Proposal and In-Depth Analysis of Emergency Treatment Procedures for Removing Fractured Abutments in Implants With Tapped-In Connections: Case Report

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In implant-supported prostheses, the most frequently reported mechanical complications after implant restoration are loosening or fracture of abutments or screws. Such complications have serious consequences, and removal of fractured abutments or screws is difficult. There are various methods to remove fractured abutment screws in implants with screwed-in connections. However, no approach has been reported to retrieve solid abutments in implants with a locking-taper implant-abutment connection, which are rarely observed in clinical settings. This study presents the case of a 62-year-old male patient with a fractured abutment in an upper-right second premolar implant. Abutment fracture is a common mechanical complication after dental implantation. Parafunctional habits and occlusal overloading may generate excessive occlusal forces, which increase the risk of mechanical complications. This report presents a series of emergency procedures for removing a fractured solid abutment and fabricating a new prosthesis to restore the edentulous area. In this retrospective analysis, the authors deeply consider the whole treatment, through which the deficiencies of the treatment are noted, and corresponding future directions are discussed. This case report presents a convenient approach to removing a solid abutment in a sudden emergency, discusses possible reasons for solid abutment fractures, designs a new rescue kit for easy retrieval of such abutments and summarizes a valid solution for removing fractured solid abutments.

Key Words: abutment fracture, mechanical complications, implant, tapped-in connection

INTRODUCTION

Dental implantation is an effective treatment for dentition defects and edentulous jaws and is widely used in clinical applications. This study investigated the survival and incidence of biological and mechanical complications of implant-supported single crowns after 5 years of function. The results of this study showed that the 5-year implant survival rate was 100% and that the corresponding success (complication free) rate was 92.9%. The 5-year incidence of biological complications was 7.1%, and the 5-year incidence of mechanical complications was 6.5%.[1] The mechanical complications consisted of implant body/fixture fracture, abutment screw fracture, abutment fracture, and prosthesis fracture.[2] Abutment fracture is a mechanical complication of dental implantation. The failure modes in abutments include abutment screw fracture, connection area fracture, abutment body fracture, abutment body distortion, screw distortion, and connection area distortion.[3] In oral implantology, abutment fractures mainly occur in the neck of an implant with a broken center screw. Higher incidences of abutment fracture have been observed in middle-aged patients, in the molar position and in larger-diameter implants.[4] The 5-year cumulative success rates in 146 maxillary and mandibular implants were 91.00% and 97.81%, respectively (Straumann AG, ITI, Waldenburg, Switzerland), and the rate of abutment fracture was 1.37%.[5] However, a study of 432 posterior tooth implants with tapped-in connections (Bicon Dental Implants System, Boston, Mass) showed that the rate of abutment fracture was 0.5% 4 years after placement.[6] Hence, abutment fracture is more likely to occur in implants with screwed-in connections than in implants with tapped-in connections. This difference is related to the different structures of the screws between abutments.

Recently, researchers have introduced methods of retrieving fractured abutment screws.[7–11] However, no study has

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described approaches to remove a fractured abutment in an implant with a tapped-in connection. That implant exhibits a unique locking-taper contact in the implant-abutment connection without a center screw. This case report introduces a series of emergency procedures to retrieve a fractured abutment in locking-taper implants. Furthermore, we evaluate the whole treatment and design a new rescue kit for retrieving solid abutments.

Case Report

A 62-year-old male patient sought treatment for a broken abutment in the second premolar implanted prostheses. The patient had received the right maxillary second premolar implant prosthesis at another institution 2 years before seeking treatment. Recently, the patient had found an abutment fracture in the second premolar implant prosthesis while dining. His preoperative record indicated that the bone mass in the edentulous region was 9-mm high with a 12-mm buccolingual diameter and a 13-mm mesiodistal diameter. The following treatments were presented to the patient: (1) placement of 2 Bicon implants with a 3.0-mm well, a 6-mm length, and a 4.5-mm diameter supporting 2 single crowns; and (2) implantation of 1 implant with a 6-mm length and a 6-mm diameter supporting a cantilever fixed bridge. To reduce costs, the patient chose the second option, which involved inserting 1 implant in the right maxillary second premolar and placing a cantilever fixed bridge to restore the maxillary premolars with a personalized abutment. The patient reported that he had no systemic diseases, such as hypertension, cardiopathy, or diabetes. A clinical examination revealed that the abutment fracture occurred near the interface between the implant shoulder and abutment, where the broken abutment fragments could be noticed below the platform of the implant (Figure 1a and b). The findings indicated that the implant was not mobile, loose, or dislocated. Moreover, the soft tissue around the implant appeared to be normal with no bleeding on probing. A radiographic examination showed that there was no obvious bone loss around the implant, the abutment fracture occurred at the implant platform level, and the broken abutment fragments were still connected with the implant (Figure 2). The dentist (W.C.) and patient discussed the following treatments: (1) implant removal and replacement with 2 new implants and prostheses, (2) implant removal and replacement with 1 new implant and cantilever, and (3) retrieval of the broken abutment fragments and replacement with new prostheses. The patient chose the conservative treatment option to remove the fractured abutment; if the broken abutment could not be retrieved, the implant would be removed instead of placing a new implant in the edentulous region.

