Case study

A novel approach for restoration of hemisected mandibular first molar with immediately loaded single piece BCS implant: A case report

Mahender Singh^a, Ranmeet Batra^a, Debdutta Das^a, Shweta Verma^{b,*}, Munish Goel^b^a Department of Oral & Maxillofacial Surgery, Himachal Institute of Dental Sciences, Paonta Sahib, Himachal Pradesh, India^b Department of Conservative Dentistry & Endodontics, Himachal Dental College, Sundernagar, Himachal Pradesh, India

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ABSTRACT

Mandibular first molars are the major standpoint for occlusion, and also have a wide peri-cemental area. Under specific conditions, hemisection of the tooth is indicated after an endodontic treatment. The following case report presents the hemisection of grossly carious, endodontically treated mandibular first molar, in a 23 year old female, followed by replacement of the mesial root with a single piece immediate loaded BCS (Bi-Cortical Screw) implant and a single unit porcelain fused to metal crown for the prosthetic rehabilitation of the remaining tooth structure, with the BCS implant providing strength and support to the weakened tooth structure. This procedure is an innovation in prosthetic rehabilitation of tooth structure left after hemisection and enhances the predictability of success rate of hemisection.

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1. Introduction

The reason many teeth do not respond to root canal treatment is because of procedural errors that prevent the control and prevention of intracanal endodontic infection.¹ Intra-canal separation of instrument often impedes or makes it impossible to accomplish appropriate disinfection procedures. Also, improper post-endodontic restoration leads to failure of root canal treatment. Once the coronal seal is lost, microorganisms, their products and other irritants from saliva may reach the peri-radicular tissues via lateral canals or apical foraminas, and thereby jeopardize the outcome of root canal treatment, regardless of the obturation technique employed.²

According to Weine, in cases with severe coronal destruction involving floor of the pulp chamber, one of the treatment options is hemisection.³ The terms 'hemi-section' and 'root amputation' are known collectively as 'root resection'.^{4,5} Hemisection refers to sectioning of a molar into two halves followed by removal of the diseased root and its coronal portion. The retained root is endodontically treated and restored with an extra-coronal restoration. Successful replacement of extracted root following endodontic failure; immediately post extraction by implants have been proven.⁶

In the past, not much stress has been given to the prosthetic rehabilitation following hemisection of the tooth. The prosthesis placed after hemisection should result in restoration of tooth form and function, along with proper distribution of occlusal forces. In routine, a modified fixed partial denture design is fabricated to splint the remaining portion of the tooth to adjacent teeth. A fixed partial denture is placed with retained root and one adjacent intact tooth as abutments. To prevent jeopardizing the adjacent tooth structure, placing an implant in the extraction socket of the diseased root appears to be a novel procedure providing prosthetic rehabilitation of tooth structure left after hemisection. This procedure enhances the predictability of success rate of hemisection. This hybrid kind of prosthesis act as a splint for root structure left after hemisection.

In BCS system (Idhe Dental, Germany), implant and abutment are fused to form a single piece. This eliminates interface problems which are experienced in case of two or three piece implants.⁷ BCS Implant (Bi-Cortical Screw or Basal cortical implants) has disc shaped screw threads which engage both the cortical and basal bone to get a high strength immediately, making BCS Implants eligible for immediate loading.

These screwable basal implants are flapless implants and are inserted through gum, without giving a single cut after extraction of teeth. Bicortical screws (BCS) are also considered basal implants, because they transmit masticatory loads deep into the bone, usually into the opposite cortical bone, while full osseointegration along the axis of the implant is not a prerequisite. The indications for BCS implants include; all kinds of situations when single or

* Corresponding author at: Department of Conservative Dentistry & Endodontics, Himachal Dental College, Sundernagar, Mandi 175002, Himachal Pradesh, India.
E-mail address: drmahenderbds@gmail.com (S. Verma).

several teeth are missing or have to be extracted, when the procedure of 2-stage implant placement or bone augmentation has failed, all kinds of bone atrophy i.e., in cases of very thin ridges.⁸

Thus, this report presents a case of hemisection of an endodontically treated grossly carious mandibular first molar where the BCS Implant was placed in the fresh extraction socket of extensively carious mesial root with endodontic failure. This case, to the best of our knowledge, is the first of its kind to be reported in literature, where a molar hemisection has been followed by immediate placement of BCS implant and prosthetic rehabilitation to attain near original form and function.

2. Case report

A 23 years-old female patient reported to the Department of Oral and Maxillo-facial Surgery with chief complaint of pain on mastication and food lodgement in her grossly carious mandibular left first molar, for which she had undergone root canal treatment around an year ago without a full coverage crown. The medical history was non-contributory.

