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ORTHOPAEDICS
Mini Review

The Bosworth Ankle Fracture: A Retrospective Case Series and Literature Review

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Received: February 18, 2016; **Published:** February 20, 2016

Abstract

The Bosworth fracture-dislocation is a rare fracture that occurs with increased force and energy. Due to the infrequency of this injury case studies have become the standard of report. We present a case series with a literature review with comparative analysis, as well as a suggested operative technique and approach that could contribute to better results. Our hypothesis is that those patients encountered early, counseled in detail with operative and post-operative expectations to reduce noncompliance, and operatively fixed with at least two 4 cortical syndesmotic screw fixation would heal faster, return to work sooner, and have better ankle function without mid to long-term complications or sequelae; compared to those fixed with one 4 cortical syndesmotic screw or no syndesmotic screw.

Keywords: *Bosworth fracture-dislocation; Treatment for Bosworth ankle injuries; Sequelae for Bosworth ankle injuries*

Abbreviations: OTA: Orthopaedic Trauma Association; OCD: Osteochondral dissicans; SER: Supination External Rotation; MRI: Magnetic Resonance Imaging; AOFAS: American Orthopaedic Foot and Ankle Society.

Introduction

The Bosworth fracture-dislocation is named after a New York based orthopaedic surgeon who contributed numerous publications on bone and joint tuberculosis and introduced streptomycin for its treatment [1] [2]. Bosworth described this injury in 1947, when he reported five fracture-dislocation patterns. This report is still one of the largest studies to date on this type of injury [3]. The definition of a Bosworth fracture-dislocation includes a fracture of the distal fibula with the proximal portion of the fibula locked behind the posterior lateral tubercle of the tibia [3]. Despite Bosworth's account of this fracture in 1947 it was clinically described in 1922 by Ashhurst and Bromer [4], without any fracture pattern or definition.

Bosworth fracture-dislocation injuries are extremely rare with no current reported incidence. There have been 61 reported cases and 34 total published articles in the literature since Bosworth's initial definition of the injury, most of these have been case studies with only one subject. This fracture has also been reported to occur at any age with Specific fracture patterns distinct to bone maturity [5]. Bartonicek., *et al*. [6] reported the largest published data on Bosworth fractures. They presented six cases as well as a detailed literature review. Most fractures published in the literature occur as a result of a supination external rotation (SER) type injury with an abnormal amount of related external rotation. Though it has not been discussed in detail, there have been reports of the fracture pattern occurring with a Maisonneuve type injury [5]. No consensus exists regarding optimal treatment protocol. This fracture pattern is known to have major sequelae associated with the results due to both misdiagnosis and under appreciation of the severity type. We present a retrospective case series review to evaluate outcome measures associated with this fracture pattern: time to healing measured both radiographically

and clinically, evaluation assessment and time to surgery, and common mid to long-term sequelae. These outcome measures are associated with specific recommended surgical guidelines and patient counseling of expectations during the approach of this rare and unique fracture. Our hypothesis for this review is that those patients encountered early, counseled in detail operative and post operative expectations in hopes of increasing patient compliance, and operatively fixed with at least two 4 cortical syndesmotic screw fixation would heal faster, return to work sooner, and have better ankle function without mid to long-term complications or sequelae; compared to those fixed with one 4 cortical syndesmotic screw or no syndesmotic screw.

Injury Mechanism

The injury mechanism of a Bosworth pattern results from an indirect force with axial loading with a supinated foot position. There is an excessive amount of external rotation, causing the talus to rotate approximately 90 degrees from its original position, pushing and locking the fibula behind the tibia in a fixed position [3,5,6]. It can occur with or without fracture and there are several different theories on the precise pathology of the injury since Bosworth's initial definition in 1947.

The literature remains unclear on the exact pathology of injury as there is no official published classification of Bosworth type fracture injuries; however there have been data suggesting specific staging types [5], as well as different fracture patterns associated with skeletal maturity. Table 1 summarizes this data.

