Case Report

Management of Fractured Implant Abutment Screws: A Case Series

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Abstract

Implant abutment screw fracture is a rare occurrence that can introduce complications and challenges for clinicians. This case report describes three abutment screw fractures that were treated using different strategies: screw fragment retrieval combined with the fabrication of a new prosthesis; the customized casting of a metal post and core with crown fabrication, and the removal and replacement of the implant fixture. The retrieved screw fragment was examined by scanning electron microscope, and a flowchart of the treatment protocol is also presented.

Key words: **implant screw fracture, abutment screw fracture, SEM, fractured screw retrieval**

Introduction

Osseointegrated implant therapy is a broadly used and promising approach in modern dentistry, with single-implant 5-year survival ranging from 95.9% to 99.1% and 10-year survival ranging from 93% to 95.2% [1-3]. However, implant restorations can be associated with both biological complications, such as peri-mucositis or peri-implantitis, and mechanical complications, such as porcelain fractures, the loosening or fracturing of the abutment screw, the fracturing of the abutment or superstructure, or crown loosening and loss[3-5].

Among all known mechanical complications, abutment screw loosening is the most common complication, with an incidence of 5.8% to 12.7% after five years of follow-up[3,6,7]. Screw loosening can be managed by retightening the screw[8]; however, frequent screw loosening may indicate overloading, which can eventually lead to abutment screw fracture or implant fracture[3,6,7]. Abutment screw fracture has a cumulative rate of 0.18% to 0.35% during the 5 years period following implant placement[3,7]. Although abutment screw fracture is rare, removing fracture fragments can be challenging or unachievable. The retrieval of the remaining screw fragments may also cause damage to the inner implant surface or the implant structure, impeding further prosthetic prefabrication.

A decision-making tree presented by Mizumoto et al. in 2018 discussed three different strategies for managing broken screws[9]. The first strategy is to retrieve the fragments and restore the prosthesis. The second strategy is to cast a customized post and core, followed by crown restoration using a conventional crown protocol. The third strategy is to remove the implant fixture entirely, followed by replacement with a new implant. This study presents three abutment screw fracture cases treated with each of these recommended strategies.

Case 1

An 85-year-old woman received implant placements at sites 45 and 46. After ten years of use, the abutment screws fractured in both implants, with porcelain fractures on the buccal and occlusal surfaces of the porcelain fused to metal crowns (Figure 1a). Both implants were 4.1 × 10 mm in size with an external hexagon connection (Biomet 3i). Mild inflammation was observed around the implant fixture. The periapical film showed minor bone loss to the first fixture thread, with stable marginal bone levels.

The patient has bruxism, with severe attrition of the teeth. Indications of clenching were observed on the tongue border, and hyperactivity in the masseter muscle was also indicated. The patient presented with fremitus in all upper teeth during occlusal contact, indicating excessive biting force.

On the day of surgery, a mid-crestal incision and flap evaluation were performed to reveal the implant fixture. The screw fragment in the implant at position 46 was loose. After cleaning debris with a scaling tip, a drill in the retrieval kit was used to remove the fragment without further damage (Figure 2a). The screw fragment associated with the implant at position 45 was tight. The use of probes and ultrasonic scaling was attempted but failed, followed by the use of the retrieval kit. A guide sleeve was stabilized on the external connection of the fixture, and an anti-rotation drill with an oblique end was inserted directly onto the fragment. Reverse rotation was applied while cautiously applying pressure to the fragment. The piece rotated for 1 mm but again became lodged in the fixture. Finally, a #311 carbide bur was inserted to drill the fragment and apply vibration to the piece, with irrigation to prevent high heat. The fragment was ultimately loosened and removed (Figure 2b).

