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Case Report
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Fixation Failure of a Volar Wrist Plate Following a Fall from a Standing Height

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Abstract

Background: Distal radial fractures are common and contribute significantly to orthopedic workload. This is a rare care where a volar locking plate, used to manage a previous wrist fracture, bent following a fall from standing height. This report discusses the mechanisms behind this injury and considers how this might have been prevented. We also discuss how hardware failure might impact on fracture repair in these uncommon injuries.

Case Presentation: A lady was admitted with pain and a deformity to her left wrist following a fall. She had sustained a left wrist fracture 20 years previously, which was treated with a volar plate. An X-ray revealed a repeat fracture of her left wrist with bending of the metal work in situ. She was taken to theatre to remove the bent plate, reduce the fracture and fix the fracture with a new plate. She also required a fasciotomy and a carpel tunnel release; however, paresthesia over the thumb, middle and ring finger remained.

Conclusion: Bending of metal work is a known complication; however this is not often following a single traumatic incident. The bending of the plate associated with the wrist fracture may have caused an inferior outcome in this case with threatening compartment syndrome and carpel tunnel syndrome. The bending of the metal work is most likely due to the older materials that were used. Newer materials are less likely to cause this response. It must be acknowledged that this injury can happen and does cause issue in management, not just operatively but pre-operatively as well, with increased pain and inability to manipulate the fracture under analgesia and sedation.

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Background

Distal radial fractures are one of the most common fractures seen by orthopedic surgeons [1]. Currently, there isn't a clear consensus on the treatment of choice for unstable distal radial fractures in elderly patients [2]. Elderly patients are usually treated with closed reduction and cast fixation, but the use of the volar approach and a locking plate is becoming increasingly popular [3-6]. A benefit of the volar locking plate in distal radial fractures is that it has a preshaped design that makes placement of the plate easier [4]. It also increases the stability of the fixation and improves blood supply to the periosteum compared to the non-locking volar approach [4,7]. Volar locking plates work just as well in older patients as they do in younger patients [4]. However, they do come with potential risks and complications, one of which is hardware failure, which is an uncommon complication occurring in about 2.4% of patients [8]. Here we report a rare case of plate failure following a fall in a 70 year old female with a previous distal radial fracture. We discuss the potential mechanism of this injury and consider how this might have been prevented. We also discuss how hardware failure might impact on fracture repair in these uncommon injuries.

Case Presentation

A 70 year old lady was admitted to the emergency department following a fall with pain and a deformity to her left wrist. She had fallen over whilst walking her dog and fell onto an outstretched left hand. There were no other injuries sustained from this fall apart from the injury to her left wrist. Her past medical history included type 1 diabetes mellitus, asthma and a chronic ulcer to her right foot. She also had two previous myocardial infarctions, one and two years earlier which were treated with cardiac stenting, and two Transient Ischemic Attacks (TIAs), two months earlier. Additionally, she had sustained a left and right ankle fracture in 2010 and 2013 respectively, which were both managed non-operatively, and a left wrist fracture, which was treated with a volar plate and screws. On examination in the emergency department the patient was alert but in pain. There was an obvious deformity to her left wrist and tense swelling to her left forearm. Her neurovascular status

was normal. She had good palpable pulses and her capillary refill time was normal. Her median and ulnar nerve function was preserved. An X-ray of the left wrist was performed. The case was discussed in the local trauma meeting and it was decided to take the patient to theatre to remove and replace the internal fixation plate. She was taken to theatre the following day. A Henrys approached was performed and a soft tissue dissection was performed to the plate. The plate was bent at the level of the unused hole and the distal screws had avulsed from the distal radius. The plate was removed which revealed a severely comminuted fracture. The fracture was reduced and alignment confirmed on image intensifier before a bridging volar Acu-Loc plate was applied and fixed with a combination of locking and non-locking screws. A fasciotomy of the flexor compartment of forearm was also performed to manage what appeared to be an impending compartment syndrome and a carpal tunnel release was performed to avoid a carpal tunnel syndrome. The flexor compartment of the forearm was swollen but not necrotic and the median nerve and the thenar branch were identified and preserved. Postoperatively the patient managed well and was discharged home with a backslab *in situ*. She was seen in follow up clinic at 2 and 6 weeks postoperatively with numbness over the thumb, middle and ring finger suggestive of some damage to the median nerve despite preservation efforts. We cannot determine at this moment if these symptoms will be reversible or not.

