EARLY CLINICAL OUTCOMES OF GUNSHOT ISOLATED FIBULAR FRACTURES TREATED NON-OPERATIVELY AT AN URBAN ACADEMIC HOSPITAL

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ABSTRACT

Objectives: To report the outcomes of wound infection and to determine the outcomes of fracture union.

Methods: A retrospective review of patients who sustained gunshot isolated fibular shaft fractures that were treated non-operatively with antibiotics at our academic hospital between June 2017 and May 2020.

Results: A total of 35 isolated fibular fracture cases were reviewed from medical records. A total 15 gunshot isolated fibular fractures were identified from which, three were excluded due to operative intervention. A total of 12 cases were finally included with 11 (91.7%) males and 1 (8.3%) female and an average age of 36.4 years. Sixty-seven per cent of the injuries involved the right-hand side and 33% on the left-hand side. Union was achieved by 91.7% (n = 11) patients, all (100%) patients had good soft tissue results, and identified complications included non-union, synostosis and nerve injury.

Conclusions: All cases of isolated fibular shaft gunshot wounds healed without infection with the intravenous antibiotic treatment instituted and fracture union was observed. Our study supports the non-operative management of low velocity gunshot isolated fibular shaft fractures.

Keys words: Isolated fibular, Gunshot wound, Antibiotic, Fracture, Fibula

INTRODUCTION

South Africa has an annual rate of gunshot related homicides of 14 per 100 000 cases. In Cape Town, they reported 111 orthopaedic gunshot patients seen in one year in an academic hospital emergency unit and on average each patient spent 10 days of admission with a cost of United States Dollar (USD) 2940 (R 24 945) per patient (1). Gunshot injuries are a common burden, that carries the second highest mortality rate 7.1% in trauma after polytrauma motor vehicle collisions (8.7%) (2).

Isolated Fibular Shaft Fractures (IFSF's) are a relatively uncommon type of long bone fracture (3). IFSF's are secondary to direct trauma and gunshot injuries. Gunshot injuries of the fibula are commonly managed non-operatively with antibiotics, irrigation, cast immobilisation, wound care and have high union rates (4,5). Tibia fractures are commonly associated with fibular diaphyseal fractures due to the forces transmitted through the interosseous membrane to the fibula (4). Non-operative treatment of low velocity gunshot trauma was previously reported with a low rate (1.8%) of infection (6). Current evidence showed patients with non-union of the fibular fracture reported persistent pain at the non-union site and are rarely asymptomatic (7).

This study aimed to establish the outcomes of gunshot isolated fibular fractures that were treated non operatively. To our understanding, this is the first study in English literature to report on early clinical outcomes of gunshot isolated fibular fractures treated non-operatively at an urban academic hospital.

MATERIALS AND METHODS

A retrospective review study of patients who had gunshot IFSF's that were treated non operatively with antibiotics at our academic hospital South Africa between 01 June 2017 and 31 May 2020. Outcome measures were: infection and union. All cases were adults above 18 years old, who sustained gunshot injuries resulting in Isolated Fibular Shaft Fracture (IFSF) with an intact tibia. Patients were excluded if they had ankle fractures, pathological fracture, close isolated fibular fracture, fibular head fracture, intraarticular fracture and less than 6 weeks follow up. Hospital patients medical records were reviewed for demographic details, treatment, clinical outcomes, radiographs and possible complications. Ethical clearance was obtained (M200630).

Trauma casualty management

Advanced Trauma Life Support (ATLS) principles were used at the trauma emergency unit. Then, the orthopaedic trauma unit protocol was done, which included leg assessment, wound irrigation with normal saline, gunshot wound dressed with paraffin gauze, immobilization with a back slab, intravenous prophylactic cefazolin, anti-tetanus toxoid prophylaxis, analgesia and radiographs of the affected leg (Table 1).