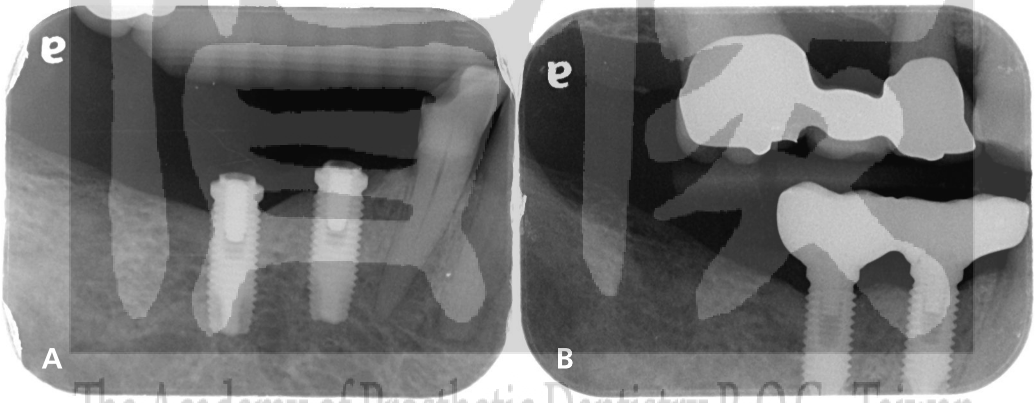

Figure 1. (a) Fractures of the coronal segments of the abutment screws at positions 45 and 46. (b) Fabrication of splinted metal milling crowns

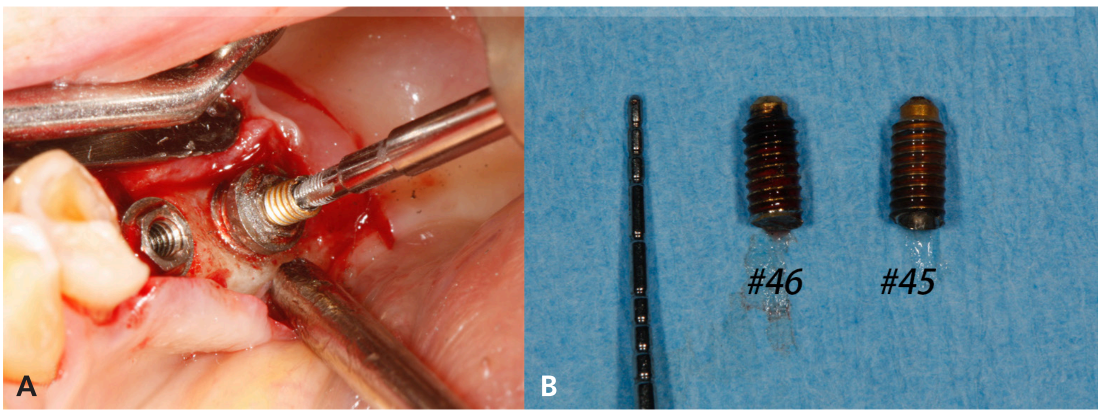

Figure 2. (a) Removal of the fractured screw at position 46 with the assistance of a retrieval kit. (b) Photos of the screw fragments. The fragment retrieved from position 46 has debris between the screw threads and may have loosened prior to fracture. The fragment retrieved from position 45 has clean threads. The fractural surface of the fragment retrieved from position 45 was damaged during drilling.

The implant fixtures at positions 45 and 46 were evaluated, revealing mild wear at the connection site. After discussion with the patient, screw-retained, full-metal, splinted crowns were placed (Figure 1b). Occlusal contact with teeth 45 and 46 during excursive movement was eliminated, and an occlusal splint was delivered as a night guard.

The fractural surface of the screw retrieved from tooth 46 was examined under a scanning electron microscope (SEM), and the surface of the screw from tooth 45 was damaged during removal (Figure 3a–d).

Case 2

A 59-year-old man suffered from an implant abutment screw fracture at tooth 16, and a previous attempt to remove the fragment failed (Figure 4a). The fragment could not be grasped after loosening, and the internal thread was damaged. The patient was diagnosed with hyperactive masseter muscle and clenching habits. No signs of bruxism were found. Anti-rotational grooves were made on the inner surface of the fixture. A customized post and core were casted using an indirect method and cemented to the implant fixture. Further fabrication of the splinted 15 and 16 crowns was performed using a conventional prosthetic protocol (Figure 4b).