On intraoral examination, the grossly carious mandibular left first molar was evident involving the furcation area and extending subgingivally in the mesial root of the tooth (Fig. 1a and b). On radiographic examination, a broken instrument was seen in mesial root of the tooth with peri-apical radiolucency. The distal root was poorly obturated. Hence the tooth was diagnosed with post-treatment apical periodontitis with radiographic evidence of instrument separation in the mesial root.

Considering the young age and awareness of the patient, it was planned to save the tooth rather than extracting it. Endodontic retreatment of distal root followed by hemisection of mesial root was planned. Instead of going for conventional fixed partial denture with tooth # 35 and distal root of tooth #36 as abutments, placement of immediate single piece BCS implant in the fresh extraction socket of mesial root of 36 was considered as a better treatment option^{6,7} to be followed by placement of a porcelain fused to metal crown. The treatment plan was explained to the patient and a written consent was obtained. The following interdisciplinary treatment protocol was then carried out.

2.1. Step 1: Retreatment of distal root of left mandibular first molar

The existing guttapercha was removed from the distal canal of the tooth using guttapercha solvent (Endosolv) and H files (Mani). It was then prepared using stainless steel files by step back technique. Following this it was obturated using lateral condensation with 2% guttapercha cones and AH plus resin based sealer. The core build up was done in retained distal root.

2.2. Step 2: Hemisection and removal of diseased mesial root followed by placement of BCS implant in the extraction socket of the mesial root

Hemisection procedure was taken-up one week after retreatment. Local anaesthesia was administered. A direct root resection of mesial root was undertaken in this case because the BCS implant has to be placed in fresh extraction socket with intact cortical bone. The tooth was carefully sectioned and the damaged mesial root removed (Fig. 2a and b). Any defects on the sound distal root were smoothed.

Following hemisection, the bone drilling was done with ATR (Advanced Technology Research) physiodispenser and reduction handpiece with internal irrigation. Initially DOS 1 pilot drill with 2 mm diameter at the base was used. Then the final preparation of the implant bed was done with twist drill no. 1 measuring 2 mm in diameter (Fig. 2c). The osteotomy was done 3 mm beyond the apex of the root to engage the healthy cortical bone to provide initial stability.⁹ Then the single piece BCS IMPLANT no. 3.5(14) (Fig. 2d) with fixed abutment was inserted very cautiously as the implant may fracture during tightening (Fig. 2d). The correct placement of the implant was seen on the radiograph (Fig. 2e). A good primary stability of the implant was achieved by engaging the cortical bone which also provides sufficient load bearing capacity. The crown preparation was done on the retained distal abutment (Fig. 2f).

The mucosa was closed with 3.0 Silk-suture over the implant. Right after the surgical intervention an impression was taken using the impression caps BCS-system and precision silicone around the teeth and the cast poured (Fig. 3a). Post operative Amoxicillin 500 mg thrice daily and Ibuprofen 400 mg BD for 5 days. Also, Chlorhexidine 0.12% mouth rinse was prescribed to the patient for 1 week.

2.3. Step 3: Placement of splint kind of prosthesis

The implant was loaded at three days interval. Single unit porcelain fused to metal crown was placed on core of retained distal root and abutment of BCS implant (Fig. 3b). The occlusion and proper extension of the margins of the prosthesis were ensured clinically and radiographically before its permanent cementation. The prosthesis was cemented with Fuji I luting glass ionomer cement (Fig. 3c).

2.4. Step 4: Clinical and Radiographic assessment

The clinical parameters assessed were pain on mastication, primary implant mobility using (Modified Miller's Mobility index)¹⁰ and gingival status around the implant (using Apse et al. Index)¹¹. Implant mobility was assessed immediately postoperatively and at a follow up period of 48 h, 1 month, 3 months and

Fig. 1. (a) Pre-operative radiograph revealing furcation involvement and broken instrument with peri-apical radiolucency in the mesial root of mandibular left first molar.³⁶ (b) Retreatment of distal root done and core build up completed.

Fig. 2. (a) Hemisection of mesial root of 36 done. (b) Hemisected mesial root. (c) BCS IMPLANT KIT with all twist and pilot drills. (d) BCS IMPLANT selected for placement in fresh extraction socket of mesial root of 36. (e) Verification of osteotomy site on radiograph. (f) Clinical placement of implant in fresh extraction socket of mesial root. (g) Verification of final implant placement on peri-apical radiograph. (h) Crown reduction in core of retained distal root.