Inpatient and outpatient management

All patients were admitted for at least 24 hours to receive three doses of antibiotics. They were discharged with the back slab, analgesia, and partial weight bearing with crutches and then full weight bearing at 6 weeks. Patients had clinical and radiological follow up (Table 1). Fractures were classified using the Orthopaedic Trauma Association (OTA) classification system for diaphyseal segment fibula fracture 4F2, of which it divides the fibular shaft into thirds of segments excluding the proximal tibiofibular joint and distal tibiofibular joint (8). Union was radiologically assessed by bridging callus across three cortices, and clinically assessed by full weight bearing without pain on the injured leg and with palpation of fracture site (9).

Table 1
GSW isolated fibular shaft flow chart

Trauma casualty management	Inpatient and outpatient follow up management
• ATLS protocol • Leg assessment • Wound irrigation with normal saline • Prophylactic antibiotics • Gunshot wounds dressing with wet gauze dressing • Anti-tetanus toxoid 0.5mL • Radiographs • Immobilize with back slab	Prophylactic antibiotics • 1g of Cefazolin three doses 8-hourly analgesia Discharge on crutches partial weight bearing full weight bearing at 6 weeks Schedule follow up reviews for: • Clinical review • Radiological review

Statistical analysis

Analysis of the data was done using the Stata software version 15.2. Z-proportion test was used to assess for differences between variable groups (categories). Fisher exact test was used to compare between two categorical variables and the Kruskal Wallis test was used to compare continuous variables between groups of categorical variables. The level of statistical significance was set at a $p < 0.05$.

RESULTS

This study had a total of 12 patients with fractures. Descriptive statistics non-normal distribution: median age was 33.5 years (Interquartile (IQR) 29.5 to 36 years; range 24-62 years). The median hospital length of stay was 2 days (IQR 2 to 5.5 days; range 1 to 16 days). The median follow-up period was 6.5 weeks (IQR 6 to 34 weeks; range 6 to112 weeks). Table 2 shows the other descriptive

statistics summarised for the 12 patients. All the cases had healed soft tissue and had received cephazolin antibiotic. The majority of the patients were males (91.7%), with an overall fracture union of 91.7% and had two human immunodeficiency virus (HIV) positive cases (16.7%) with 100% union. There were 75% of patients who were employed, 58.3% were smokers, 33.3% took alcohol and 25% were both smokers and drank alcohol. The most common fractures were on the right leg (66.7%) and the fracture sites were uniformly distributed between the distal, middle and proximal third of the legs (33.3%).

Table 2
Descriptive statistics

Variable	Categories	Frequencies	Percentages	P-values
Gender	Male	11	91.67	< 0.0001*
	Female	1	8.33	
Soft tissue	Heal	12	100	< 0.0001*
	Issues	0	0	
Union	United	11	91.67	< 0.0001*
	Nonunion	1	8.33	
Antibiotic (Kefzol)	Yes	12	100	< 0.0001*
	No	0	0	
Side	Right	8	66.67	< 0.0001*
	Left	4	33.33	
Comorbidities	No	10	83.33	< 0.0001*
	Yes	2	16.67	
Employment status	Yes	9	75.0	< 0.0001*
	No	3	25.0	
Smoking status	Yes	7	58.33	0.0237*
	No	5	41.67	
Alcohol	Yes	4	33.33	< 0.0001*
	No	8	66.67	
Social behaviour	None	2	16.67	(reference)
	Alcohol only	5	41.67	0.0001
	Smoking only	2	16.67	1.0000
	Both	3	25.0	0.1649
Fracture site	Proximal third	4	33.33	(reference)
	Middle third	4	33.33	1.0000
	Distal third	4	33.33	1.0000