An approach to remove the fractured abutment in implants with tapped-in connections has not been reported. Therefore, the following emergency techniques were devised and used to remove broken abutments in case of such an emergency:

1. Use a high-speed handpiece equipped with a slender silicon carbide bur with a 1.1-mm-diameter tip to cautiously make a linear access hole from the center of the fractured abutment to near the abutment margin until reaching the bottom of the abutment. Hold the handpiece firmly with both hands to avoid damaging the internal surface of the implant (Figure 3a and b).
2. Insert an extender (Figure 4a) with a flat and thin cusp into the linear access hole on the abutment and rotate less than 180° to move the fractured solid abutment out of the implant (Figure 4b). Then, completely loosen the broken abutment fragments in the implant. Carefully remove the fractured abutment to avoid damaging the internal structure of the implant (Figure 5).
3. Abundantly rinse and suction excess water to ensure that all parts of the abutment are retrieved.
4. Place a 6.5 mm $\times$ 5.0 mm 0° healing abutment with a 3.0-mm post (Bicon) into the implant. Then, observe the area around the implant for 1 week to ensure the formation of a peri-implant cuff and transgingival contour.

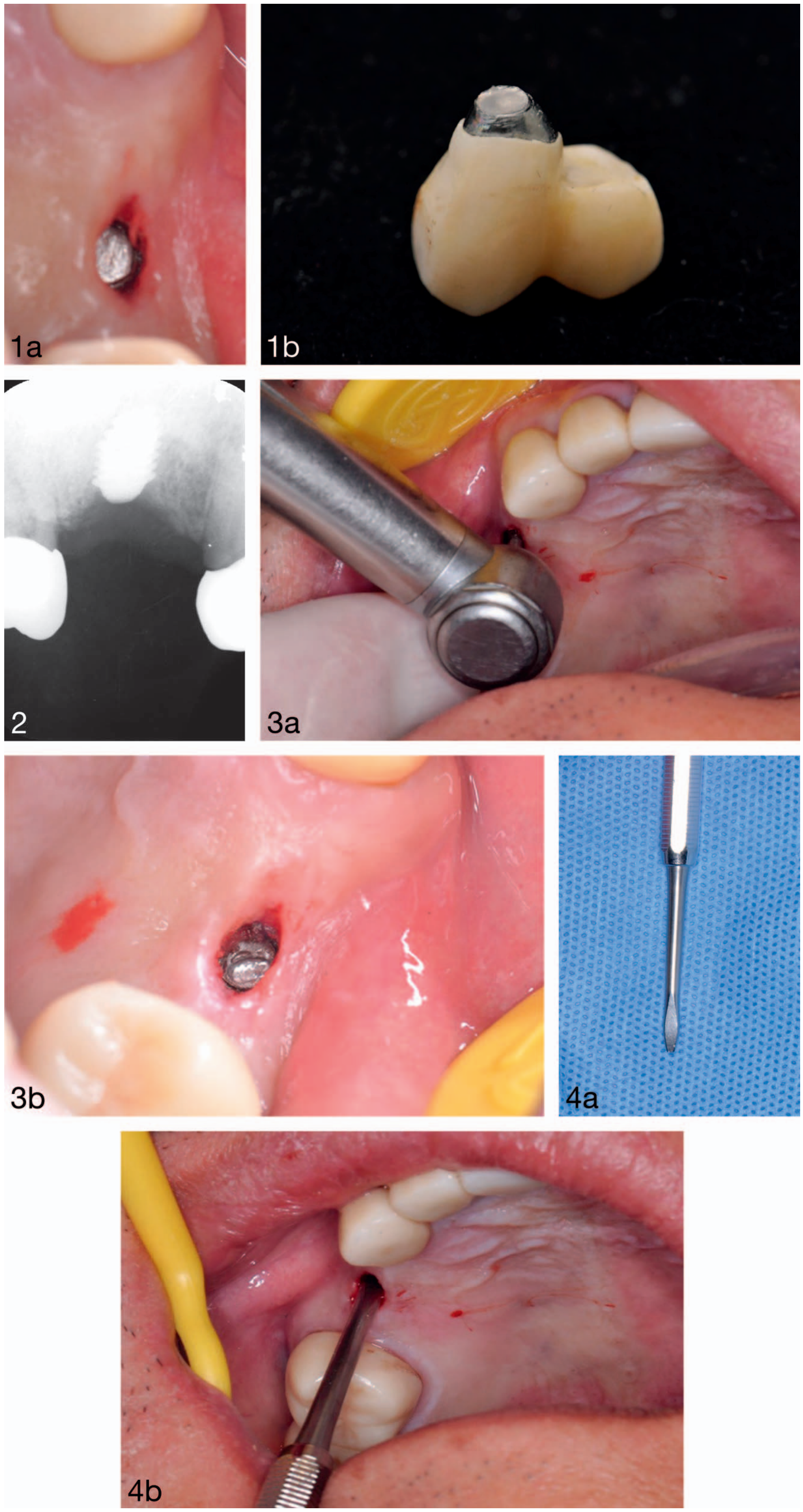
After 1 week, the situation around the implant was stable and normal. A titanium impression with a 3.0-mm post was inserted into the implant. A plastic impression sleeve was snapped onto the impression post, and polyether rubber was used to take the impression. Then, a 5.0 mm $\times$ 2.0 mm 0° stealth shouldered abutment with a 3.0-mm post (Bicon) was selected. An yttria-stabilized zirconia cantilever (Zenostar, Wieland Dental, Pforzheim, Germany) (Figure 6) was fabricated to restore the missing right maxillary first and second premolars (Figure 7). The occlusal force of the prosthesis had to be less than that of the natural tooth because the implant lacks the cushioning effect provided by the periodontal ligament.

