Fixing Component Failure and Fracture

Retrieving the Fractured Implant Abutment Screw

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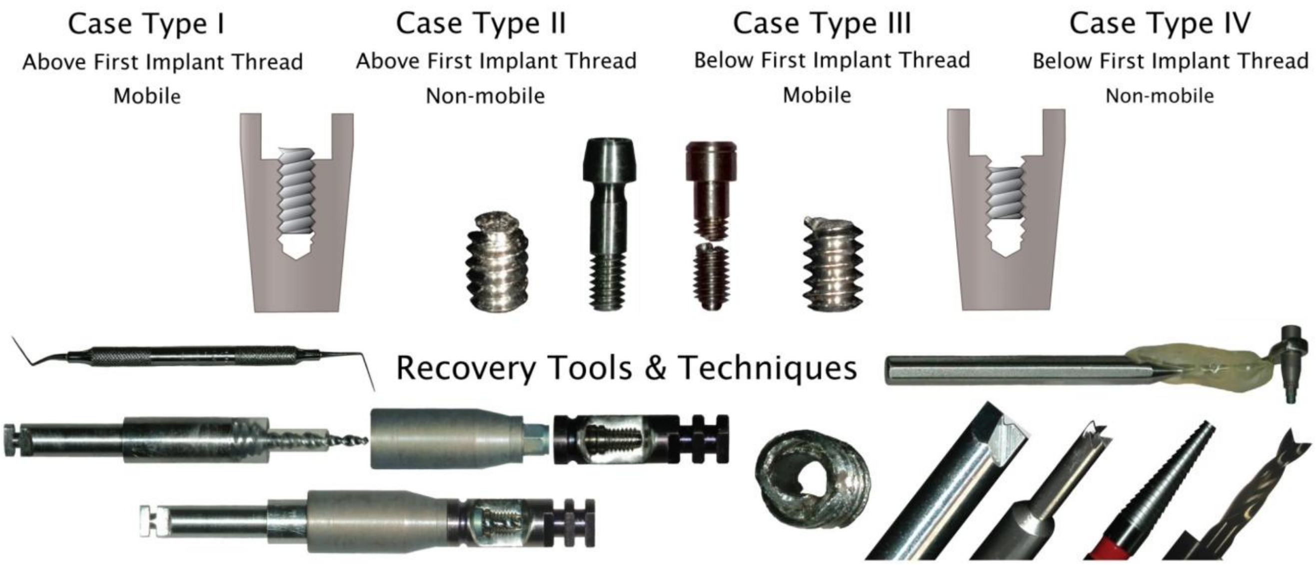


Evaluating component failure in an implant supported case is never a welcomed clinical situation and most likely one that is significantly disruptive to the schedule, producing anxiety in the patient and treatment team alike. This paper is focused on only one aspect of mechanical implant failure: safely retrieving the fractured abutment screw from an otherwise functional and healthy implant. Most dental practitioners are trained in handling implant components involving routine clinical applications, not the specific mechanical techniques to effectively evaluate and recover from these aberrant situations. The following protocol was carefully developed over the last four years while successfully treating more than 125 mechanically distressed implant cases, the majority of which involved a fractured abutment screw. To increase the likelihood for a positive outcome, it became apparent a structured approach was needed, along with critical tooling to support a highly predictable result.

Prior to evaluating a specific fractured screw case the following points should be recognized:

1. A primary key for a successful recovery is detailed visualization. Microscopic evaluation in the 10x-25x magnification range opens up a whole new world beyond conventional loop magnifications. The importance of realizing the nuances in fracture topography, screw fragment position as it relates to the top implant thread, mobility of the fragment and detailed verification of progress during the recovery effort cannot be overstated.
2. When the fragment is evaluated for the first time, realize it will never be easier to remove. Each effort can potentially complicate the retrieval, making the problem more difficult to resolve. Therefore, all efforts should focus on maintaining the integrity of the implant and, as much as possible, the screw fragment as well.
3. All screw fragments are removable: either in one piece or in pieces, but preferably in one piece with the least amount of instrumentation possible. The pertinent questions then become, "What is left once the implant is clear? Has the effort protected the implant from iatrogenic damage or, if not, now much damage is there?" Secondly, how much effort will be involved to recover the fragment or repair the implant?
4. If clearing the fragment involves rotary or ultrasonic instruments be aware dimensions are small and tolerances are tight which produces a fine line between mobilization with resolution, distortion of the screw fragment or implant threads producing a locking of the screw fragment, or worse, unrecoverable implant damage.