Study	Mechanism
Bosworth, 1947 (3)	1. Leg pushes forward and rotates externally with the talus moving from its anatomical position from under the tibia and putting increased force on the lateral collateral ligaments drawing the fibula behind the tibia. 2. If there is adequate amount of force, the fibula then breaks against the posterior tibial border and stays fixed on the posterior tubercle
Perry., *et al*. 1983 (5)	1. Rupture/avulsion of Anterior Inferior Tibiofibular Ligament (AITFL) 2. Rupture/avulsion of Posterior Inferior Tibiofibular Ligament (PITFL) 3. Rupture of the anteromedial part of the capsule followed by rupture of the interosseus ligament 4. Interosseous membrane tears at a point 4-6 cm proximal to the ankle joint 5. External rotation continues, the fibula is then forcefully pushed posterior by the intact lateral collateral ligaments causing the fibula to be entrapped behind the posterolateral ridge of the tibia 6. Talus continues to rotate around the intact deltoid and medial malleolus, causing the fibula to undergo a supination external rotation type fracture at the level of the ankle joint 7. Medial malleolus fracture or rupture of the deltoid ligament
Meyers., *et al.* 1957 (19)	1. Forward momentum of the leg 2. Eversion of an adducted foot
Schatzker., *et al*. 1977 (11)	1. Posterior dislocated talus 2. External rotation of talus 3. Ruptures of the AITFL and PITFL 4. Fracture of the fibula
Bartonicek., *et al*. 2007 (6)	1. Children and adolescents intact fibula with epiphyseolysis of the fibula and tibia (Salter Harris type I) 2. Young patients with closed distal tibia physis, the fibula will dislocate without fracture due to increased elasticity of osseous structures 3. Middle aged and older dislocation occurs with fibula fracture either distally or proximally due to increased elasticity

Table 1: *Summary of injury mechanism throughout literature.*

The authors recommend staging and classifying the ankle fracture with the Lauge-Hansen or Danis Weber OTA type B/C system, which have become the gold standard classifications for ankle fractures [7]. The definition of the Bosworth injury is dependent on the amount of dislocation and the position of the fibula and tibia with the associated mechanism at the time of injury.

Patient and Methods

To be considered for our cohort, patients had to have undergone fixation of their Bosworth injury at our institution (John Peter Smith Hospital, Fort Worth, Texas, USA). Patients were identified by fracture pattern and type, and reviewed using their electronic medical record through the attending surgeon's practices (TM). A retrospective chart assessment was performed on all patients from 06/01/2012 -07/31/2014 and the data was reviewed by the study group (MD,TM,VK). Exclusion criteria included any patients that were less than 18 years of age, pregnant women, and prisoners. This restrospective case series review demonstrated outcome measures with specific recommended guidelines based on results from our cohort. These include age, gender, extremity involved, classification of fracture patterns, early evaluation assessment with time to surgery, time to healing measured both radiographically and clinically, and common sequelae. Preoperative images were classified with the Lauge-Hansen or Danis Weber OTA type B/C system for ankle fractures.

Evaluation assessment and time to surgery were defined and determined by the interval between initial evaluation of the patient in the emergency department and the number of days prior to going to the operating suite. Additionally, the amount of time from injury until evaluation was also reported and measured in days.

Time to healing was determined by fracture healing status with serial physical and radiological examinations of the patients in order to determine the union interval [8]. Serial reviews included evaluation of union interval of the fracture site as well as evaluation to weight bearing status postoperatively. Osseous union was described with three radiographic views evaluated by the authors. Though there is a lack of a general consensus in defining fracture healing in the literature, four guidelines were utilized in the current study to assess clinical healing and three guidelines were utilized to assess radiographic healing [8]. Table 2 demonstrates these specific criteria.

Clinical criteria to define fracture healing	Radiographic criteria to define fracture healing
1. No pain or tenderness to palpation on physical examination	1. Bridging of fracture with callus or trabecular bone
2. No pain noted over hardware	2. Bridging of fracture with two cortices
3. No pain or tenderness with weight bearing	3. Absence of hardware failure or loosening
4. Ability to walk and perform activities of daily living without pain or tenderness	

Table 2: *Summary of cohort clinical and radiographic healing.*

Common mid to long-term sequelae are include osteochondral dissicans (OCD) of the talus and/or tibia, hardware pain/loosening and/or breakage, post traumatic arthritis in ankle joint, post traumatic arthritis in adjacent joints (i.e., subtalar joint, talonavicular joint, calcaneocuboid joint, midfoot joints). These parameters typically occur or become symptomatic after full weight bearing has been initiated. Complications or sequelae including hardware pain, continued tenderness with palpation, pain with range of motion, delayed weight bearing status, delayed healing, pain with ambulatory status, were all recorded. Education and counseling prepare the patient and the family during the perioperative period. Discussions should include time to surgery, method of fixation with specific guidelines discussed above, and common complications. Though this should not be any different than other traumatic injuries, keeping the patient educated with the postoperative outcomes will help prevent false expectations and aids in compliance. The authors' operative technique/approach and patient education for expectations were not associated with the outcome measures.

