ECRONICON OPEN ACCESS

EC ORTHOPAEDICS
Research Article

Jones Fracture Fixation: Minimally Invasive Management of 67 Cases

Gordon L Slater[1]*, Emily E Walters[2], Martin J O' Malley[3] and Sarah A Armstrong[1]

[1]Department of Sports Foot and Ankle Surgery, Edgecliff Medical Centre, Australia

[2]The University of Texas Medical School at Houston, USA

[3]Department of Foot and Ankle Surgery, Hospital for Special Surgery, USA

***Corresponding Author**: Gordon L Slater, MBBS, FRACS (Orth), FAOrthA, Sports Foot and Ankle Surgery, Level 2, Suite 211, 203-233 New South Head Road, Edgecliff NSW, 2027, Australia.

Received: August 10, 2016; **Published:** August 19, 2016

Abstract

Aim: The purpose of the study was to evaluate the effectiveness of percutaneous fixation of Jones fractures using a 4mm titanium cannulated screw.

Methods: Sixty-seven patients (40 females and 27 males) who elected to undergo surgical intervention of a Jones fracture were reviewed. All patients had Jones fractures were fixed with 4mm titanium cannulated screw between 2007 and 2015 by a single surgeon. There were no exclusion criteria. Patient files where reviewed to determine treatment success and obtain objective information regarding injury aetiology; radiographic findings; time from injury to surgery; time to union; complications or secondary procedures required; and return to pre injury activity.

Results: Sixty-seven patients with a mean age of 38 years were reviewed. Time from injury to surgery ranged 1 day to 30 weeks, with a mean of 1 - 2 weeks. Surgical fixation of Jones fracture resulted in 98.5% (66 cases) radiological union with a mean time to union of 8.9 weeks. One patient with diabetic neuropathy developed asymptomatic strong fibrous non union, with symptom resolution. Four patients developed infections post operatively and were treated with a course of oral antibiotics; there where zero incidents of deep vein thrombosis or neurological injury. Eighteen patients reported residual pain or discomfort around the screw site 1 of which had a prominent screw head. Fifteen patients underwent removal of screw, with symptom resolution; three patients experienced symptom resolution with anti-inflammatory agents. At follow up there are no incidences of refractures, screw breakages or nerve injury. All patients returned to activity.

Conclusion: Percutaneous fixation of Jones fracture using a 4 mm titanium cannulated screw has shown to be an effective treatment approach and valid technique for the management Jones fractures across all patient demographics.

Keywords: *Jones Fracture; Internal Fixation; Fifth Metatarsal; Treatment; Metatarsal Fracture*

Core Tip

Percutaneous surgical fixation is a commonly used technique for the management of Jones fracture which otherwise can result in prolonged recovery phase, delayed unions, non unions and risk of refractures. We present the outcomes and treatment success of 67 patients who elected to undergo surgical intervention of a Jones fracture between 2007 and 2015. All patients were fixed with 4mm titanium cannulated screw by a single surgeon. To our knowledge this is the largest published World Series by a single surgeon. Radiological union was achieved in 98.5% of cases. The authors would recommend percutaneous fixation as a valid technique using a single 4 mm titanium cannulated screw.

Introduction

While the incidence of the Jones fracture is a rather frequent occurrence in all patient demographics, there is not a clear consensus

regarding how such fractures should be addressed. A Jones fractures is a transverse fracture at the metaphyseal-diaphyseal junction which Sir Robert Jones specifically classified as being 'the proximal ¾ segment of the shaft distal to the styloid [1,2]. A Jones fracture is usually caused by forceful ankle plantarflexion and forefoot adduction, leading to excessive force being placed on the lateral boarder of the forefoot and metatarsal heads [3,4]. This unique type of fracture includes the articulation of the fourth and fifth metatarsals [5] and is known for its tendency to have delayed healing time. This in turn can result in non-unions and treatment difficulties for clinicians [2, 6-9].

Figure 1: *Jones Fracture.*

The potential complication of prolonged healing may be due to a watershed area of the blood supply in the metaphyseal-diaphyseal junction [2, 10-12]. The classification system by Lawrence and Botte delineates three fractures zones and is the most widely cited anatomic classification [13].