Case 3

A 40-year-old woman presented with an implant-supported fixed prosthesis at the lower left first molar (Ankylos, Dentsply Sirona). After five years of use, the implant crown fractured at the abutment neck due to frictional resistance in the conical connection. The fractured abutment remained tight after the screw fragment was retrieved (Figure 5a). The implant fixture was removed, and guided bone regeneration was performed. A new implant fixture (Institute Straumann AG) was inserted after six months and has since remained stable (Figure 5b).

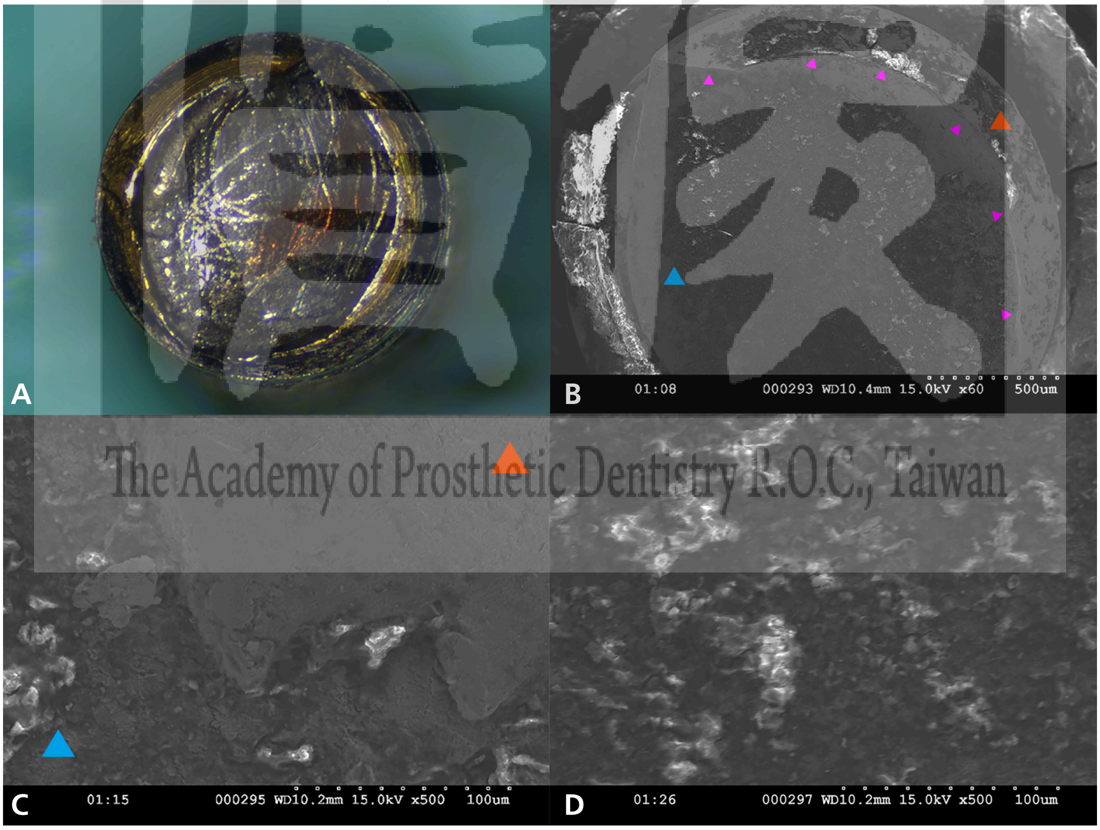

Figure 3. (a) Image of the fractural surface from the coronal portion of the screw retrieved from position 46 under a light microscope (4×) reveals scratches caused by the ultrasonic tips. The fractural surface has a sharp edge. (b) The fractural surface of the screw retrieved from position 46 at 500× using a scanning electron microscope (SEM). Smooth (red) and rough (blue) portions reveal the 2 phases of the fracture. The smooth surface characterizes the start of the fracture; chewing motions smoothed the surface until the fracture of the whole screw occurred, resulting in the formation of a rough fractural surface. (c) Smooth (Red) and rough surfaces (Blue) under 3000× SEM. (d) Coarse particles of the rough surface under 4000× SEM.