Like all dislocations of the foot or ankle, this injury should be surgically reduced as soon as possible to lower complications; however there is a balance of specific timing that is dictated upon soft tissue edema. There should be a concern to avoid edematous tissue. If this is encountered, a delay may be necessary for several days to allow the soft tissue to improve. A delta frame or spanning external fixator may be needed due to soft tissue edema and the need for an immediate reduction attempt.

Authors' operative technique and approach

The common longitudinal lateral fibular incision approach was utilized, with both sharp and blunt dissection in a layer-by-layer fashion until the fracture or deformity is encountered. Care was taken to protect the superficial peroneal nerve if encountered as well as

the adjacent peroneal tendons. The fibula dislocation was reduced by pushing the fibular more medial while wedging it over the posterior tubercle with a retractor device to assist in the wedge. Plate and screw decision was at the discretion of the surgeon. The amount of cortices encountered and the amount of screws utilized during the syndesmotic reduction was at the discretion of the surgeon; however the authors recommend at least two 4 cortical syndesmotic screw fixation as outcomes are favorable compared to only one 3 or 4 cortical screw or no syndesmotic fixation. The talus and tibia plafond was inspected for OCDs during distraction of the fibula after hematoma removal. Arthrex (Naples, FL) 3.0 suture anchors were utilized to secure the anatomical position of the lateral collateral ligaments and augmented to the inferior extensor retinaculum. The peroneals were inspected after reduction to assess subluxation around the distal fibula. The medial malleolus was reduced and fixated at the discretion of the surgeon's preferences. Incision closure was at the discretion of the surgeon. A well-padded posterior splint was applied with fiberglass (orthoglass) and plaster.

The authors' recommend the first postoperative visit within four to seven days. The posterior splint was kept intact until suture removal then the patient was transitioned to an immobilization/cam boot. If compliance was in question, a short leg cast was recommended. Weight bearing regimens were started 6-8 weeks postoperatively pending union and pain status. Physical therapy was utilized on an as needed basis.

Results

Descriptive variables recorded for each patient are included in Table 3. Five total male patients were included in our study (n = 5) with three right ankles and two left ankles. The classification of fracture pattern included four SER 4 and one dislocation without fracture demonstrated in Figure 1a. An MRI was ordered for this patient, as there were not any fractures noted on radiograph during initial assessment. Unsuccessful reduction lead to inspection of surrounding soft tissues with an MRI which demonstrated an isolated syndesmosis ruptures and dislocation of the fibula behind the tibia (Figure 1b). The mean patient age was 42(±21). The average time to surgery was 10(±5) days. The average time to healing was 7(±1) weeks.

Patient	Age	Gender	Extremity Involved	Classification of fracture pattern
Patient 1	57	Male	Right	SER 4/Weber B
Patient 2	71	Male	Left	SER 4/Weber B
Patient 3	27	Male	Right	SER 4/Weber B
Patient 4	34	Male	Right	SER 4/Weber B
Patient 5	20	Male	Left	Dislocation without fracture. Only rupture of syndesmosis noted on imaging

Table 3: *Variables recorded of each patient in the cohort.*

Figure 1a: *Demonstrates pre operative radiographs of the Bosworth dislocation. There are no fractures noted. Note the "axilla" sign on the medial aspect of the anterioposterior image.*

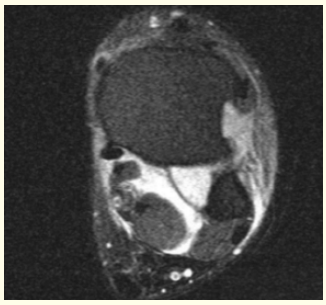

Figure 1b: *Demonstrates a coronal T2 MRI that was taken after unsuccessful reduction. An MRI was obtained rather than a CT as there were not any fractures noted on radiograph. In order to visualize exact soft tissue restrictions an MRI provided a detailed image of the reason.*

Detailed results of the outcome measures tested are listed in Table 4a along with listed comparisons of our measures from similar articles published since the year 2000 (Table 4b). Noncompliance and none or one 4 cortical syndesmotic screw determination was most commonly associated with delayed healing, post-operative pain, and early signs of osteoarthritis. Though not statistically significant, Figure 2 demonstrates the need for a strict protocol when encountering this unique ankle dislocation with at least two 4 cortical fixation (as shown in Figure 3).