Fig. 3. (a) Upper and lower casts with splint kind of prosthesis in place. (b) Verification of margins of prosthesis intraorally. (c) Final luting of prosthesis done. (d) Follow up photograph at 6months interval.

6 months with two rigid instruments which were used to apply a labiolingual force and a score was given using *Modified Miller's Mobility index*.

Radiographically bone density around the implant and crestal bone loss were assessed. Changes in the bone density were evaluated immediately after implant placement and at a follow up period of 1, 3 and 6 months. Seven 1 mm^2 regions-of-interest (ROI) around the implant were evaluated and summed up to attain mean bone density.¹² The eight reference points at which the bone densities were evaluated are as follows:

- Crestal: Point A and G, at the top of implant neck on the mesial and distal aspect, respectively.
- Middle: Point B and F, 3 mm below the base of implant neck on the mesial and distal aspect, respectively.
- Apical: Point C and E, on the mesial and distal aspect of the implant apex between the two apical helices respectively and D directly below the implant apex.

The pre-operative bone density was standardized to have a single value of 100% in all subjects and post operative

values were calculated as percentile of this value using this formula:

$$\frac{100}{\text{Mean of Bone density (Pre-operative)}} \times \text{Mean of Bone density (Post-operative)}$$

Scoring for bone density:

Score	Bone density
0	90–100%
1	80–90%
2	70–80%
3	<70%

Crestal bone loss was evaluated at a follow up period of 6 months by summing up the mean values of mesial and distal marginal bone loss levels from the implant's neck using the intraoral periapical radiographs.

The same parameters were also assessed at 1 year interval.

2.5. Treatment outcome

The one week follow-up showed good healing and evidence of good oral hygiene. The patient could chew well from that side. There was no pain on mastication and mobility of implant at all time intervals (score 0 according to Modified Miller Mobility Index). The probing depth around the prosthesis and in the furcation area was within the normal limits at all time intervals. There was minimal gingival inflammation present around the implant at all time intervals (score 1 according to Apse et al.). The score for gingival inflammation at 6 months and 1 year follow up was 0. The mean marginal bone loss around the implant at 6 months was 0.57 ± 0.13 mm and at 1 year was 0.75 ± 0.13 mm. The assessment of mean bone density around the implant showed the gradual increase in bone around implant with time (Tables 1 and 2).

Near 100% bone density was reached at 6 months and 1 year follow-up (Fig. 4a and b).

3. Discussion

Two different approaches for immediate loading of dental implants are currently known. Both have in common the implicational concept that splinting/stabilization of several implants is accomplished through the prosthetic superstructure. The first approach relies on the compression screw principle. Screw implants of this type can result in lateral condensation of spongy areas. Implant stability is greatly increased by a mechanism that could be regarded as “corticalization” of the spongy bone (KOS). The second approach is to establish cortical anchorage of thin screw implants [bicortical screw (BCS)] or basal implants.

Buhler stated that hemisection should be considered before every molar extraction, because it provides a good, absolute, and biological cost saving alternative with good long term success. A guiding principle should be to try and maintain what is present.^{4,5} When the tooth loses part of its root support, it will require a restoration to permit it to function independently or serve as an abutment for fixed partial denture or splint. Thus, restoration is required for function and stabilization of occlusion.

In the present case, single piece BCS implant was placed in fresh extraction socket of hemisected mesial root.⁶ Wongthai P and Rosen J, in their case report in 1993, described the replacement of the mesial root of the mandibular first molar, 5 months after hemisection, with a root form implant followed by two separate crowns for the retained distal root and the implant 4 months after the implant placement.¹³ The immediate-loading dental implants are more predictable than before,¹⁴ though the chances of crestal bone loss are comparatively higher.¹⁵ With BCS implants, surgical procedures are not necessary, which means immediate extraction and implant placement is possible with immediate fixed teeth. The smooth long shaft of the BCS implant makes it virtually impossible for bacterial colonization and migration along the implant body. It helps to avoid peri-implantitis, the commonest problem seen with

Table 1
Assessment of bone density levels at different time intervals at crestal and middle level of implant length.

ROI → Timing ↓	Crestal (at top of implant neck)		Middle (3 mm below the base of implant neck)		Mean	Percentage %	Score
	Point A (mesial)	Point G (distal)	Point B (mesial)	Point F (distal)			
Pre-operative	104	106	113	111	108.5	100%	–
Immediate post-operative	62	68	80	87	74.25	68.43%	3
After 1 month	72	79	98	95	86	79.26%	2
After 3 months	88	94	104	103	97.25	89.63%	1
After 6 months	100	102	108	110	107.5	99.07%	0

Table 2
Assessment of bone density levels at different time intervals at 3 points at base of implant.