The patient's progress with the new prosthesis was followed for 2 years. A periapical radiograph showed that the peri-implant crestal bone levels were stable (Figure 8).

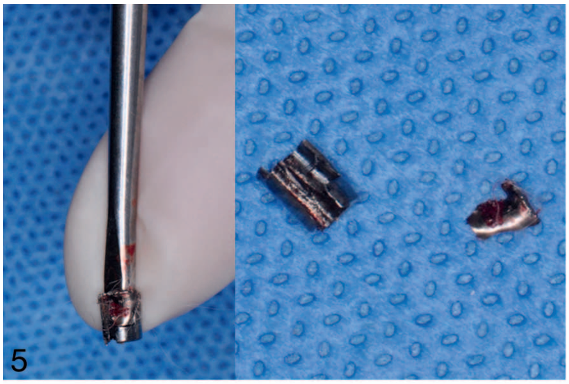
Discussion

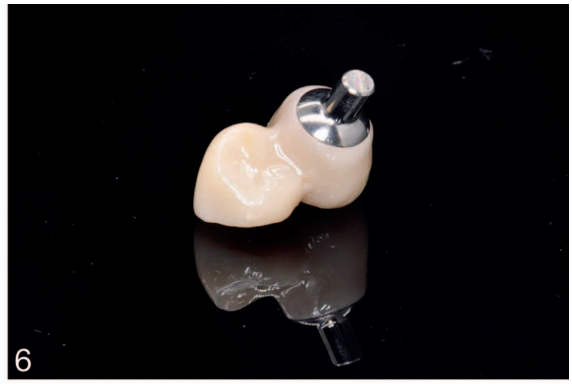
Abutment fracture is a mechanical complication after dental implantation that is related to various factors. The main causes are mechanical problems, including metal fatigue due to biomechanical overloading and parafunctional habits, and the loss of supporting tissue, which leads to infection or peri-implantitis.[2,12,13] In this case report, the reasons for abutment fracture were likely mechanical problems due to biomechanical overloading, including incorrect occlusion design and abutment material fatigue.