5. Before starting the recovery process, the implant interface mechanics and dimensions, along with the dimensions and actions of the recovery tools, should be thoroughly studied and understood. The operator has to appreciate how a specific tool is designed to work, and also how it can be misused to create an iatrogenic problem.

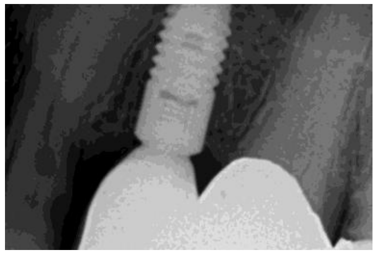
The Diagnostic Algorithm to Assess and Direct Treatment

A diagnostic algorithm has emerged to assess the difficultly and potential risks involved with retrieval. This algorithm simply focuses on fragment position and mobility to direct the appropriate retrieval strategy. For ease of discussion, case types have been assigned to the four basic fragment presentations. The Type I case is the easiest and safest to retrieve, progressing to the Type IV case which carries the highest potential for implant damage. Two additional case types, V and VI, are added to describe implant damage, most of which is iatrogenic.

The first evaluation criterion is to assess the fragment position as it relates to the top implant thread. This is initially done radiographically and confirmed microscopically. The second criterion is mobility of the fragment. Of course, this has to be assessed microscopically and most efficiently with an endodontic explorer.

The Type I Case

The Type I case presents with the top of the fragment positioned above the implant first thread and is mobile. (Fig. 1)



1. Radiograph of a typical Type I case, visualizing the position of the fragment just above the first implant thread.

Type I Case Treatment Protocol

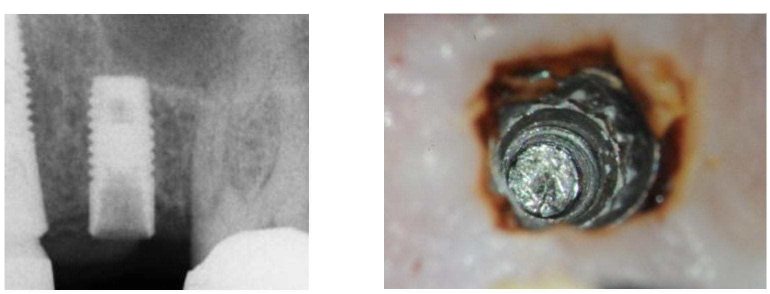
This represents the best possible scenario, as often retrieval can be achieved with just rotation of the fragment with the endodontic explorer and lubricant, coupled with a dose of patience. As mentioned above, visualization of uneven areas in the surface topography of the fracture can provide a small purchase point for increased torque to accelerate the process. As the implant threads are not exposed and therefore not at instrumentation risk, slow speed fragment removal tools[1,2], often referred to as fragment forks, of an appropriate diameter can be utilized to accelerate the process. If safe access is present, a surgical length ¼ round bur, under microscopic guidance, briefly engaged on the exposed outside diameter of the screw fragment will rotate the fragment clear of the implant threads. As with all rotary instruments, care must be taken to avoid accidental contact with the implant interface.

The Type II Case

The Type II case presents with the top of the screw fragment still positioned above the implant first thread, but the fragment is not mobile and therefore not easily removed. An example of this type of failure has presented clinically with a history of screw failure upon initial insertion. Hypothetically, if the leading screw thread happens to hit an obstruction which stops rotation while the head of the screw continues to be torqued, screw fracture can occur, which often results in a non-mobile screw fragment. Removal requires application of enough removal torque to overcome the friction that prevents counterclockwise removal rotation. This is where a precision removal system, including system specific drill guides, drills, and removal tools along with the appropriate strategy, is paramount to avoid further complication. If handled correctly, the case can resolve almost as easily as the Type I case. However, if not handled correctly the advantage of having the fragment above the first thread can be lost and the case then becomes a Type IV, with possible implant thread damage. Therefore, the treatment protocol for a Type II case is identical to and will be described below under the Type IV treatment protocol.

