



Reconstruction Plate Fracture: Mechanism and Recent Advances

Monika Parmar¹, Manish Kumar Sharma^{2*}, Anupriya Sharma³

¹Professor, Department of Oral and Maxillofacial Surgery, HP Government Dental College and Hospital, Shimla, Himachal Pradesh, India.

Email: monanegi@gmail.com,
Orcid ID: 0000-0002-9978-1075

²Resident, Department of Oral & Maxillofacial Surgery, HP Government Dental College and Hospital, Shimla, Himachal Pradesh, India.

Email: manishsharmamfos@gmail.com,
Orcid ID: 0000-0002-1722-3118

³Associate Professor, Department of Dentistry, Dr Radhakrishnan Government Medical college, Hamirpur, Himachal Pradesh, India.

Email: anu_s_priya@yahoo.com
Orcid Id: 0000-0003-3098-8980

*Corresponding author

Received: 12 December 2022

Revised: 18 January 2023

Accepted: 31 January 2023

Published: 28 February 2023

Abstract

Reconstruction plates with or without bone grafts are used to restore mandibular continuity, form and function following segmental resection of mandible. Fracture of reconstruction plate is observed in 2.9 % to 10% of cases reported in the literature excluding other complications. In this case, we report the fracture of stainless steel reconstruction plate used without bone graft and its management using locking reconstruction plate with non vascularised iliac crest graft following removal of the fractured plate. Review of literature describing incidence, pattern and causes of reconstruction plate fracture and its management is discussed.

Keywords:- Mandibular Reconstruction plate, Reconstruction plate fracture, Non- vascularised iliac crest bone graft, Mandibular segmental resection, Odontogenic keratocyst.

INTRODUCTION

Mandibular segmental resection is needed as a part of the treatment for carcinomas of the oral cavity, benign tumors and extensive cystic lesions of the jaw resulting in facial deformity and impaired oral functions like mastication, speech, swallowing, saliva retention etc. Reconstruction plates with or without autogenous bone grafts are used for restoration of bone continuity, facial contour and mandibular function. Fracture of the reconstruction plate along with other

complications like infection, oro-cutaneous fistula, screw loosening and plate exposure are among the various complications reported with the use of mandibular reconstruction plates.^[1,2] Here we are presenting a case of reconstruction plate fracture with the review of literature.

CASE REPORT

A 23 year old male came to the Department of Oral & Maxillofacial Surgery in November 2018 with the complaint of pain and difficulty in mouth opening and chewing food since 3

weeks. Patient was diagnosed in the year 2014 with Odontogenic keratocyst in the left body of mandible and was managed by segmental resection of mandible along with reconstruction of mandible with 2.4 mm Stainless Steel Reconstruction plate. On clinical examination, face was asymmetrical with hollowing of left lower jaw with painful and restricted mouth opening. There was a collapsed mandibular arch in left posterior region and obliteration of left vestibular region. No wound dehiscence or exposure of Reconstruction plate was seen. On radiological examination fracture of Reconstruction plate was observed. [Figure 1] Patient presented no history of any external injury over lower jaw but gave history of cracking sound while eating hard food 3 weeks back. All the routine blood investigations were normal. Informed consent was taken from patient. A left submandibular incision was given and layer wise dissection was done and the fractured stainless steel reconstruction plate was removed. [Figure 2] Right non-vascularised iliac crest graft was harvested and the mandibular continuity defect was reconstructed with non-vascularised iliac crest graft and fixed with 2.4 mm Titanium Locking Reconstruction plate. [Figure 3 and Figure 4] Layer wise suturing was done and negative pressure drain was placed. There was minimal amount of intra operative bleeding and no infectious complications were found post operatively. Intermaxillary elastics were placed and maintained for 14 days. Patient was followed every three months for one year. During follow up normal occlusion was restored and remained stable with maximum inter-incisal opening of 40mm at one year post operatively.

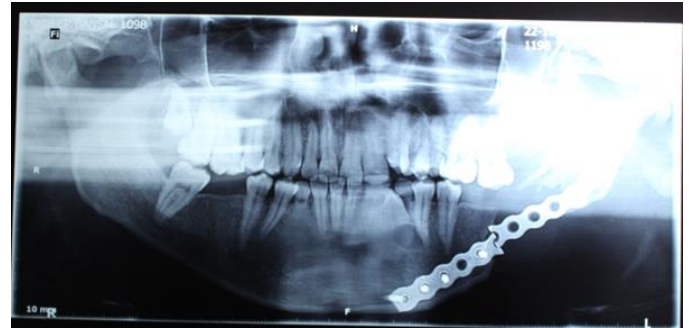


Figure 1: An Orthopantomogram showing a fractured stainless steel mandibular reconstruction plate