*The significance tests were within variable comparisons

Table 3
Bivariate comparison of factors stratified by fracture position

Variable	Categories	Proximal	Middle	Distal	P-value
Union	United	4(100)	4(100)	3(75.0)	1.000
	Nonunion	0	0	1(25.0)	
Age	Median (IQR)	33.5(30-48.5)	33.5(31.5-36)	31.5(26-46.5)	0.8370
Hospital length of stay	Median (IQR)	2(2-3.5)	1.5(1-4.5)	5(3-11)	0.2757
Weeks of follow up	Median (IQR)	6(6-12.5)	8(6.5-29)	32.5(6-85.5)	0.5378

Interquartile range (IQR)

Table 3 shows the stratified analysis of the fracture position and other variables. The majority of the patients with distal third fractures had 75% union. Those who had proximal and middle third fractures had 100% union. None of the considered variables were statistically significant between the groups. The median hospital stay was highest among those with distal fractures who stayed for 5 days; however, this was not significantly different from the other middle and proximal fracture positions, p-value=0.2757. Similarly, those who had a distal fracture had the highest weeks of follow-up 32 weeks compared to those who had middle and proximal fractures. However, the differences were not statistically significant, p-value=0.5378.

DISCUSSION

South Africa has an annual rate of gunshot related homicides of 14 per 100 000 cases (1). Our data demonstrate a high incidence of gunshot IFSF's in males than females with a ratio of 11:1. The right-hand side was dominant with 67% of the injuries and 33% on the left-hand side. The median hospital stay was 2 days and the patient age range was 24 to 62 years. Fractures were classified using the Orthopaedic Trauma Association (OTA) classification system for diaphyseal segment fibula fracture 4F2 and all 12 patients had 4F2B.

Gunshot wound

Musculoskeletal damage is directly linked to the kinetic energy of the gunshot bullet. Injuries are classified as high velocity greater than 2000 feet per second and low velocity less than 2000 feet per second (10-12). Gustilo and Anderson had classified gunshot wounds as type 3, a special category with no reporting on the gun that was used and no mention of the bone that was injured. More reporting has been done on gunshot extremities with rare reporting on the isolated fibular gunshot fractures (13). Maqungo *et al.* (12), classified tibial gunshot fracture treatment into two types, with type one fractures treated non-operatively for 6 weeks and type two were treated with intramedullary nailing. We then subclassified the tibial gunshot fractures into type 1A and B, by adding isolated fibular gunshot fractures with a similar treatment as per the modality used in our centre (Table 4).

Table 4
Tibia and fibular gunshot approach

Type 1	Fracture pattern	Treatment option
A	Cortical continuity tibial gunshot fracture	Nonoperative: Partial weight bearing Antibiotic 6 weeks duration Back slab plaster of Paris
B	Fragmented isolated fibular gunshot fracture	
Type 2	Complete tibia fracture	Operative: Locked intramedullary nailing

Antibiotics

In our academic hospital, every gunshot wound is treated as contaminated and therefore, the wounds are more likely to be infected if prophylactic antibiotics are not given urgently in the trauma emergence unit. We prophylactically give a cephalosporin (i.e. Cephazolin) three doses over 24 hours prior to discharge of the patient. The cephazolin prophylactic antibiotic has been the antibiotic of choice since 1974 according to Gustilo and Anderson on open fractures (13). Prophylactic antibiotic uses for low velocity gunshot wounds remain controversial with less consensus. Prophylactic antibiotics are given regularly with the fear of litigations, hospital protocols and personal preference by orthopaedic surgeons (14). Sathiyakumar *et al.* (15) recommend the use of broad-spectrum first-generation cephalosporin for at least three days and held back on debridement policies. Low velocity gunshot wounds can be treated in the outpatient department with good clinical outcomes (6,12). Papasoulis *et al.* (16) reported similar outcomes on patients who were treated with oral and intravenous prophylactic antibiotics. The infection rate with the use of antibiotics ranges from 1.8% to 2.5% and higher without antibiotics (6,12,14 - 16).