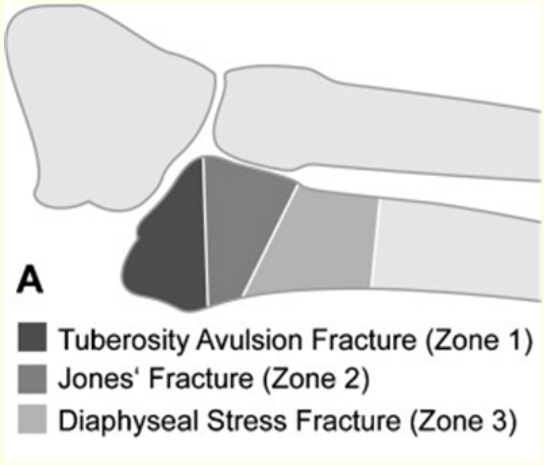

Figure 2: *Lawrence and Botte Classification of proximal Fifth metatarsal fractures [3].*

Treatment of the Jones fracture may vary depending on the location, classification and demands or expectations of the patient [14]. Many advocate for a more conservative treatment approach when treating non-displaced, acute fractures. Although widely accepted as an appropriate treatment approach, various studies have reported higher rates of delayed union, non-union, or re-fractures when conservative management is utilized in active individuals [8,10,13, 15-23]. Surgical fixation as a treatment approach for the management of Jones fractures was first described in 1978 by Kavanaugh., *et al*. [8]. Since then many studies have produced high success rates with operative

management [16,18-19,26-27]. With the advent of percutaneous fixation, it would appear that union rates can be improved, immobilization times reduced and refracture rates diminished.

In 1984, Torg., *et al*. [14-16] designed a classification scheme that divided Jones fractures into three types (type I, type II and type III) based on radiographic findings. The goal of this system was to help surgeons tailor their treatment approach based on the specific characteristics of the fracture subtype. As a result, surgeons are able to select the most suitable treatment option for each patient, thereby increasing the likelihood of positive treatment outcomes while simultaneously minimizing the risk of complications. Type I and II fractures can be treated either conservatively with a period of 6 to 8 weeks of non-weight bearing or with surgical intervention [5]. Type III fractures require surgical intervention due to the nature of the fracture [15].

We analyzed the treatment outcomes of patients who underwent internal fixation of a Jones fracture using a 4mm titanium cannulated screw by a single surgeon over the last 15 years. The goal of this paper is to guide diagnosis, review current treatment of Jones fractures, and to highlight a successful, minimally invasive treatment approach that, in our experience, generates successful and long-lasting results.

Materials and Methods

This retrospective study reviewed 67 patients who elected to undergo minimally invasive surgical fixation of a Jones fractures between 2007 and 2015. Patients were referred from primary care physicians for surgical opinion, and all surgeries were performed by a single surgeon. All patients who elected to undergo surgical intervention were reviewed, and there were no exclusion criteria. The study group of 67 patients included 40 females and 27 males.

Patient Characteristics	
Characteristic	Value
Total	67
Age, mean	38
Sex, n	
Male Female	27 40
Side	
Left Right	33 34
Fracture Type	
Acute (< 6 weeks) Non Acute (> 6 weeks)	36 31
Etiology	
Sport Non Sport Stress Fracture/Unknown	20 30 12
Time to Surgery, wk	< 1 - 30
Mean, wk	1-2

Table 1: *Study group of patients.*

Patients ranged in age from 12 - 72 years old, with a mean age of 38 years. The following objective findings were extracted from each patient's chart: surgery date, etiology of injury, radiographic findings, time from injury to surgery, time to radiologic and clinical union, noted complications or secondary procedures required, return to pre injury activity, and type of 4mm cannulated screw used.

Patients who presented within 6-weeks of fracture where categorized as acute and treated with screw fixation only. Those who attended beyond 6-weeks post fracture were categorized as non-acute, and were treated with a combination of screw fixation and bone graft.

Six patients, all of whom were treated prior to October 2014, received autologous bone graft through portals targeted over the fracture. Following identification of the fracture, a wire was inserted down the fifth metatarsal canal. A cannulated drill was then placed over the wire and osteoplasty was performed via the second incision. The autograft was harvested through a portal on the ipsilateral calcaneus and extracted using a core reamer. This was then impacted at the fracture site.

For the 14 patients who were treated after October 2014, the surgeon chose to use a recently developed bovine synthetic bone graft, which was laced with Platelet-derived growth factor (PDGF). In this circumstance, a wire was first placed into the styloid of the 5th metatarsal. Then, the canal of the 5th metatarsal was reamed and synthetic bone was injected down the reamed site. The screw was then inserted over the guide wire. Fluoroscan was used throughout the procedure.