Discussion

This case is unusual in that the plate failed as a result of trauma from a fall. Volar plates are known to fail due to loosening or breaking of the screws as well as bending or breaking of the plate [8]. However, bending of the plate typically occurs as a result of stress fractures that are caused by damage over time, as opposed to acute trauma [5]. Repetitive use of the wrist, particularly if patients use their wrists to assist standing, has been shown to cause both titanium plates and the screws to break [9,10]. In the elderly, prolonged stress is more likely to weaken the hardware to the point of breaking [11]. Osteoporosis, obesity and muscle wasting can also contribute to hardware failure [11].

The choice of hardware itself can determine the success or failure of the plate, and poor selection can contribute to the stress that it is under [11]. There is a higher rate of failure in plates made from titanium than those made from steel [12]. Additionally, an unfilled screw hole is a potential weak point in the plate from which it can bend or break and so failure to fill all of the screw holes could be a reason for hardware failure [9,13].

Axial load testing of volar hybrid and locking plates, which aims to replicate long term stress on a plate, demonstrated that the mechanism of failure was by distal fracture collapse and plate bending [14,15]. These tests found that the force required to bend volar plates with a single-head design was 1025 Newtons (N) [15]. Models suggest that falls onto outstretched hands at a height greater than 0.6 m generate enough force to fracture the distal radius [16]. Given that estimates of the force required for a radial fracture range from 1640 N to 3390 N, i.e. greater than the force required for volar plates to fail, it is not so surprising that the plate failed in our case [17-19]. Despite this, plate failures due to trauma are extremely rare, with only a handful of cases reported in the literature [5,11]. Axial load tests fail to take into account is the ability of the bone to heal, it could be that the fracture healing is what usually prevents the peri-implant injuries [14,15]. Plates are not usually removed electively from the distal radius as there is an increase in morbidity from repeat surgery [5]. However, if complications such as synovitis or tendon rupture occur then they can be removed [20,21]. Hardware is also removed in cases of mal/non-union, infection or pain [20]. Bent plates can cause swelling and damage to the surrounding tissues as well as nerve injuries and as such, our patient required the removal of the plates and screws [5]. In this case the removal of the original plate and screws was quite complicated. One of the factors that can make removal of volar locking plates more complicated is cross-threading of the screw in the plate [20]. This can be caused by poor positioning of the screws or use of excessive force when drilling [22]. The use of a torque limiting screwdriver is thought to be essential to prevent this from happening, and is perhaps something that could have been done to make this plate removal easier [22]. There have been similar case reports of plates bending following road traffic collisions [5,11]. Lucke-Wold et al. [11] suggest that the mechanism of injury for plate bending following a road traffic collision could also apply to those of falls. In their case, the plate used in the patient's initial fracture repair was a thin, four-hole 'T plate' rather than a locking plate, which could mean she had a less stable repair, thus causing the plate to bend [11]. The patient then had the deformed plate removed and was fixed using a volar plate [11]. Another case report by Kanji et al. [5] also chose to exchange the 'T plate' that was used in the original fracture repair and replace it with a locking plate. In these cases, volar locking plates were chosen to replace the damaged plates. However, for the majority of distal radial fractures there is still no clear evidence that these locking plates provide better outcomes for patients than non-surgical management [5]. Whilst volar locking plates have shown to be effective, they may not outweigh the complications, albeit rare ones, of hardware failure, that could be circumvented through the use of non-surgical management [4].

Summary

Decisions on how to treat these distal radial fractures should be made on a case-by-case basis. Hardware failure is a rare complication of distal radial fracture repair, but high impact injuries from falls or road traffic collisions can make this more likely. Plate selection, delayed healing, and surgical technique can all contribute to hardware failure. Additionally, measures should be taken during fracture repair to ensure that should hardware need to be removed at a later date, it is not made more complicated than necessary.

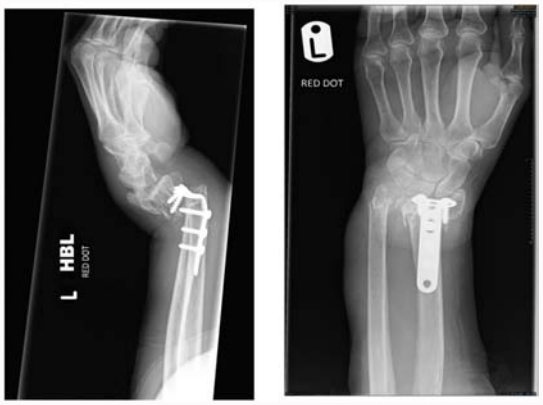

Figure 1: Lateral and AP radiograph of distal radius fracture and bending of the volar plate at the site of fracture.

Figure 2: Lateral radiograph post-operatively demonstrating the reduced fracture fixed with a new volar plate. This image also demonstrates the extent of comminution at the fracture site from this injury.

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