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A Ten Year Review of Use of External Fixation in Gustilo and Anderson Type Iii Open Tibia & Fibular Fractures in Jos University Teaching Hospital

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Abstract
Background: *The use of percutaneous pins fixed to the bone and anchored to a scaffold is the mainstay in the management of open fractures(1,2,3).There is an increase in the number of patients requiring external fixation in our setting (4,5). We present a review of our experience of this device in our center.*
Method*: This is a retrospective study of patients who were treated for Gustillo and Anderson type III open fractures of the tibia & fibula with external fixation in Jos University Teaching Hospital during the period 2004 to 2013.We treated open fractures by immediate resuscitation (ATLS protocol), operative debridement and stabilization with external fixation devices. Various methods of wound care employed included; direct wound closure, skin grafting, flap cover, healing by secondary intention depending on the nature of the wound. Data extracted was analyzed using epi info version 3.5.3.*
Results: *A total of 74 patients with various forms of Gustilo and Anderson type III open fractures of the tibia and fibula were treated. There were 63(85.1%) male and 11(14.9%) female making a male female ratio of 5.7: 1 and a mean age of 37.97+_13.57 years. There were 15(20.2%) type IIIA, 58 (78.4%) type IIIB and 1 (1.4%) type IIIC fractures. At presentation, contaminated wounds were 34(45.9%) while 49 (66.2%) were infected, of which 15(20.2%) had established chronic osteomyelitis. Following treatment, 52(70.2%) had infection 19(25.6%) pin tract infection 29(39.1%) chronic osteomyelitis, 4(5.4%) had cellulitis with septic arthritis of the ankle joint. All the fractures united although 29(39.1%) had delayed union.*
Conclusion: *External fixation devices are useful in the management of open fractures of Gustilo& Anderson type III. This has improved the outcome of care in our patients and has proven to be averitable tool for tackling open fractures with multiple comorbidities and complications arising simultaneously from trauma.*
Key words*. Open fractures, external fixation, Gustilo and Anderson*

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I. Introduction

External fixation is a method of stabilization of fracture segments in an anatomical pattern using threaded pins anchored to a bar or bars with clamps(1,6).It's importance is demonstrated by It's versatility in fracture reduction, realigning fracture fragments, and maintaining the reduction without interfering with the wound(7). The various methods of use span from life saving conditions such as in pelvic fractures(for hemorrhage control), open fractures, trauma in children, limb lengthening and deformity corrections, damage control, salvage technique in treatment of complications arising from extremity trauma. Of all these, its application in Gustilo and Anderson type III open fractures is of immense importance in our setting as it ameliorates the difficulties associated with management of this group of fractures and the attendant soft tissue injuries which often result in large soft tissue defects. Its usefulness in the early stabilization of open fractures is appreciable. Its versatility allows the trained user to navigate its various attributes to suit the desired configuration of the pathology (7). So far, it is the acclaimed method of stabilization of complicated open fractures of the extremities around which other methods revolve (2,8).

Previously, various modifications of cast molded and supported with a splint were used in our center. In these methods, the open fracture is reduced, wound dressed and cast applied, windows are made in the cast to expose the wounds for dressings and sometimes Anderson-Hutchins technique (9) involving insertion of threaded pins in the bone fragments & reinforced with cast was used. The disadvantage is that the openings result in further weakening of the cast with resultant loss of reduction and mal-alignment (10). As a result of this, some form of re -enforcements have to be made with a strut placed across the openings and molded with cast material to form what is popularly called a J-bar. Various forms of complications from cast application

which range from; skin burns, maceration, hyper pigmentation, dermatitis, fracture disease (10) were noticed.The absorption of fluid from wound discharge and dressing agents with resultant foul smell and a risk of infection (7),the weight of the cast, its brittle tendencies and restrictive nature makes it uncomfortable and suboptimal in the care of open fractures(10,11).

. External fixation has been in use by physicians and surgeons for thousands of years (12).Current literature offers no evidence to support the use of internal fixation as superior to external fixation especially in unstable fractures (13). In some series external fixations are converted to internal fixation after the wounds are taken care of. External fixators have the advantage of serving as an exoskeletal framework through which the deformed or deformable skeleton is supported and realigned depending on the set goals of the surgeon (13). Besides it provides access to the extensive wound. It is to be noted that although external fixators were discovered 14 years earlier than plaster of Paris, it's availability, affordability and skill required for application(10,11) have made the Plaster of Paris more popular. With time however, the use of external fixation has proven more desirous over other methods of stabilization of type III fractures of the extremity as it allows for easy wound care without spillage while maintaining bone stability. We present a ten year review of our experience with this device.