Surgical Technique for Fractures within 6 weeks

Surgery was carried out under general anesthesia with the additional use of a knee block, administered by the anaesthetist under ultrasound guidance prior to induction. In the last 4 years, infiltration has been used instead of a knee block. Prophylactic antibiotics were commenced during the procedure. Patient was placed in a lateral decubitus position on the operating table. An ankle tourniquet was applied and foot was exsanguinated. Standard prepping and draping occurred.

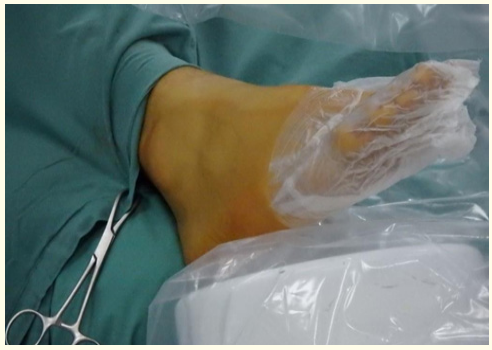

Figure 3: *Standard set up and draping.*

Under Fluoroscan control a wire was introduced into the styloid of the 5th metatarsal. A percutaneous arthrotomy was performed at the 5th TMT joint. A smooth guide wire was introduced into the metatarsal styloid and passed down the barrel of the 5th metatarsal.

Figure 4: *Smooth guidewire being introduced into the metatarsal styloid and advancement down the barrel of the 5th metatarsal.*

The wire was confirmed to be in the metatarsal on both AP and lateral views on fluoroscopy.

Figure 5: *Fluoroscopic image of the guidewire advanced into the 5th metatarsal.*

A 1cm incision was made based on the wire entry point. A smooth cannulated drill was inserted and the metatarsal drilled across the fracture site.

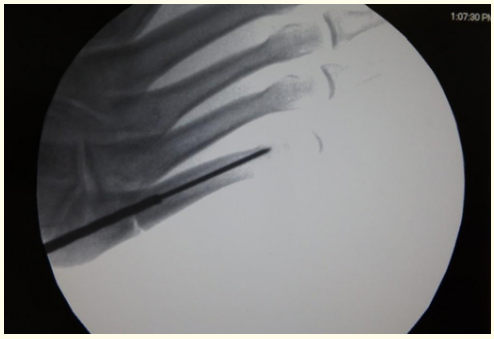

Figure 6a: *Smooth cannulated drill being inserted at the wire entry point and the metatarsal drilled across the fracture site.*

Figure 6b: *Fluoroscan confirmation.*

Under power, a 50mm x 4mm cannulated screw was inserted into the metatarsal and the fracture was noted to close.

Figure 7: *Injection of Synthetic Bone Graft down the canal of the 5th metatarsal.*

After obtaining good fixation, a 10ml syringe was used to administer local anesthetic and a steroid. Finally, the wounds were closed with using a single Nylon stitch.

Surgical Technique Fractures greater than 6 weeks

Surgery was performed under general anesthesia with the additional use of a knee block, administered by the anaesthetist under ultrasound guidance prior to induction. Once again, in the last 4 years, knee block has been substituted for local infiltration. Prophylactic antibiotics were commenced during the procedure. Patient was placed in a lateral decubitus position on the operating table. An ankle tourniquet was applied and foot was exsanguinated. Standard prepping and draping occurred. Under Fluoroscan control the fracture was identified and a wire was introduced into the styloid of the 5th metatarsal. A second wire was introduced into the fracture site. A cannulated drill was then placed over the wire and an osteoplasty was performed with a drill via the second incision. The Autograft was harvested through a portal on the ipsilateral calcaneus and a core reamer used to extract the Autograft. This was then impacted at the fracture site. In later cases after October 2014, Wright Medical Synthetic Bone was injected down the canal in place of autologous bone graft.

Figure 8: *Insertion of 4mm Integrant screw and washer.*

A 50 mm x 4 mm cannulated screw and washer was then selected. Under power the screw was inserted into the metatarsal and the fracture was noted to compress. Good fixation was obtained. An injection with local anaesthetic and steroid was administered with a 10 ml syringe spinal needle. The wounds were closed with using a single Nylon stitch.

Figure 9: *Fixation and screw placement confirmation obtained under fluoroscan control.*

Post Operative

Those treated with a Smith & Nephew 4mm screws (61 patients) were weight bearing at 4 weeks. Those treated with 4mm Integrant screws, (6 patients) were non weight bearing for two weeks and then ambulatory in a cam walker.