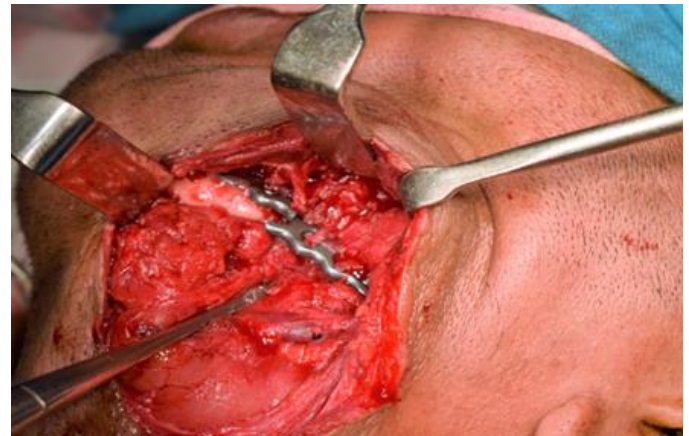


Figure 2: (in colour) An intra operative image showing mandibular reconstruction plate fracture.

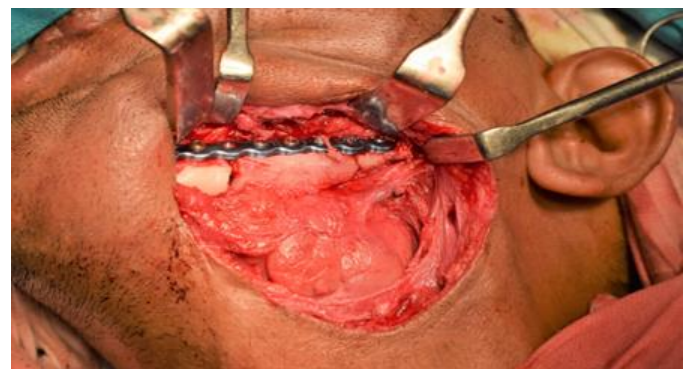


Figure 3: (in colour) An intra operative image showing reconstruction of mandible with non-vascularised iliac crest graft with 2.0 mm Locking Titanium Reconstruction plate



Figure 4: One year post operative follow up Orthopantomogram of patient.

DISCUSSION

Reconstruction plate is used with vascularised or non-vascularised bone graft for restoring mandibular form and function with maintenance of bone continuity and contour following segmental resection of mandible in order to treat extensive cystic lesions, benign and malignant tumors of the oral cavity.^[1] Mandibular arch defects can also be restored only with mandibular reconstruction plate without the use of bone graft easily and quickly without donor site morbidity with maintenance of good oral function and esthetics.^[3,4]

Spiessl et al (1976) first used three dimensional bendable plates to reconstruct mandibular segmental defects following tumor resection.^[3,5] Initially AO stainless steel reconstruction plates followed by Titanium Non-locking reconstruction plates were used. Introduction of Titanium hollow screw osseointegrating reconstruction plates (THORP) was later on followed by the advent of Locking mandibular Titanium Reconstruction plates with new design improvements incorporated to make the plates of thinner profile.^[6,7,8]

Complications associated with the use of mandibular reconstruction plates includes infection, oro-cutaneous fistula, wound dehiscence, screw loosening, plate exposure and plate fracture with combined incidence rate ranging from 30% to 45%.^[1,3,6] Rate of plate fracture is reported to be in the range of 2.9 % to 10.7 % in patients without bone graft.^[2,6,9,10,11,12,13] Minnen et al reported only 3% incidence of Stainless steel Reconstruction plate fracture and suggested its use when other options are inappropriate.^[11] Rate of plate fracture is more in patients who are treated with reconstruction plate without bone graft than with bone graft.^[6,10,14]

Factors that seem to influence the fracture of the reconstruction plate includes type of plate used, size of the defect, number of teeth remaining in the dentition and functional loading of mandible which varies from patient to patient depending on type of diet consumed, forces of mastication and length of time passed since surgery.^[2,15]

Bending of Reconstruction plates while adapting to the remaining mandibular segments generate residual stresses and increase notch sensitivity which further affect the mean stress when repetitive mastication produce metal fatigue impairing its fatigue properties. Inner curvature of the reconstruction plate specially at shoulder fillet particularly at the notch of plate edge are the sites of initial crack which further propagates in cyclic manner under the masticatory load resulting in plate fracture over time.^[2,10,13]