Reference	Patient	Time to surgery	Time to healing	Common sequelae	Main conclusion of article
Current Study	Patient 1	12 days	8 weeks, weight bearing noted at this time as well as clinical and radiographic healing. No syndesmotic screw utilized. Syndesmosis tested intraoperatively and intact.	Continued pain noted after radiographic healing after weight bearing had been initiated. The patient was not compliant with treatment regimen. Early signs of osteoarthritis noted with osteophytes. Patient lost to follow up.	Bosworth fracture-dislocations are extremely rare. Even though they are not commonly encountered, treatment options should include rapid assessment and diagnosis with associated anatomical operative fixation with specific guidelines for syndesmosis repair. A step by step guide is important and outcomes are improved when encountering this difficult ankle fracture.
	Patient 2	14 days	9 weeks, weight bearing noted at this time, clinical and radiographic healing, mild pain with weight bearing, 1 four cortical syndesmotic screw utilized.	Patient weight bearing at 8 weeks with continued pain associated with weight. The patient began weight bearing prior to instructions. Not compliant with treatment regimen. Early signs of osteoarthritis noted with subchondral cyst formation.	
	Patient 3	14 days	6 weeks, weight bearing noted at this time, clinical and radiographic healing, mild pain with weight bearing, patient fixed with 1 three cortical syndesmotic screw.	Continued pain noted after radiographic healing. The patient was compliant with treatment regimen.	
	Patient 4	10 days	6 weeks, weight bearing noted at this time, clinical and radiographic healing, patient weight bearing at 6 weeks with no pain, 2 four cortical syndesmotic screws utilized.	None. The patient was compliant with the treatment regimen.	

	Patient 5	1 day	6 weeks, weight bearing noted at this time, clinical and radiographic healing, no fracture associated with Bosworth dislocation, patient weight bearing at 6 weeks with 2 four cortical syndesmotic screws utilized.	None. The patient was compliant with the treatment regimen.	

Table 4a: *Tabulates the current studies outcome measures and results with time to surgery, time to healing, and common sequelae noted.*

Reference	Time to surgery	Time to healing	Common sequelae	Main conclusion
Bartonicek., *et al*. J Orthop Trauma, 2007	1. 3 Days 2. Closed Reduction Successful 3. 7 days 4. 2 days 5. 0 days 6. Not provided	1. No acute measures, relate 8 years after surgery the patient had no subjective complaints 2. Not provided 3. No acute measures, relate 5 years after surgery the patient was fully weight bearing and no pain noted with ROM 4. Not provided 5. No acute measures, relate 3.5 years after surgery the patient was subjectively satisfied and with normal ROM 6. No acute measures, relate 3 years after surgery the patient had no complaints	1. Hardware from the medial malleolus fixation after 2. Severe post traumatic arthritis with an ankle arthrodesis performed after 2 years 3. Syndesmotic screws were removed 8 weeks after surgery due to pain 4. Reported continued pain in ankle 2.5 years, mild widening noted in the syndesmosis, subchondral cyst noted in ankle, decrease in both dorsiflexion and plantarflexion approximately 5 degress in both planes 5. None 6. Decrease in dorsiflexion and plantarflexion approximately 5 degrees in both planes at 3 year mark	Surgical treatment options are best, due to extensive ligament damage. Authors relate best outcome is with anatomical reduction and fixation.
Beekman & Watson, J Bone & Join Surgery, 2003	Not provided	No acute measures, at 1 year post operatively the patient returned to recreational ativities, syndesmotic screw removed at 14 weeks	Compartment syndrome (anterior, lateral, deep posterior compartments) antalgic gait with decreased ankle dorsiflexion and plantarflexion	Bosworth fractures and compartment syndrome with an ankle fracture are rare. Authors relate vigilance must be utilized when treating injuries associated with prolonged dislocation.
Delasotta., *et al*. Foot & Ankle International, 2013	Not provided	No acute measures, 6 months post operatively there was excellent radiographic position and at 8 months the patient had no complaints	Authors note an anterior compartment musculature interposition	If closed reduction is not successful the authors recommend admitting the patient for neurovascular and compartment checks while scheduling for an emergent surgery.
Elanti., *et al*. J of Emergency Med, 2013	Not provided	No acute measures, at 3 months the patient had full ROM and was pain free	No complications noted with case study; however, the authors mention compartment syndrome, avascular necrosis fo the talus and post traumatic osteoarthritis of ankle as possible common complications	The authors argue to avoid repeated closed reduction attempts due to soft tissue insults and proceed to immediate open reduction internal fixation.