The Type III Case

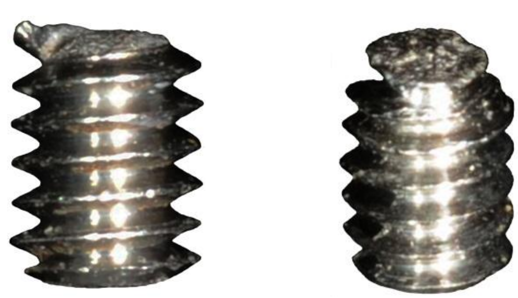
The Type III case presents with the top of the screw fragment positioned below the implant first thread and is mobile. (Fig.2)



2. Radiograph and clinical microscope photo of a typical Type III case visualizing the position of the screw fragment below the implant first thread.

This represents a significant possibility for removal complications as implant threads above the top of the screw fragment are exposed. Any accidental contact to the fragment - implant thread can produce metal distortion of the fragment or implant thread which will effectively lock the fragment, preventing upward rotation. The situation will then demand more aggressive means to deliver enough torque to overcome the iatrogenic obstacle. This can occur with misused rotary retrieval or ultrasonic instrumentation.

Sometimes, depending on morphology of the screw fragment fracture, the fragment will be downwardly mobile but only upwardly mobile with significant difficultly. This can be so much so, it is often misinterpreted as an implant thread obstacle. This scenario is often due to the leading sharp edge of the fractured thread catching on the implant thread in the counterclockwise upward direction and does not necessarily indicate implant thread damage, especially if no prior recovery efforts have been attempted. (Fig.3)



3. Example of two recovered screw fragments. The left fragment potentially will resist upward mobility. The right fragment does not present with the same obstruction.

Type III Case Treatment Protocol

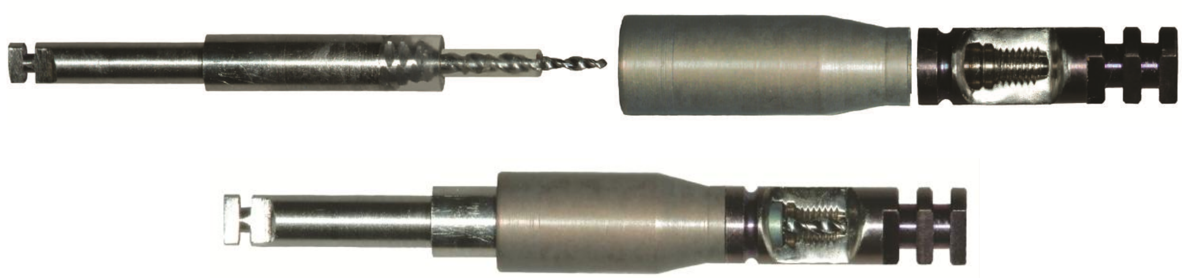
Often, with microscopic guidance and operator patience, the fragment can be conservatively maneuvered enough upward to convert the case to a Type I case. Conversely, a Type I case can accidently be converted to a Type III case if the fragment is inadvertently moved downward but once beyond the first implant thread the fragment may not be easily upwardly mobile. If the fragment cannot be maneuvered up with conservative means, the case then has to be treated like a Type IV case, which is described below.

The Type IV Case

The Type IV case presents with the top of the screw fragment positioned below the implant first thread with no fragment mobility. As in the Type III case, there presents a significant opportunity to incur iatrogenic implant damage with removal attempts. This case type cannot be safely and predictably resolved without a precision recovery protocol utilizing a precision drill guide with the appropriate utilization of fragment mobilization tools and techniques. If mobilization techniques are not successful, then a total drill out becomes necessary.

Type IV Case Treatment Protocol

Employing a technique to initially mobilize the fragment is preferable to immediately launching into a complete drill out technique, for several reasons. With the mobilizing technique, all thread contact can be avoided so it is inherently safer for the implant as there are fewer risky mechanical steps with reduced opportunity for complications. On average, this translates into less chair time. Unfortunately, the clinical dilemma when confronted with a Type II or IV case is the availability of system specific recovery tools for effective and safe implementation of this protocol. Depending on the implant system, there may be some recovery tools available which meet these criteria. However, careful evaluation of the available tools should be completed prior to moving into a clinical setting as some systems have compromised tolerances, while others force an immediate aggressive total drill out approach followed by a tapping sequence. The author has circumvented this issue by custom designing and machining prototype tools as needed, which allow precision guidance with or without committing to a total drill out scenario. (Fig.4)



4. Modified drill prototype, guide and windowed analog both separate and assembled.

The following drilling strategy is presented to illustrate the concept of safely mobilizing a fragment by first drilling concentrically, away from the implant threads, then mobilizing the fragment with a removal tool. Other tooling may accomplish this as well, but remember the goal is to prevent the removal tool from walking off the fragment into the implant wall or distorting the implant- screw interface.