Results

A total of 67 patients (40 females and 27 males), with a mean age of 38 were operated on. Mean time from injury to surgery was 1 - 2 weeks (ranging 1 day to 30 weeks). The etiology of injury for each patient is listed in Table 1. Successful union was achieved in 94% of cases after the primary surgery, with a mean time for clinical union of 8.9 weeks (ranged 4 - 28 weeks). Four patients developed infections post operatively and were treated with a course of oral antibiotics; there where no incidents of deep vein thrombosis or neurological injury. No screw breaks or nerve injuries were reported in our study group. Although Asnis cannulated screws were initially selected as the preferred screw, in later cases, Integrant screws were selected, as this new option was more clinically suitable. All patients returned to activity. Radiological union was achieved in 98.5% of cases (66 cases). All patients clinically united (100%).

Eighteen patients reported residual pain or discomfort around the screw site, one of which had a prominent screw head. Of these, fifteen patients underwent a secondary procedure for removal of screw, with mean time for removal of screws being 53 weeks (range 16 - 162 weeks). Pain resolved after screw removal. For the three patients with residual discomfort who did not have a secondary procedure, symptom resolution was achieved with anti-inflammatory agents.

Four cases resulted in non-union following the primary surgery, three of which underwent secondary procedures. One healed with insertion of a second screw and two healed with exchanging screws and further bone graft. All three patients' fractures healed uneventfully. The remaining patient with a non union, had diabetic neuropathy and developed asymptomatic strong fibrous non union, with symptom resolution.

Discussion

Ever since British orthopedic surgeon Sir Robert Jones described the Jones fracture in 1902 multiple treatment options have been proposed. This type of fracture is known for its poor healing contributing to delayed union and refractures in the general population. This makes treatment particularly difficult for clinicians. In competitive athletes an even greater imperative exists to be able to treat the fracture in a way that results in predictable outcomes and earlier return to pre injury activities. Surgical fixation has shown in several studies to be the superior treatment approach over non surgical management. In a study, non-operative management resulted in a high incidence of delayed union, non union and refracture (44%), while surgical fixation obtained satisfactory results of 95%. A recent published paper by Kerkhoffs., *et al*. [20], reviewing management of fifth metatarsal fractures, found that a consensus exists within the literature that surgical intervention results in superior union rates and shorter recovery time.

Although historically surgical management was primarily recommended in the athlete population, several authors have advocated this approach as the primary management over a conservative treatment for non athletes. They believe this reduces immobilization period and optimizes union and recovery times. Portland., *et al*. reported exceptional results with 100% union rate of acute fractures after immediate surgical intervention, with no complications or refractures. Quill further lends support to early intramedullary screw fixation after observing 33% of fractures treated conservatively resulted in refractures [24].

To our knowledge, our study is the largest retrospective study on percutaneous surgical treatment of Jones Fractures undertaken by a single surgeon. The purpose of our study was to review outcomes of patients who have undergone percutaneous fixation of a Jones fracture between 2007 and 2015, and to evaluate the effectiveness of this treatment approach. No cases where excluded from our study, all patients who opted for surgical intervention were included. All cases successfully clinically united (100%) with a mean of 8.9 weeks and 98.5% (66 cases) radiologically united. Screw fixation (acute and non acute fractures) (Table 1), resulted in a 94% union success rate (63 patients) after a single procedure. The largest cause for secondary procedure was discomfort originating from the screw site (22%). This

was generally reported as a dull ache in relation to irritation from the screw head. This is a common finding within the literature [32]; reporting screw head discomfort in 32% of patients and DeLee., *et al.* [16], noting a further 30% of their patients reporting discomfort.

Of the four patients in our study who developed non union following the primary surgery, three underwent a secondary procedure and radiologically united with a 4mm x 50mm screw exchange and further bone grafting. The causation of initial non union related to length of time from a historical non union, patient's gross weight and early return to activity. The fourth patient had diabetic neuropathy and developed an asymptomatic strong fibrous nonunion.

Despite the high success rate of intramedullary fixation, failures can occur. Over the years, different types and diameters of screw have been reportedly used for internal fixation of Jones fractures, however the optimal screw choice remains to be defined [15,23,25]. Countless biomechanical studies have been performed to assess the various available screws [13, 15,26-31]. A combined clinical and biomechanical study conducted in 2004, by Reese., *et al*. [15] showed, when submitted to cyclonic fatigue testing, screws of 6.5mm or greater in diameter rated superior to those less than 4.0mm; titanium was less fatigue resistant than stainless steel and cannulated was less fatigue resistant than solid screws of equal geometry. In another studies, De Vries [32] notes higher rates of non union in stainless steel screws compared with titanium screws. While a study comparing solid to cannulated by Metzl., *et al.* [33] found, although no difference in union rate, a greater number of adverse events occurred with solid screws (hardware failure; intraoperative fracture; and symptomatic hardware).