Increased incidence of plate fracture depends upon plate design as well as mechanical properties of metal used. Titanium show elastic



deformation twice as stainless steel with less stress shielding during physiologic loading as Titanium has low modulus of elasticity compare to stainless steel. Despite of the low mechanical strength of Titanium, with corrected dimensions it can be made as strong as Stainless steel with 30% to 40% less stiffness. All these mechanical factors make Titanium plates less prone to fracture over time compare to Stainless steel plates. Stainless steel plates also have increased fretting corrosion leading to more screw loosening compared to Titanium plates.^[15]

Titanium is biocompatible, show superior ductility with ease of contouring as well as less signal interference on MRI & CT.^[8]

Plate is mostly fractured at its junction with the residual mandible which is the area of stress during function leading to metal fatigue and is also the most frequent area of plate bending while adaptation of plate to the contour of mandible. The reconstruction plate in our case report also fractured near the junction of plate with the mandible. Angular plates are shown to have more chances of fracture compare to straight plates.^[10] The reconstruction plate used in our case was of the angular type.

According to HCL classification, reconstruction plate fracture is commonly seen in patients treated having Type L defect.^[11,14] The case presented in this report also had type L defect. When coronoidectomy is performed with segmental resection specially involving angle region of mandible due to which masticatory force of temporalis muscle is not transferred to mandible during function resulting in less stress on reconstruction plate which may reduce hardware related complications.^[14]

Most studies reported plate fracture early in post operative time generally within 2 years but most cases appear in less than 6 months.^[12,13,14,16,17,18] In the case presented in this report the stainless steel reconstruction plate has performed fairly well and fractured after four years since surgery.

Locking Plates are a kind of internal-external fixator with screw heads locking into plates. This gives an advantage that plate need not to be bent to be perfectly adapted to mandible resulting in less stress concentration and less chances of plate fracture. Other complications like screw loosening and bone resorption are also reduced as there is less compression of plate to the bone.^[7,19]

Recently attempts have been made to develop New Hybrid Reconstruction plates having continuous profile, non-uniform thickness, triangular cross-section pattern with locking screw feature to secure bone transplant at position that favours prosthetic rehabilitation with dental implants.^[20]

With advances in the Reconstruction plate material and design, improvement in the incidence of plate fracture is noted.^[6] Use of non- locking plates with regular profile are no longer recommended due to its higher complication rates as newer design reconstruction plates with low profile and locking screws are available.^[4,7,21] Use of 2 mm Locking Reconstruction plate with vascularised bone flap in the reconstruction of mandibular segmental defect gives the advantage of improved malleability, low contour, better cosmesis with similar complication risk as with 2.4 mm Locking Reconstruction plate.^[8,19]

Militsakh et al reported no fracture of 2mm LRP when used with vascularised free flap.^[8]

Fractured plates should be treated immediately as this not only inhibit oral functions (mastication, deglutition) and cause facial contour deformity but can further cause contamination, dehiscence and plate exposure.^[2]

Peacock et al described a novel technique of repairing fractured reconstruction plates with custom prosthesis with minimal invasive

surgery in patients who are not amenable for autologous tissue reconstruction due to reasons of poor health or prognosis.^[2]

CONCLUSIONS

Fracture of reconstruction plate can occur more commonly when used alone. With new advances in reconstruction plate design and its use along with vascularised or non vascularised bone grafts, the incidence of plate fracture is decreasing.