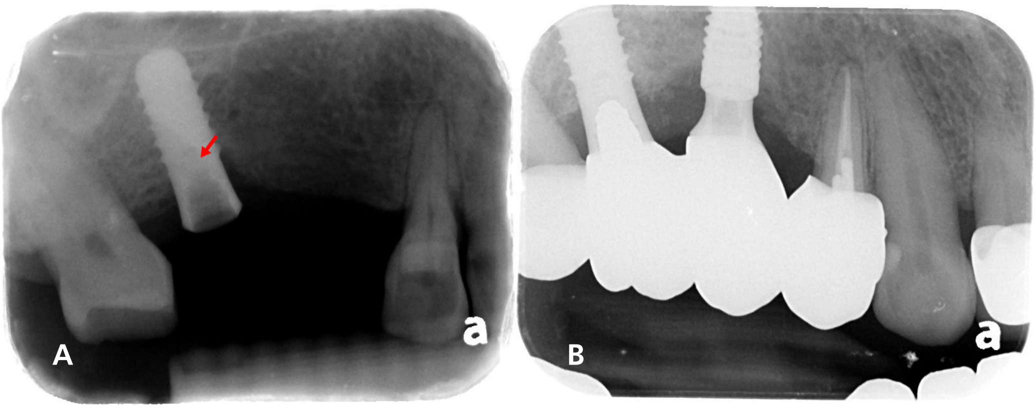

Figure 4. (a) Damaged internal thread. The red arrow shows the unretrieved screw fragment.
(b) A post and core were cast using an indirect method, and a splinted prosthesis was placed at positions 15 and 16 implants.

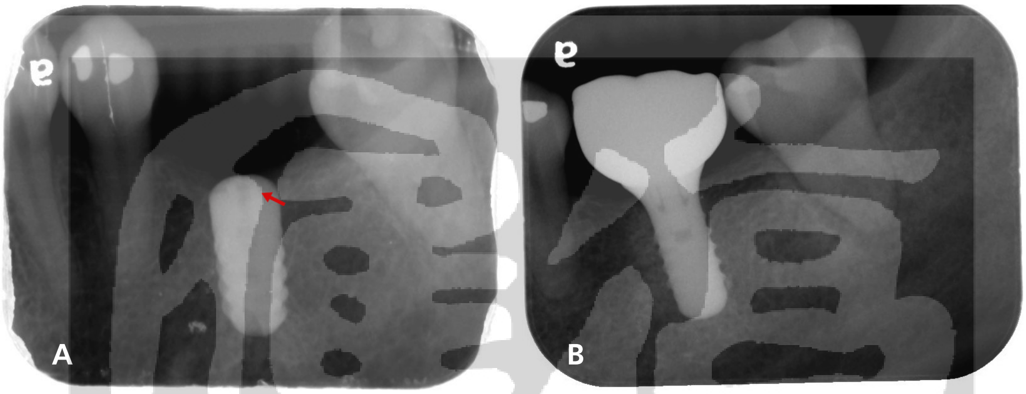

Figure 5. Removal of the implant and reimplantation.
(a) The screw was successfully retrieved, but the fractured abutment remained (red arrow).
(b) Removal of the implant fixture and reimplantation.

Discussion

The incidence of abutment screw fractures is low, occurring at a rate of 0.18% to 0.35% during the five years following placement. A study by Kim et al.[10] found that most screw loosening and fractures occurred in the posterior crowns, with an incidence of 1.6% for anterior crowns, 8.9% for posterior crowns, and fractures occurring most commonly in the mandibular first molar and maxillary central incisor[11-15]. The 3 cases presented in our study included fractures in the maxillary and mandibular first molar and second premolar.