Khan & Borton, Foot & Ankle International, 2008	Not provided	No acute measures, syndesmotic screw was removed after 6 weeks of non weight bearing, then the patient progressed to weight bearing as tolerated with no complaints at 12 weeks	Limited ankle dorsiflexion of 10 degrees after initial treatment, the uathors make references to other articles to include compartment syndrome, avascular necrosis of the talus, ankle joint post traumatic arthritis	The authors coined the term "the axilla sign" being a cortical density in the axilla shoulder of the medial tibial plafond seen in anterior-posterior as well as the mortise radiographs which represents persistent internal rotation of the tibia due to locking of the proximal fibula shaft behind the posterior tibial tubercle.
Lui., *et al*. Arch Orthop Trauma Surg, 2008	1. 0 days 2. 0 days 3. 0 days 4. 0 days	1. Not provided 2. Not provided 3. Not provided 4. Not provided	1. Reported ankle capsular contracture, extensor tendon adhesions, and osteophyte formation 2. Reported ankle capsular contracture and osteophyte formation 3. Reported ankle capsular contracture and osteophyte formation 4. None	Early detection and reduction is important as delayed reduction may results in a stiff ankle with both capsular and extracapsular pathology.
Schepers., *et al*. J Foot & Ankle Surg, 2012	0 days, after failed closed reduction	Nonweight bearing in short leg case 6 weeks, hardware removed at 9 months, painfree at 12 months	Reported talar osteochondral lesions noted intraoperatively, the patient was painfree at 12 months	A high index of suspicion for a Bosworth fracture dislocation is needed in the case of an irreducible ankle fracture dislocation.
Wright., *et al*. Injury, Int J Care Injuried, 2012	Not provided	Nonweight bearing in plaster cast for 6 weeks and was discharged 12 weeks post operatively and weight bearing without complications	None	Radiographs can be easily misinterpreted so the authors recommend using axial CT if there is any uncertainty. Authors also utilized a posterolateral approach during surgery.
Yeoh & Tan, J Orthopaedic Surgery, 2013	1 day	3 months recovered well with no complaints and returned to work	Split thickness skin graft added 10 days post operatively, 2 weeks later graft taken with good healing of wound, 16 weeks syndesmotic screw removed	Surgery performed despite soft tissue swelling due to risk of skin necrosis. If there is no immediate danger to the soft tissue, surgery should be delayed to allow the soft tissue edema to subside and improve in order to avoid skin breakdown.

Young., *et al*. J of Orthop Trauma, 2001	Not provided	Not provided	Compartment syndrome of the anterior compartment, EHL contracture, residual pain and hyperextension deformity of the hallux	Compartment syndrome after ankle fracture is rare. The deep posterior compartment and the anterior compartment may be involved. High index of suspicion for these complications as well as early decompression fasciotomies can decrease long term sequelae of untreated compartment syndrome
Zhu, Chinese Journal of Reparative and Reconstructive Surgery, 2013	1-5 days with average of 1.8 days	Average healing at 9.5 weeks, average full weight bearing at 12 weeks, average AOFAS score 89.5	Infection occurred in 1 case	Specifically for Bosworth ankle fractures the authors report that good results can be achieved by early diagnosis and open reduction internal fixation.