From a biomechanical standpoint Pietropali., *et al*. [28] concluded the choice of solid versus cannulated screws is a surgeon's preference after comparing biomechanical stiffness in 4.5mm in cadavers. The use of cannulated should however minimize the occurrence of adverse events and provide ease of insertion, as well as precise screw placement by use of the guide wire into tortuous bone [2,15,22,33]. Several studies have concluded that no less than 4.5mm screws should be used to obtain adequate intraosseous purchase and compression at the fracture. While Glascow., *et al*. [discourage the use of internal fixation devices other than a 4.5mm solid malleolar screw, as they correlate with failure. Ishikawa [5], also denoted that a larger screw diameter that fits the fifth metatarsal canal will minimize the risk of refracture.

Despite this, our study demonstrated 100% clinical union with low morbidity rate, no refractures to date and zero incidence of screw breakage, using a 4mm titanium cannulated screw and washer with or without bone grafting. Our authors recommend titanium for its flexibility which allows it to curve to the fifth metatarsal; while a cannulated screw allows for the procedure to be performed by percutaneous fixation which provides less disruption to the soft tissue.

Conclusion

Percutaneous fixation has proven to be a reliable and efficacious technique for the management of Jones fractures. The benefits of surgical intervention, such as better union rates and earlier return to weight bearing activity, are well documented in the literature. In our retrospective study, clinical union was achieved following the initial surgery, with 98.5% showing evidence of radiologic union. There were no instances of re-fractures and patients returned to weight bearing early (two or four weeks) compared to patients who received non-operative treatment.

In lieu of controversy regarding the optimal type and size of screw to use for fixation, we recommend use of a single 4mm x 50mm titanium cannulated to give adequate intraosseous purchase of the fracture. Although our approach is not widely employed, for the last 15 years we have achieved excellent results while simultaneously minimizing adverse outcomes.

Bibliography

1. Jones RI. "Fracture of the base of the fifth metatarsal bone by indirect violence". *Annals of Surgery* 35.6 (1902): 697-700.

2. Zwitser EW and Breederveld RS. "Fractures of the fifth metatarsal; diagnosis and treatment". *Injury-International Journal of the Care of the Injured* 41.6 (2010): 555-562.

3. Smith TO., *et al*. "Interventions for treating proximal fifth metatarsal fractures in adults: A meta-analysis of the current evidence-base". *Foot Ankle Surgery* 17.4 (2011): 300-307.

4. Portland G., *et al*. "Acute Surgical Management of Jones' Fractures". *Foot Ankle International* 24.11(2003): 829-833.

5. Ishikawa SN. "Fractures and dislocations of the foot". In: Canale ST and Beaty JH. Campbell's Operative Orthopaedic. Philadelphia: Elsevier (2013): 4197.

6. Carp L. "Fracture of the fifth metatarsal bone: with special reference to delayed union". *Annals of Surgery* 86.2 (1927): 308-320.

7. Dameron Jr TB. "Fractures and anatomical variations of the proximal portion of the fifth metatarsal". *Journal of Bone Joint Surgery American Orthopaedic Surgeons* 57.6 (1975): 788–792.

8. Kavanaugh JH., *et al.* "The Jones fracture revisited". *Journal of Bone Joint Surgery American Orthopaedic Surgeons* 60.6 (1978): 776-782.

9. Theodorou DJ., *et al*. "Fractures of proximal portion of fifth metatarsal bone: anatomic and imaging evidence of a pathogenesis of avulsion of the plantar aponeurosis and the short peroneal muscle tendon". *Radiology* 226.3 (2003): 857–865.

10. Clapper MF., *et al*. "Fractures of the fifth metatarsal: Analysis of a fracture registry". *Clinical Orthopeadics and Related Research* 315 (1995): 238–241.

11. Smith JW., *et al*. "The intraosseous blood supply of the fifth metatarsal: implications for proximal fracture healing". *Foot Ankle* 13.3 (1992): 143–52.

12. Vorlat P., *et al*. "Predictors of outcome of non-displaced fractures of the base of the fifth metatarsal". *International Orthopeadics* 31.1(2007): 5–10.