Abutment screw fracture may be caused by biomechanical overloading, improper placement techniques, or a non-passive fit prosthesis. In addition, functional cyclic loading with extended periods of clinical use, repeated retightening of loose screws, poor design of the fixture–abutment connection, inadequate tightening, screw joint movement, or metal fatigue after screw loosening can also induce fatigue fractures[16].

Implant overloading can be multifactorial, and the design of the occlusal scheme plays an important role. The loading on the abutment and screw increases as the load becomes more inclined in both platform–switch or internal connection implants[17] and minimizing off-axial loading can reduce the risk of screw loosening. The splinting of implant crowns is another influencing factor, as splinted implant crowns provide a more even distribution of stress loading, which may reduce the risk of screw loosening[18]. In a split-mouth study of 15 patients, screw loosening was only observed in non-splinted, single implants, with an incidence of 5 of 15 implants[19]. However, no significant differences in the incidence of prosthetic complications were observed between crown–implant ratios (C–I ratio) of >1.5 and <1.5 in clinical studies [20]. The diet and parafunctional activities of the patient can also influence the load placed on the implant[21], and other factors, such as opposing dentition and prosthetic materials, should also be considered in the risk assessment.

The connections between prosthetics and dental implants can be classified into three groups: external connections, internal connections, and conical connections[22]. Different connections can influence stress distribution. With external connections, occlusal stress is transmitted to the screw and joint of the connection, and studies have reported a higher incidence of screw loosening and fracture in implants that use an external connection compared with internal or Morse-tapered connections[23,24]. However, some studies have also presented conflicting results, showing no significant differences between the different connections[25]. With conical connections, the tapered contact between the implant and the abutment interface forms a strong friction resistance force that retains the abutment position even after screw removal[26]. If the abutment fractures, this friction makes removal more difficult. The development of a pertinent appliance is critical for the treatment of conical connections.

The depth at which the fracture occurs also influences screw retrievability. Fractures that occur closer to the platform or are more coronal are easier to access. In cases fractured at the apical third, poor visualization and difficulty accessing the fragment can increase the risk of damaging the screw threads. Even after loosening the fragment, the ability to grasp and remove the fragment may be limited by available instruments.

In 2018, Mizumoto et al.[9] suggested that fragment retrieval methods were associated with different levels of risk. The low-risk method involves using basic instruments and scalers, such as rigid explorers and ultrasonic tips, preventing damage to the internal surface of the fixture. The moderate-risk method involves the use of rotary instruments to remove the fragment, including customized drills or commercial retrieval kits that utilize low-speed rotary instruments, such as the Fragment Fork (Astra Tech; Dentsply Sirona), ITI Dental Implant System (Institute Straumann AG), and IMZ TwinPlus Implant System 1 (Dentsply Sirona). These retrieval kits are specifically designed for fragment retrieval and contain two components: sleeves or cylinders to guide the drills and prevent damage to the internal surface and burs with oblique or specialized tips that can grasp the coronal section of the fragment. If retrieval kits are unavailable, clinicians may fabricate customized burs to match the fractured piece[27] or modify impression posts into specific guide tubes to protect the internal surface[28]. Fragments may also be retrieved by drilling freehanded; studies have recommended placing a notch on the screw fragment, away from the center, to form a lever with which to rotate the fragment[12] or drilling the whole fragment until it loosens. Some cases described the use of re-tapping tools to re-tap damaged threads and the replacement of the old prosthesis using new screws that provide larger preloads[29].

If the fragment is unremovable or the internal thread is damaged, the last resort is to modify or remove the implant. Removing the old implant fixture and reimplanting a new fixture may restore implant function and is associated with the most predictable outcome. Other common treatments include submerging the implant fixture or casting a customized post and core for the remaining fixture. A customized metal coping may be fabricated directly or indirectly after cementing the metal post to the implant fixture. A prostheses can then be fabricated following conventional protocols, and the implant may be reused[30]. However, disadvantages include further cement wash-out, reduction in the strength of the remaining walls, and increased risk of implant fracture from a wedging effect, depending on the amount of preparation necessary[15].