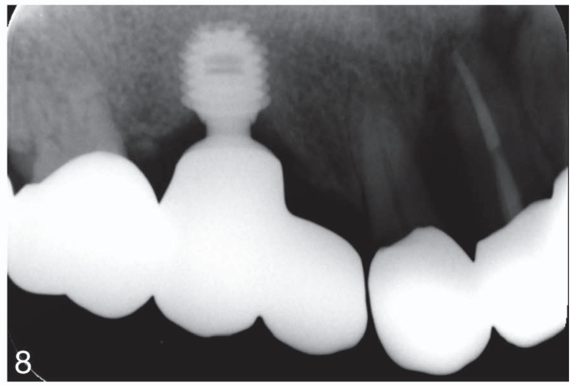
The fracture strength of an abutment is related to the abutment design, structure, and materials.[3,14–21] The fracture strength of abutments decreases significantly when the number of loading cycles exceeds 1 000 000; moreover, the fracture strength of internally connected implant abutments is significantly higher than that of externally connected abutments.[14] Patankar et al[15] reported that the fracture resistance of platform-switched abutments with a Morse taper connection is higher than that in standard conventional abutments. Compared with standard implants and platform-switched abutments, sloping shoulder implants have greater stress distribution at the implant-abutment interface and at the crestal area.[16] Sloping shoulder implants have the ability to distribute the stress apically, thereby reducing the magnitude of stress

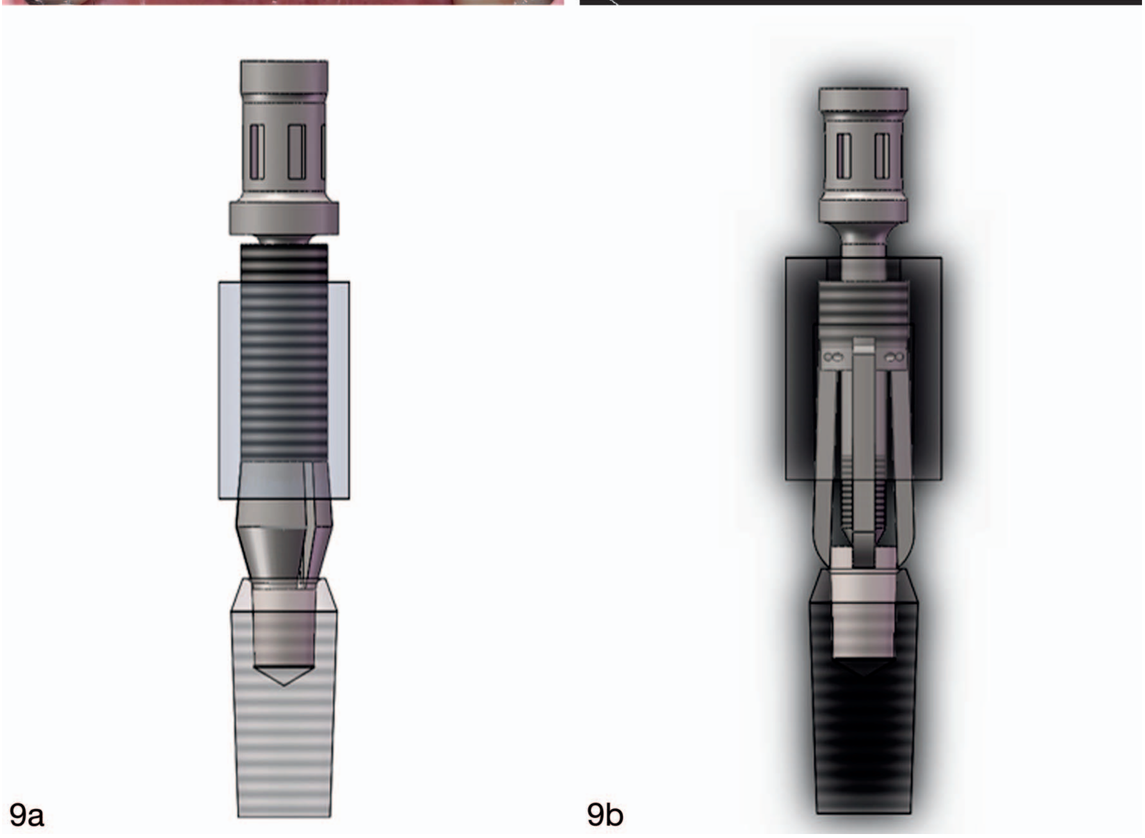


Figures 1–4. Figure 1. (a) Fractured abutment fragments of the implant in the clinical examination. (b) Broken abutment with crowns. **Figure 2.** Radiographic examination. **Figure 3.** (a) A slender fissure bur in a high-speed handpiece. (b) A linear access hole from the center of the fractured abutment to near the abutment margin. **Figure 4.** (a) An extender with a flat and thin cusp. (b) Inserting the extender into the linear access hole on the abutment to move the fractured abutment.