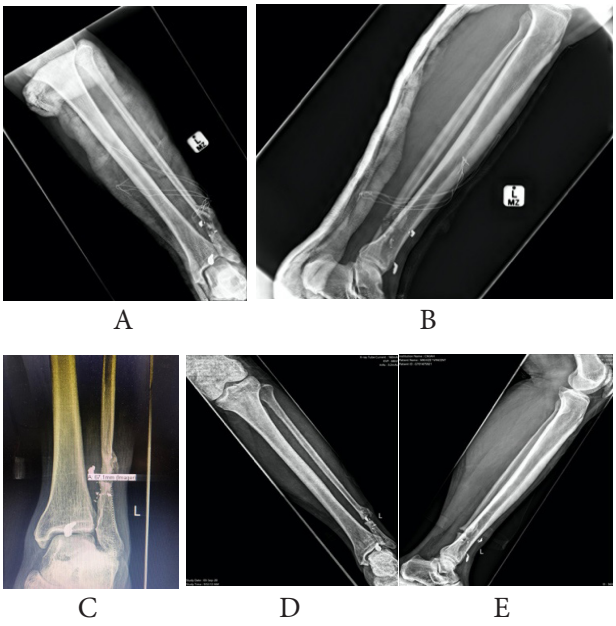
Early use of antibiotics is more effective than injury debridement in the prevention of infection and nonunion. According to Patzakis and Wilkins (17), giving early antibiotics before debridement decreased the infection rate from 13.9% without antibiotics to 2.3% (2 of 84 cases) with antibiotics used and there was no difference in infection rate in injuries debrided within and beyond 12 hours (17). We administer intravenous antibiotics based on patients weight and "as soon as possible" as per ATLS protocol (18). Our results demonstrate a 0% infection rate on all our cases treated with intravenous antibiotics.

Union

Union rate on isolated fibular gunshot fracture was reported to be high (4). Graham (3) reported a missed none gunshot fracture case of an isolated proximal fibular fracture that was treated nonoperatively with good union results following trauma to the leg. Inklebarger and Clarke (19) had a single none gunshot fracture case of non-union isolated fibular fracture on an athlete that was diagnosed by use of ultrasound modality. Mendola *et al.* (20) reported a single case of a female rugby player who injured herself during a game, sustained an isolated fibular fracture and she was able to weight bear with no assistance. Sarpong *et al.* (21), in their nine years study with 13 patients reported isolated fibular stress fracture with good results after conservative treatment. Atilla *et al.* (22) reported a case of an alpine skier who had an isolated fibular fracture that was missed on initial assessment only diagnosed after six months on a review. We report a single case (8.3%) complication of non-union from this study, a 58 year old male with a right distal third IFSF non-union, he had no significant past medical history and a good follow up over a year. He was clinically asymptomatic and the non-union was 67.1mm above the distal tip of lateral malleolus on radiographic measurement done on Picture Archiving Communication System (PACS) (Figure 1). There is still a controversy on how much residual distal fibular length is needed for ankle stability. Pacelli *et al.* (23) recommends that 3.9 to 8 cm was needed to maintain ankle stability in their eleven cadaveric study.

Figure 1

A and B: Anteroposterior and lateral views on the day of the injury. C: Nonunion measuring 67.1mm on PACS D and E: Anteroposterior and lateral views demonstrating the nonunion



Fracture union is impacted by HIV infection, especially in patients who have not started treatment. In this study, 16.7% (2 of 12) cases were HIV positive with 100% union and were on antiretroviral treatment (ART). Kamat and Govender (24) studied the effects of HIV on fracture union and had 2376 cases grouped into three with closed ankle injuries. HIV positive patients World Health Organisation (WHO) clinical stage IV had high nonunion of over 12.45%. Of this group