13. Scott AT and Nunley JA. "Percutaneous Fixation of Proximal Fifth Metatarsal Fractures". In: Maffulli N and Easley M (eds.) Minimally Invasive Surgery of the Foot and Ankle. Springer: London (2011): 199-212.

14. Roche A and Calder J D F. "Treatment and return to sport following a Jones fracture of the fifth metatarsal: a systematic review". *Knee Surgery Sports Tramadol Arthroscope* 21.6 (2013): 1307-1315.

15. Reese K., *et al*. "Cannulated screw fixation of Jones fracture: A Clinical and Biomechanical Study". *American Journal of Sports Medscape* 32.7 (2004): 1736-1742.

16. Torg JS., *et al*. "Fractures of the base of the fifth metatarsal distal to the tuberosity: classification and guidelines for non-surgical and surgical management". *Journal Bone Joint Surgery American Orthopaedics surgeons* 66.2 (1984): 209-214.

17. DeLee JC., *et al*. "Stress fracture of the fifth metatarsal". *American Journal of Sports Medscape* 11.1 (1983): 349-353.

18. Josefsson PO., *et al*. "Jones fracture: surgical versus nonsurgical treatment". *Clinical Orthopeadics* 299 (1994): 252-255.

19. Zelko RR., *et al.* "Proximal diaphyseal fractures of the fifth metatarsal: treatment of the fractures and their complications in athletes". *American Journal of Sports Medscape* 7.2 (1979): 95-101.

20. Yates J., *et al*. "Jones fracture of the fifth metatarsal: Is operative intervention justified? A systematic review of the literature and meta-analysis of results". *Foot* 25.4 (2015): 251-257.

21. Kerkhoffs GM., *et al*. "Treatment of proximal metatarsal V fractures in athletes and non-athletes". *British Journal of Sports Medicine* 46 (2012): 644-648.

22. Japec M*., et al*. "Treatment of proximal fifth metatarsal bone fractures in athletes". *Injury International Journal of the Care of the Injured Factor* 46.6 (2015): S134-S136.

23. Porter DA., *et al*. "Fifth Metatarsal Jones Fracture Fixation with a 4.5-mm Cannulated Stainless Steel Screw in the Competitive and Recreational Athlete a Clinical and Radiographic Evaluation". *American Journal of Sports Medscape* 33.5 (2005): 726-733.

24. Quill GE Jr. "Fractures of the proximal fifth metatarsal". *Orthopeadics Clinical North American Family Physician* 26(1995): 353–61.

25. Porter DA Rund AM. "Comparison of 4.5 - and 5.5mm cannulated stainless steel screws for fifth metatarsal Jones fracture fixation". *Foot Ankle International* 30.1 (2009): 27-33.

26. Horst F., *et al*. "Torque resistance after fixation of Jones fractures with intramedullary screws". *Foot Ankle Int*ernational 25.12 (2004):914–919.

27. Kelly IP., *et al*. "Intramedullary screw fixation of Jones fractures". *Foot Ankle International* 22 (2011): 585–589.

28. Pietropaoli MP., *et al*. "Intramedullary screw fixation of Jones fractures: a biomechanical study". *Foot Ankle Int*ernational 20.9 (1999): 560–563.

29. Shah SN., *et al.* "Intramedullary screw fixation of proximal fifth metatarsal fractures: a biomechanical study". *Foot Ankle International* 22.7 (2001): 581–584.

30. Sides SD., *et al.* "Bending stiffness and pull-out strength of tapered, variable pitch screws, and 6.5-mm cancellous screws in acute Jones fractures". *Foot Ankle International* 27.10(2006): 821–825.

31. Vertullo CJ., *et al*. "Torsional strains in the proximal fifth metatarsal: implications for Jones and stress fracture management". *Foot Ankle International* 25.9 (2004): 650–656.

32. DeVries JG., *et al*. "Cannulated screw fixation of Jones fifth metatarsal fractures: a comparison of titanium and stainless steel screw fixation". *Journal Foot Ankle Surgery* 50.2 (2011): 207–212.]

33. Metzl J*., et al*. "A clinical and radiographic comparison of two hardware systems used to treat Jones fracture of the fifth metatarsal". *Foot Ankle International* 34.7 (2013): 956–961.

34. Glasgow MT., *et al*. "Analysis of failed surgical management of fractures of the base of the fifth metatarsal distal to the tuberosity: The Jones fracture". *Foot Ankle Int*ernational 17.8 (1996): 449-457.

Volume 3 Issue 6 August 2016