Table 4b: *A summary and comparison of all published articles since the year of 2000 with specific details relating to our studies outcome measures and results.*

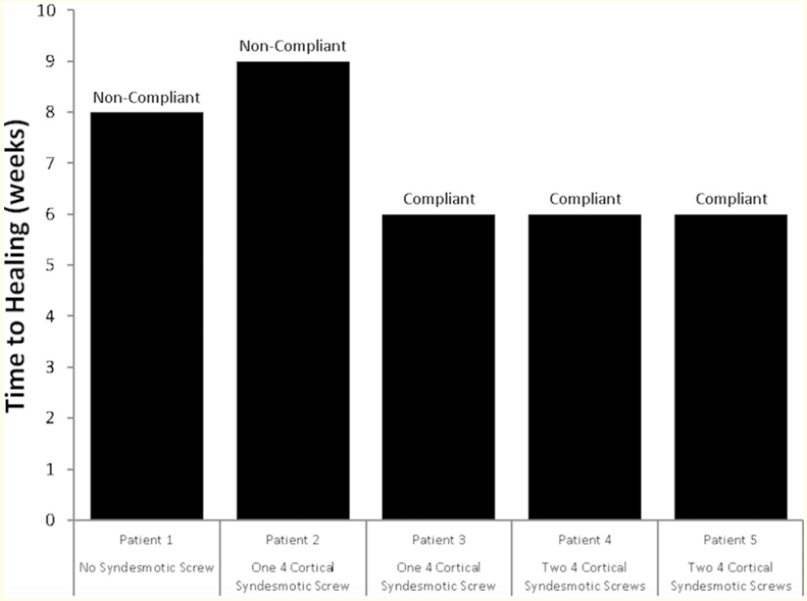

Figure 2: *A bar graph showing time to healing coupled with compliance and the number of screw fixation cortices. As demonstrated in the results two 4 cortical syndesmotic screw fixation along with compliance are associated with a quicker time to healing.*

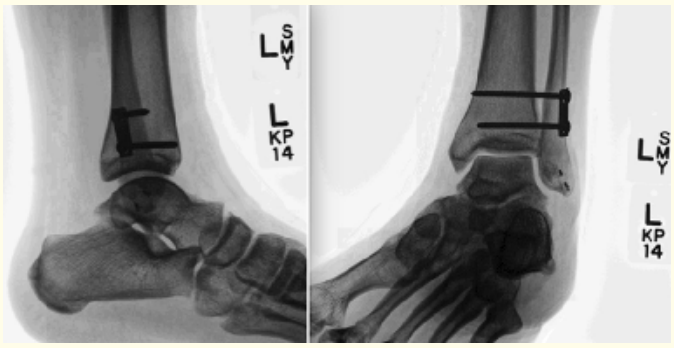

Figure 3: *Demonstrates post-operative fixation of the dislocation with two 4 cortical sydnesmotic screw fixation and suture anchors as the lateral collateral ligaments were transected to assist with reduction.*

Discussion

Bosworth fracture-dislocations studies reported in the literature are commonly case studies or recommended treatment plans only without the mention of results. If outcome is reported it is only a short time after injury with good or great results directly after operative fixation. This gives a false sense of long-term effect and the justification for further prospective randomized or prospective comparative studies. The problem encountered with Bosworth pattern of injury however, is that it is rare with only 61 cases and 34 articles reported over 50 years, making case studies the standard for reporting.

Specific guidelines for encountering this fracture or injury type are necessary to prevent further sequelae and to offer optimal outcomes during the workup, interval to fixation, as well as post operatively. Our study confirmed our hypothesis as those patients encountered in an earlier time frame, those that were compliant, and those that were operatively fixed with two 4 cortical syndesmotic screw fixation healed faster and had better outcomes without complaints of pain or early signs of osteoarthritis as seen in Figure 2. Of note, patient 3 healed in 6 weeks according to our criteria in Table 2; therefore it is difficult to ascertain if noncompliance or two 4 cortical fixation is the rationale of his healing status. However, it is important to note that he continued to have pain with weight bearing status beyond his time to healing compared to patient 4 and 5. Thus, the authors contribute this to only one 4 cortical fixation and recommend the treatment protocol stated above and shown in Figure 3.

In order to assist with a diagnosis of Bosworth fracture-dislocations it has been recommended that confirmation is made radiographically using a full-length (knee to ankle) view [9-11]. Khan., et al [12] evaluated twelve publications since the initial Bosworth publication in 1947 and found that documented cases on Bosworth fracture-dislocations have a unique visible cortical radiodensity on the medial tibial plafond on post injury radiographs [12]. They coined this finding as "the axilla sign" and determined that it can be visible on standard mortise radiographs [12]. They attribute the visual sign to persistent internal rotation of the tibia as a result of the locking of the proximal fibular shaft behind the posterior tibial tubercle [12]. Computed tomography [13] can also be a strong utilization instrument for education in diagnosis of the injury pattern as well as for surgical planning [6]. Figure 1a shows this radiographic finding by visualizing the axilla sign on the lateral aspect of the medial malleolus shoulder. Irwin et al., recommends obtaining CT for any posterior malleolus fractures to determine the integrity of the distal syndesmosis and fracture pattern [14]. This can also be beneficial for these fractures patterns that do not follow a standard mechanism or if there is question to the fibula locked behind the tibia. An MRI can also be beneficial should soft tissue be in question for the affect of the initial reduction as seen in Figure 1b.