Some studies have applied different methods to reuse implant fixtures. One study presented the conservative restoration of an implant transfer cap screw using a build-up crown with a resin composite [16]. Another study replaced the prosthesis in the implant fixture using shortened screws, in which the previously fractured screw fragments was pressed apically, providing room for the placement of a new, shortened screw[15].

Based on the 3 cases described in the present study, we can conclude that factors influencing the outcomes of fractured abutment screws include the connection type, the depth of the fractured screw, and whether the screw is tight or loose. Fragments that are more coronal and looser are easier to retrieve. Conical connections are associated with a large degree of frictional resistance, introducing increased difficulty when attempting to remove a fractured abutment fragment. The estimation and management process for determining how to approach a fractured screw retrieval is presented as a flowchart (Figure 6). The design of the implant prosthesis should be evaluated to avoid factors that cause overloading, and close follow-up is necessary for high-risk patients.

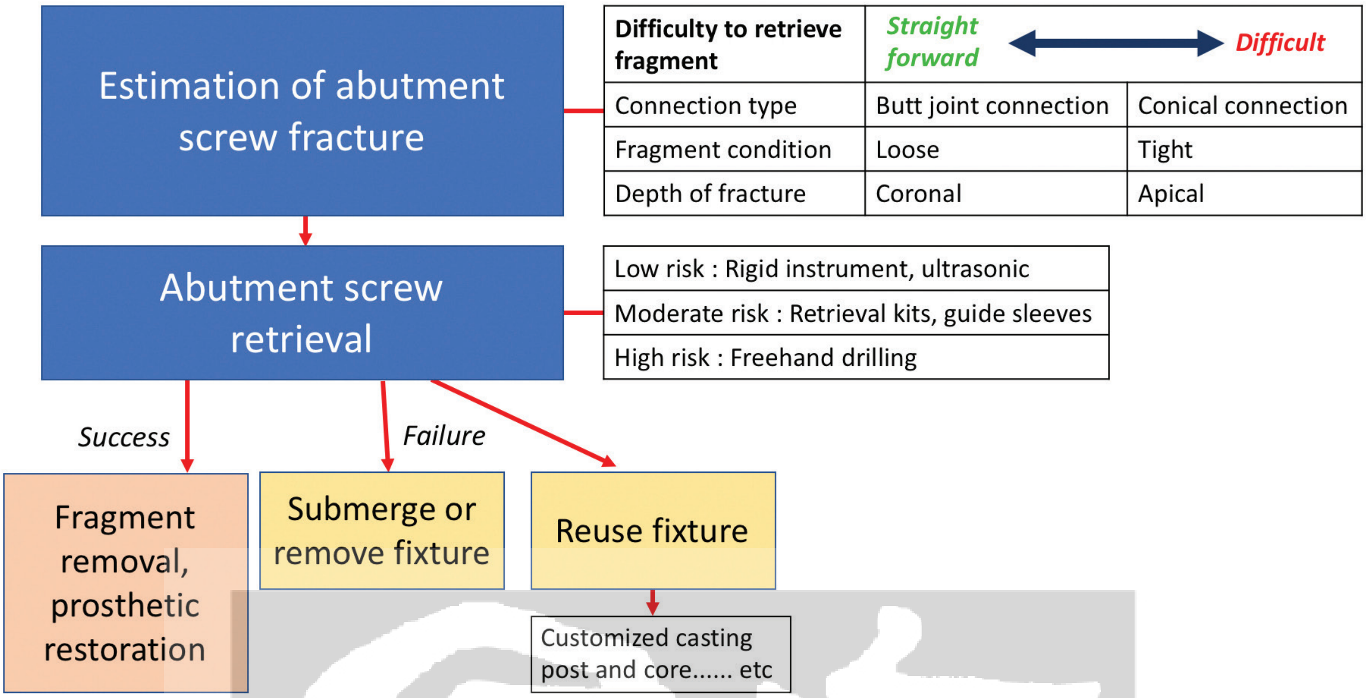

Figure 6. Flowchart of fractured abutment screw retrieval evaluation.

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