandes-Neto AJ, Neves FD.
Management of fractured dental implants: a case report. Implant Dent. 18(1):10-6;2009.

22- Manzoor B, Suleiman M, Palmer RM. The effects of simu-lated bone loss on the implant-abutment assembly and likeli-hood of fracture: an in vitro study. Int J Oral Maxillofac Im-plants. 28(3):729-38;2013.

23- Marcelo Coelho Goiato • Agda Marobo Andreotti • Daniela Micheline dos Santos • Adhara Smith Nobrega • Fernanda Pereira de Caxias • Lisiane Cristina Bannwart. Influence of length, diameter and position of the implant in its fracture incidence: A Systematic Review. J Dent Res Dent Clin Dent Prospect 13(2):109-116;2019.

24- Jung RE, Pjetursson BE, Glauser R, Zembic A, Zwahlen M, Lang NP. A systematic review of the 5-year survival and complication rates of implant-supported single crowns. Clin Oral Implants Res. 19(2):119-30;2008.

25- Zarb GA, Schmitt A. The longitudinal clinical effectiveness of osseointegrated dental implants: the Toronto study. Part III: Problems and complications encountered. J Prosthet Dent. 64(2):185-94;1990.

26-Allen PF, McMillan AS, Smith DG. Complications and maintenance requirements of implant-supported prostheses provided in a UK dental hospital. Br Dent J. 182(8):298-302;1997.

27- Victor Eduardo de Souza Batista, Fellippo Ramos Verri, Daniel Augusto deFaria Almeida, Joel Ferreira Santiago Junior, Cleidiel Aparecido Araújo Lemos & Eduardo PizaPellizzer .Finite element analysis of implant-supported prosthesis with pontic and cantilever in the posterior maxilla, Computer Methods in Biomechanics and Biomedical Engineering, 20(6):663-670;2017 .

28-Chen XY, Zhang CY, Nie EM, Zhang MC. Treatment planning of implants when 3 mandibular posterior teeth aremissing: a 3-dimensional finite element analysis. ImplantDent. 21:340–343;2012.

29- Gahlert M, Burtscher D, Pfundstein G, Grunert I, Kniha H, Roehling S. Dental zirconia implants up to three years in function: a retrospective clinical study and evaluation of prosthetic restorations and failures. Int J Oral Maxillofac Im-plants. 28(3):896-904;2013.

30- Srinivasan M, Vazquez L, Rieder P, Moraguez O, Bernard JP, Belser UC. Efficacy and predictability of short dental im-plants (<8 mm): a critical appraisal of the recent literature. Int J Oral Maxillofac Implants. 27(6):1429-37;2012.

31-Green NT, Machtei EE, Horwitz J, Peled M.Fracture of dental implants: literature review and reportof a case. Implant Dent. 11:137–143;2002.

32- Krogh P. Surgical and biomechanical advantagesof large-diameter implants. In: Siddiqui AA, Caudill R.Proceedings of the Fourth International Symposium onImplant Dentistry: Focus on Esthetics; January 27 through 29, 1994; San Diego, CA. J Prosthet Dent. 72:623–634;1994.

33- Muroff FI. Removal and replacement of a fractured dental implant: case report. Implant Dent. 12:206–210;2003.

34- Rangert B, Jemt T, Jorneus L. Forces andmoments on Branemark Implants. Int J Oral Maxillofac Implants. 4:241–247;1989.

35- Rangert B, Krogh PHT, Langer B, Roekel NV.Bending overload and implant fracture: a retrospective clinical analysis. Int J Oral Maxillofac Implants. 10:326–333; 1995.