The following example demonstrates the mobilization of a M1.6 screw fragment:

1. A concentrically placed center dimple is placed prior to any drilling. Introducing a small diameter drill without a starting dimple allows the drill to wonder off dead center as the drilling starts. The resulting hole will then be off center or the lateral load on the drill will result in drill fracture. A Type II case can be center dimpled with a surgical length ¼ round bur or guided center drill. The Type IV case, which is deeper into the implant, is generally dimpled with guidance, due to the difficultly of visualizing and controlling the process while under magnification. The center dimple should be verified for concentricity prior to step two.
2. The guided drilling protocol is initiated utilizing a .031” drill to the depth of about .020 (.5mm). This is enough to provide a side wall for the mobilization tool, a two fluted fragment fork. [2] (Fig.5)

5. Fragment fork with sharp end and side cutting features.

The drill diameter was chosen as it interfaced well with the 1mm fragment fork while maintaining enough wall thickness to keep the side wall from distorting into the implant threads. This fork design can be purchased in two diameters, 1mm or 1.4mm. In this example the 1mm is utilized as the 1.4mm exceeds the diameter of the M1.6 predrill size which is only 1.25mm. In other words, if a drill greater than 1.25 mm is introduced it will attack the implant threads. The fragment fork is then introduced, hand driven with downward pressure, to cut into the undersized centering hole grabbing the fragment and hopefully providing enough friction to allow for rotation up and out. The undersize center hole insures positive engagement into the drilled hole's side wall while protecting the fragment from distortion, and in the Type IV case, locking into the implant threads. The whole procedure is designed to protect the implant from fragment fork damage.

3. If mobilization is not successful in the first attempt, the process is repeated again with constant microscopic monitoring to ensure maintenance of concentricity. If the second effort is unsuccessful then a total drill out is most likely indicated. This scenario is more likely to occur if there has been prior screw fragment or implant thread distortion secondary to previous recovery attempts.

If mobilization has failed with the above technique, the only recourse is to proceed into a total drill out scenario. The process would then continue with:

4. Continued concentric guided drilling until the body of the screw is eliminated. In this example of a M1.6 screw fragment removal, the final drill size would be 1.25mm or .049". If another screw diameter is involved, the protocol has to be modified accordingly. The importance of drilling concentrically throughout the procedure becomes more apparent at this time, as the body of the screw cannot be eliminated without implant thread damage if concentricity has not been maintained. A tap should not be introduced to clear the remaining screw thread fragments until

the body of the screw has been removed. Eccentric drilling will damage threads on one side but will leave a portion of the screw body creating a blockage on the other which will impede the tapping progress. Using excess force on a tap to push through this problem can result in tap breakage and creation of a very difficult problem to resolve without iatrogenic implant damage. Taps are hardened by heat treating to the point of being brittle and clearing a fractured tap fragment without creating thread damage to the implant is very difficult.

5. Once the screw body has been cleared a tap can then be carefully introduced to clear the screw thread fragments. This is done, again with microscope guidance, starting with a plug tap which has 3-5 tapered threads and progressing to a bottoming tap which has 1-2 tapered threads. Copious irrigation and picking fragments clear with an endodontic explorer can be helpful as well. The process is finished when the bottoming tap runs freely and the implant is confirmed clear with the microscope.

In the event the implant has incurred damage during the retrieval procedure the determination has to be made as to the restorability and strategic importance of the implant.

The Type V Case

The Type V case is a case which has suffered iatrogenic implant damage that could be useable and stable but in its present condition cannot be re-restored with stock components. In some situations, explanting might create additional issues, hence the motivation to save the implant. However, the problems which need to be resolved can be great, so the indications for this kind of effort to save the implant are limited in scope.

The Type VI Case

The Type VI case is a case where the iatrogenic damage to the implant is so great there is no indication or possibility to re-restore the implant. Explant or sleep are the only options.

Recovery Tooling Resources

1. Nobel Biocare NP M1.6 Ref # 28862
2. Dentsply Implants Astra Tech Fragment Fork 1.0 Ref # 22122
Fragment Fork 1.4 Ref # 22632