REFERENCES

1. Maurer P, Eckert AW, Kriwalsky MS, Schubert J. Scope and limitations of methods of mandibular reconstruction: a long-term follow-up. *Br J Oral Maxillofac Surg.* 2010;48(2):100-4. doi: 10.1016/j.bjoms.2009.07.005.
2. Peacock ZS, Afshar S, Lukas SJ, Kaban LB. Customized repair of fractured mandibular reconstruction plates. *J Oral Maxillofac Surg.* 2012;70(10):e563-73. doi: 10.1016/j.joms.2012.06.002.
3. Lavertu P, Wanamaker JR, Bold EL, Yetman RJ. The AO system for primary mandibular reconstruction. *Am J Surg.* 1994;168(5):503-7. doi: 10.1016/s0002-9610(05)80111-4.
4. Arias-Gallo J, Maremonti P, González-Otero T, Gómez-García E, Burgueño-García M, Chamorro Pons M, et al. Long term results of reconstruction plates in lateral mandibular defects. Revision of nine cases. *Auris Nasus Larynx.* 2004;31(1):57-63. doi: 10.1016/j.anl.2003.09.006.
5. Mariani PB, Kowalski LP, Magrin J. Reconstruction of large defects postmandibulectomy for oral cancer using plates and myocutaneous flaps: a long-term follow-up. *Int J Oral Maxillofac Surg.* 2006;35(5):427-32. doi: 10.1016/j.ijom.2005.10.008.
6. Klotch DW, Gal TJ, Gal RL. Assessment of plate use for mandibular reconstruction: has changing technology made a difference? *Otolaryngol Head Neck Surg.* 1999;121(4):388-92. doi: 10.1016/S0194-5998(99)70226-3.
7. Knott PD, Suh JD, Nabili V, Sercarz JA, Head C, Abemayor E, et al. Evaluation of hardware-related complications in vascularized bone grafts with locking mandibular reconstruction plate fixation. *Arch Otolaryngol Head Neck Surg.* 2007;133(12):1302-6. doi: 10.1001/archotol.133.12.1302.
8. Militsakh ON, Wallace DI, Kriet JD, Girod DA, Olvera MS, Tsue TT. Use of the 2.0-mm locking reconstruction plate in primary oromandibular reconstruction after composite resection. *Otolaryngol Head Neck Surg.* 2004;131(5):660-5. doi: 10.1016/j.otohns.2004.04.033.
9. Freitag V, Hell B, Fischer H. Experience with AO reconstruction plates after partial mandibular resection involving its continuity. *J Craniomaxillofac Surg.* 1991;19(5):191-8. doi: 10.1016/s1010-5182(05)80546-3.
10. Shibahara T, Noma H, Furuya Y, Takaki R. Fracture of mandibular reconstruction plates used after tumor resection. *J Oral Maxillofac Surg.* 2002;60(2):182-5. doi: 10.1053/joms.2002.29817.
11. van Minnen B, Nauta JM, Vermey A, Bos RR, Roodenburg JL. Long-term functional outcome of mandibular reconstruction with stainless steel AO reconstruction plates. *Br J Oral Maxillofac Surg.* 2002;40(2):144-8. doi: 10.1054/bjom.2001.0738.
12. Gellrich NC, Suarez-Cunqueiro MM, Otero-Cepeda XL, Schön R, Schmelzeisen R, Gutwald R. Comparative study of locking plates in mandibular reconstruction after ablative tumor surgery: THORP



- versus UniLOCK system. *J Oral Maxillofac Surg.* 2004;62(2):186-93. doi: 10.1016/j.joms.2003.04.012.
13. Martola M, Lindqvist C, Hänninen H, Al-Sukhun J. Fracture of titanium plates used for mandibular reconstruction following ablative tumor surgery. *J Biomed Mater Res B Appl Biomater.* 2007;80(2):345-52. doi: 10.1002/jbm.b.30603.
 14. Seol GJ, Jeon EG, Lee JS, Choi SY, Kim JW, Kwon TG, et al. Reconstruction plates used in the surgery for mandibular discontinuity defect. *J Korean Assoc Oral Maxillofac Surg.* 2014;40(6):266-71. doi: 10.5125/jkaoms.2014.40.6.266.
 15. Futran ND, Urken ML, Buchbinder D, Moscoso JF, Biller HF. Rigid fixation of vascularized bone grafts in mandibular reconstruction. *Arch Otolaryngol Head Neck Surg.* 1995;121(1):70-6. doi: 10.1001/archotol.1995.01890010056010.
 16. Katakura A, Shibahara T, Noma H, Yoshinari M. Material analysis of AO plate fracture cases. *J Oral Maxillofac Surg.* 2004;62(3):348-52. doi: 10.1016/j.joms.2003.05.009.
 17. Schupp W, Arzdorf M, Linke B, Gutwald R. Biomechanical testing of different osteosynthesis systems for segmental resection of the mandible. *J Oral Maxillofac Surg.* 2007;65(5):924-30. doi: 10.1016/j.joms.2006.06.306.
 18. Lindqvist C, Söderholm AL, Salo A, Subasinghe J, Ylijoki S, Skutnabb K, et al. A comparative study on four screw-plate locking systems in sheep: a clinical and radiological study. *Int J Oral Maxillofac Surg.* 2001;30(2):160-6. doi: 10.1054/ijom.2000.0037.
 19. Farwell DG, Kezirian EJ, Heydt JL, Yueh B, Futran ND. Efficacy of small reconstruction plates in vascularized bone graft mandibular reconstruction. *Head Neck.* 2006;28(7):573-9. doi: 10.1002/hed.20455.
 20. Wu CH, Lin YS, Liu YS, Lin CL. Biomechanical evaluation of a novel hybrid reconstruction plate for mandible segmental defects: A finite element analysis and fatigue testing. *J Craniomaxillofac Surg.* 2017;45(10):1671-1680. doi: 10.1016/j.jcms.2017.07.010.
 21. Kim Y, Smith J, Sercarz JA, Head C, Abemayor E, Blackwell KE. Fixation of mandibular osteotomies: comparison of locking and nonlocking hardware. *Head Neck.* 2007;29(5):453-7. doi: 10.1002/hed.20541.

Source of Support: Nil, Conflict of Interest: None declare