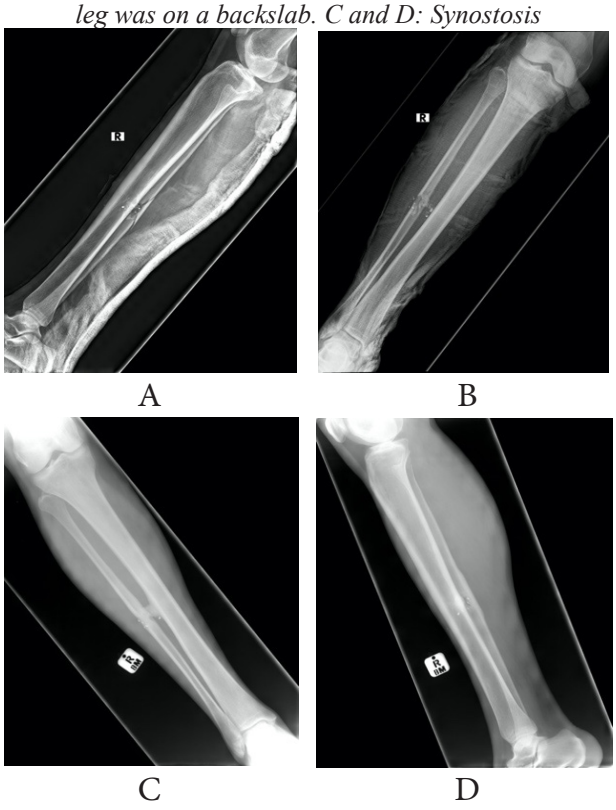
755, HIV positive patients WHO clinical stage I-III had at least 1.26% nonunion rate of this group of 729 cases and the last group of 829 HIV negative cases had 1.5% nonunion rate. Harrison *et al.* (25), on their study of 27 cases of open tibial fracture with seven HIV positive cases, five of the seven developed infections and three out of seven cases had not united at six months follow up. According to the South African ART clinical guidelines, all persons living with HIV are qualified to initiate ART irrespective of age, Cluster of Differentiation 4 (CD 4) cell count and clinical stage, if there are no contraindications and ART should be started within 7 days (26).

Synostosis

This study reports a rare complication finding of one (8.3%) case with a right midshaft tibiofibular synostosis (Figure 2), a 37 year old female who was asymptomatic at 49 weeks regular follow up. She had a past medical history of Human Immunodeficiency Virus (HIV), and she was managed conservatively. Sonnery-Cottet *et al.* (27), reported 12 cases from the literature review and 2 cases from their study with synostosis, all cases were male and 50% of the cases were treated operatively. An option for conservative treatment is still recommended in synostosis.

Figure 2

A and B: Demonstrate the level of the fracture and the leg was on a backslab. C and D: Synostosis



A B C D

Superficial peroneal nerve injury

Our cohort had a single patient a 62 year old male with a right proximal third IFSF associated with a superficial peroneal nerve injury. He had loss of sensation over of dorsum of the foot and anterolateral aspect of the lower leg, and loss of ipsilateral foot eversion. He was managed conservatively and at 19 weeks, he had regained foot eversion and sensation on the leg and foot. Seddon (28) described neuropraxia as short-lived paralysis with an irregular pattern of recovery. Current literature reports on the use of the superficial peroneal nerve as an autograft in treating peripheral nerve injuries, Ribak *et al.* (29) on their study had eleven cases with peripheral nerve injuries of the upper extremities treated with superficial peroneal nerve. Al-Kashmiri and Delaney (30) reported a single case of a circus performer, who sustained a proximal fibula fracture with peroneal nerve injury and the case was treated non-operatively. We therefore, conclude that superficial peroneal nerve can be treated non-operatively.

CONCLUSION

All gunshot isolated fibular shaft wounds healed with no infection with the intravenous antibiotic treatment instituted and good fracture union was observed. Our study supports the intervention of treating low velocity isolated fibular shaft gunshot fractures non-operatively. Our overall complication rate was 3 (25%) cases. Prospective further research is needed in closed and all open IFSF's.

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