Figures 5–9. Figure 5. Broken abutment fragments. **Figure 6.** Yttria-stabilized zirconia crowns. **Figure 7.** Occlusal view of the final prosthesis. **Figure 8.** Periapical radiograph showing the implant after 1 year of use. **Figure 9.** (a) Design of a new rescue kit used when the site of the solid abutment fracture is deep. (b) Design of a new rescue kit used when the site of the solid abutment fracture is above the implant-abutment interface.

concentrations. Single-tooth, nonsplinted implants with a crown to implant ratio ranging from 0.86 to 2.14 do not exhibit a high occurrence of biological or mechanical complications.[21] The Bicon implant used to avoid abutment fracture in this study had a crown to implant ratio of approximately 1.8; moreover, this implant had a platform switch with a Morse taper connection and a sloping shoulder.

The risk factors identified for locking-taper implant failures are the timing of the implant placement relative to extraction, the coating of the implant, and the number of pontics.[22] Cantilevered implant restorations suffer from mechanical and biological complications, and the occurrence rates of these mechanical and biological complications are 8.3% and 15.2%, respectively.[23] The use of a cantilevered implant restoration could still be a viable treatment option in many instances; however, the length and number of cantilevers must be considered.[24,25] In this case report, there was sufficient bone around the implant to bear the stress due to the few short cantilevers. In addition, the stress applied during mastication may range between 441 N and 981 N in molars and between 245 N and 491 N in premolars. In this case, a 6-mm-long, 6-mm-diameter implant that is permanently implanted in a molar could support 2 premolars. Our research group measured the fracture strength of abutments with a 3.0-mm post (Bicon), which reached up to 2000 N—much higher than the occlusal force in the posterior region.

Personalized abutments depend on the conditions of different patients to address the heterogeneity in hard and soft tissues; however, these abutments cannot match other components of the implant with high precision. That could augment microleakage and micromovement in the implant-abutment interface. Previously, personalized abutments, whose strength was different from that of prefabricated abutments, were used in implant prostheses. In consideration of the close adaptation and strength of prefabricated abutments, prefabricated abutments were chosen to connect the implant and crown in this case report.

Some researchers have supported several precautions for selection to avoid biological and mechanical complications in implants.[26] In this case report, several improvements were made during treatment to avoid abutment fracture. An implant with a diameter of 6 mm and a length of 6 mm was selected to support occlusal loading. A thick prefabricated implant abutment with a 3.0-mm post was chosen to promote adaptation between the abutment and the implant and reduce the pumping effect. A 7-mm-long cantilever bridge was used, which has little impact on abutment fracture. Moreover, the occlusal loading of the implant was alleviated.

Various methods have been used to remove fractured abutments in implants with screwed-in connections.[7–11,27,28] These approaches depend on the structure of the center screw to remove the fractured abutment, and there is a need to replace the inner threads. However, these methods are not appropriate for abutments in implants with tapped-in connections. To date, no approach has been reported to retrieve fractured solid abutments in implants with tapped-in connections. Due to the lack of a corresponding rescue kit, the dentist provided a time and money-saving emergency solution in which a slender silicon carbide bur was used in a high-speed handpiece under copious irrigation to create a linear access hole for an extender. In contrast to a low-speed handpiece, a high-speed handpiece is a precision device for efficiently and rapidly removing tissue with no pressure, slip, or vibration.[28] The present case was followed up for 2 years without any further complications.

In retrospect, the authors believe that the aforementioned approach might damage the internal surface of the implant and could be used for emergency treatment only. According to such a clinical situation, the dentist designed a new rescue kit for the retrieval of solid abutments with different fracture locations (Figure 9a and b). The device and method are proprietarily combined with a corresponding ratchet and torque control device as follows. First, the circlip section of the connecting sleeve is wrapped around the fractured abutment to precisely guide the position when the site of the solid abutment fracture is above the implant-abutment interface. The circlip contacts the internal surface of the implant when the site of the solid abutment fracture is deep. Then, the device is fixed to the fractured abutment by means of a self-tapping rod. The clinician holds the device along the implant axis to extract the fractured abutment along with the corresponding ratchet and torque control device.

Conclusion

Preventing complications after dental implantation is necessary to avoid implant failure. Once mechanical complications occur, especially abutment fracture, professionals should first consider removing the broken abutment. If the broken abutment cannot be removed, the implant should be removed and subsequently replaced with a new implant. For implants with tapped-in connections, the procedure presented in this case report should be used only in emergencies. Using this approach supports fractured abutment removal while avoiding implant removal and saving patient time and money. However, clinicians must explain the consequences and risks in using such procedures and provide alternative treatment options to the patient. In addition, the rescue kit for solid abutment retrieval is expected to be manufactured for use in such situations.

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Note

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