The data presented by Bartonicek., *et al*. [6] referenced severe osteoarthritis as a result to late fixation in one of their cases. Even though there was not any mention of specific visual analog scales or AOFAS scores, they did report successful results with satisfied patients up to 8 years after operative fixation [6]. The most severe encountered complication with this injury has been compartment

syndrome and vascular compromise [6,15]. Two cases out of 61 report associated compartment syndrome, despite the low percentage, it is better to error on the side of immediate fixation and avoid this devastating complication [15,16]. Beekman & Watson [15] report an anterior, lateral, and deep posterior compartment syndrome in which the patient was sent home after initial assessment and closed reduction attempts with plans to set him up for surgery after several days due to soft tissue swelling [15]. The patient then reported back to the emergency department 12 hours later with out of proportion pain, pain with passive stretch, and pain not controlled with oral medication. Compartment pressures associated with this injury are likely encountered due to increased stress placed on adjacent compartments. Standard ankle fractures with associated compartment syndrome are rare thus the importance of classification of this fracture-dislocation becomes even more relevant and time dependent. Vascular compromise of the posterior tibial artery has been encountered with this injury type although contribution is likely due to the mechanism of injury being a severe motor vehicle collision with associated posterior tibial tendon rupture [6]. The authors also contribute associated increased tension on the extensor retinaculum with posterior dislocation of the fibula and adjacent injury to dorsalis pedis [6].

Bosworth fracture-dislocations are often missed in the primary setting due to rarity and unfamiliarity. In order to prevent skin necrosis, possible compartment syndrome, and a mal-aligned joint, immediate evaluation and correct diagnosis is recommended. Closed reduction is difficult and repeated attempts (more than two) could potentially cause irreversible injury and should raise suspicion for operative intervention, which becomes absolute in order to release the dislocation. The amount of energy that occurs raises suspicion of adjacent pathology to include OCDs of the talus or tibial plafond. Articular involvement of the talar dome at the lateral shoulder is increased due to the amount of energy transferred with this dislocation and should be ruled out during distraction of the fibula [17]. The medial shoulder of the talus should be evaluated as the rotation of talus causes abutment of the medial portion on the anterior portion of the medial malleolus [17]. There is a reported 40 percent involvement of talar dome lesions with associated ankle fracture dislocation and though this has not been evaluated in any other Bosworth fracture dislocation studies, it is likely increased due to the amount of energy transferred through the talus [18]. This is important to rule out intraoperatively in order to avoid further need for surgery and continued complication and/or patient dissatisfaction (18). Hardware pain, loosening, and breakage can cause mid to long-term complications after aggressive weight bearing has been initiated and often varies from patient to patient. Syndesmotic screw removal is based on surgeon preference and is typically performed with or without plate removal should hardware problems occur. Lastly, post-traumatic arthritis is common with injury adjacent to any articular surface with or without associated mal-alignment; making osteoarthritis the most common complication with mid to long-term follow up.

Conclusion

Bosworth fracture-dislocations are an extremely rare yet severe fracture type. Even though they are not commonly encountered, treatment options should include rapid assessment and diagnosis with associated anatomical operative fixation as described for optimal results. Our study provides related complications based on our methods and other studies as well as a step-by-step guide when encountering this difficult ankle fracture. Time to healing, both clinically and radiographically was improved with at least two 4 cortical syndesmotic screws utilized. Additionally, evaluating patient compliance demonstrated the need for extensive pre and post operative counseling with the family and those involved with the patient. Complications such as osteoarthritis, osteochondral lesions, and delayed healing were avoided when following this protocol and can benefit those surgeons that encounter this fracture type in the future.

Financial Disclosure: None reported

Conflict of Interest: Each author certifies that he or she has no commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.

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Volume 3 Issue 1 February 2016