ROI → Timing ↓	3 points at the base of the implant			Mean	Percentage %	Score
	Point C (mesial)	Point D (center)	Point E (distal)			
Pre-operative	158	160	150	156	100%	–
Immediate post-operative	135	131	130	132	84.62%	1
After 1 month	145	140	140	141.67	90.81	0
After 3 months	146	140	138	141.33	90.59%	0
After 6 months	150	151	142	147.67	94.66%	0

Fig. 4. (A) Bone density at 6 months follow-up. (B) Bone density at 1 year follow-up.

conventional implants leading to their failure.⁷ Excellent primary stability can be obtained along the vertical surfaces of these implants with no need for corticalisation. Also, there is no need for a second uncovering surgical procedure which is necessary in conventional two piece implants. This reduces patient anxiety and also provides for prosthetic rehabilitation within 2–3 days.⁷

Restoration can contribute to periodontal destruction, if margins are defective or if nonocclusal surfaces do not have physiologic form. An improperly shaped occlusal contact area converts acceptable forces into destructive forces leading to ultimate failure of hemisection. Thus, the occlusal table is reduced in size in order to decrease the forces on the retained hemisected root. Cuspal inclines are made less steep to reduce laterally directed forces and eliminate the nonworking contacts. Retained root is restored as premolar which helped to reduce the masticatory load. All these factors were kept in mind while fabricating the splint kind of prosthesis in the present case.

In this case report the implant showed score 0 of Modified Miller's Mobility index at all time frames of follow-up. Lack of clinical movement does not mean the true absence of mobility. A healthy implant may move less than 75 μm yet it appears as zero clinical mobility. Clinical lack of implant mobility does not always coincide with a direct bone–implant interface. However, when observed clinically, lack of mobility usually means that at least a portion of the implant is in direct contact with bone, although the percentage of bone contact cannot be specified.¹⁶

The two critical factors that determine the success of an immediately, functional loaded construction is the proper insertion of the implant into cortical or corticalized bone with high primary stability and then the prevention of overloading of the bone-to-implant interface during the bone's healing. Both these aspects are covered well while the placement of BCS implant. In the present case report near 100% bone density levels were achieved at the end of 1 year follow-up. This increase in the bone density is due to special dual mode of healing of BCS Implant, similar to that seen in BOI Implants. There is plenty of space around the vertical aspects of BCS implants and inside the insertion socket. These spaces are filled with blood after the implant has been inserted. Healing in these areas further leads to remodelling into woven bone (a process that takes approximately weeks), which is subsequently pervaded by osteons. Then the further remodelling leads to increase in bone density.

Also, masticatory forces transmitted through the basal implants may create local microcracks in the cortical bone. These microcracks are repaired by a process called remodelling. This, however, will temporarily increase the porosity of the affected bone region and temporarily reduce the degree of mineralization additionally. Basal implants in this status have a good chance of getting reintegrated at a high degree of mineralization, if loads are reduced to an adequate amount.¹⁰

The mean Crestal bone loss inferior to 1.5 mm during the first year in function and an annual bone loss not exceeding 0.2 mm thereafter had been proposed as one of the major success criteria⁸. In our case, the mean Crestal Bone Loss was 0.57 ± 0.13 and 0.75 ± 0.13 mm at 6 months and 1 year follow-up, respectively.

Primary stability is generally achieved at the apical aspect of the implant fixture, but there is usually somewhat of a gap between the circumferential aspect of the immediate implant and the extraction socket wall, similar to seen in our case (Fig. 4a and b). The dimensions of this gap—sometimes referred to as the jumping distance—will vary depending on a number of factors, such as tooth type, the particular morphology of the extraction socket and the diameter of the implant being placed.¹⁷ The presence of a peri-implant gap affects both hard and soft tissue healing, and if not properly managed, may compromise function and jeopardize aesthetics. To manage this jumping gap; when treatment plan includes extraction (and potential immediate implant therapy), teeth should be extracted in the most atraumatic manner possible. Forces should be applied with low velocity and high duration to minimize trauma to the adjacent hard tissues, and the sectioning of multi-rooted teeth ought to be employed to prevent damage to facial plates and furcal bone, especially for molars.

Hence in the present case the patient continued to maintain healthy prosthesis with BCS implant. However, implant failure is easier to describe than implant success or survival and may consist of a variety of factors.

4. Conclusion

This case highlights the interdisciplinary approach of molar hemisection, implant placement and prosthetic rehabilitation as an innovative procedure providing immediate results with minimal patient apprehension and long term stability.

Conflicts of interest

The authors have none to declare.

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