II. Method

This is a retrospective study of consecutive patients admitted and treated for Gustilo and Anderson type III open fractures of the tibia and fibula in the department of Orthopedics and Trauma of Jos University teaching Hospital from January 2003 to December 2014. Patients with mangled limbs (Mangled Extremity Severity Score MESS > 7) designated for amputation, those treated with methods of stabilization other than external fixation, multiple injured patients at presentation were excluded. Patients that were offered external fixation devices for limb lengthening, arthrodesis and those primarily with gangrene and unsalvageable limbs were also excluded. Data was obtained from the records in patients case notes and operation notes.

Classification of wounds was done in theater after exploration and debridement, copious irrigation with normal saline. The Tchanz screws were inserted in near- near (adjoining fracture ends) and far-far (distant from fracture site) manner after the bone was predrilled, with the assistant stabilizing the fractured ends. Rigid monolateral frame of AO type with four Tchanzscrews construct was used to aid accessibility and easy adjustment of the fracture configuration. Wounds were reviewed forty eight hours after debridement and dressings commenced. Subsequent dressings were carried out daily at bedside with saline while pin sites were cleaned with saline and dressed with iodine soaked gauze. Closure of wounds was guided by the status of the tissue bed, absence of discharge and availability of healthy granulation tissue. Antimicrobial prophylaxis was used in all patients in theater and subsequently based on sensitivity pattern.

External devices were left for at least six weeks to allow for soft callus formation. Decision to remove the device was guided by the development of callus at the fracture site assessed clinically and radiologically. At this stage a cast is applied and reviewed after six weeks. No bone grafting was done in all the fractures.Data analysis was done using epi info 3.5.3

III. Results

There were 74 patients, 63(85.1%) male and 11(14.9%) female with a M:F ratio of 5.7:1 with a mean age of 37.97+_13.57 and an age range from 15 to 70 years (Table 1). Causes of injuries (Table 2) included; fall from height 1 (1.4%) ,gunshot injuries 20 (27%) ,motor vehicle crash 25 (25.7%) motorcycle crash 19(33.8%) , and 9 (12.2%) occurred in pedestrians injuries. All the patients had type III fractures. Fifteen (20.2%) had type IIIA, 58 (78.3%) had type IIIB and 1(0.01%) had type IIIC. 41 (55.4%) were on the right and 33 (44.6%) on the left. More than 80% of them indicated right handedness. The duration from the time of injury to presentation at our facility ranged from two hours to one hundred and eighty days. The mean injury-presentation time was 13.48_+ 38.72 days. Patients that presented on the day of injury within 6 hours were 25(33.3%).Among the patients that presented on the day of the injury 12(48%) did not develop infection .One patient had tibia fracture with transection of the popliteal artery, presented within two hours and had successful vascular repair. Those admitted with established infections were 40(54.1%) while 35(47.2%) had bone loss from free fragments and from sequestrectomy. Various forms of wound cover were offered. 26(35.1%) direct skin closure, 24 (32.4%)skin graft, 17(23%)flaps, 7(9.5%) patients healed by secondary intention. The duration of use of external fixation lasted between 6 weeks to 43 weeks with mean of 9.35+_6.41 weeks. Those with co-morbid conditions (Table 3) such as diabetes, sickle cell disease, chronic liver disease and hypertension constituted 21.7% of the patients. 39 (52.7%) of the patients healed without limb shortening, 23(31.07%) had less than 1.5 cm shortening , 6(8.1%) had between 1.5 and 2.5cm while 6(8.1%) had over 2.5cm shortening(Table 4).Union of fractures was achieved in all cases and none was converted to internal fixation. 45(60.8%) had clinical and radiological union in twelve weeks. Patients that had more than 2.5 cm shortening were counseled for limb lengthening but all declined.No mortality was recorded during and after our intervention.

TABLE 1: AGE DISTRIBUTION

AGE	FREQUENCY	PERCENTAGE
11-20	6	8.1
21;30	20	27.0
31-40	22	29.7
41-50	12	16.2
51-60	9	12.1
61-70	5	6.7
	74	100%

TABLE 2 MECHANISM OF INJURIES

CAUSES OF INJURIES	NUMBER	PERCENTAGE
FALL	1	1.3%
GUNSHOT	20	27.0%
MVA	25	33.8%
MCC	19	25.7%
PEDESTRIANT	9	12.1%
	74	100%

TABLE 3: . COMORBID CONDITIONS

COMORBIDITY	**Frequency**	**Percent**
Chronic Liver Disease	1	1.4%
Diabetes	4	5.4%
Hypertension	10	13.5%
NO CO MORBIDITY	58	78.4%
Sickle Cell Anaemia	1	1.4%
Total	74	100.0%

TABLE 4: LIMB SHORTENING

LENGTH	FREQUENCY	PERCENTAGE
0cm	39	52.7%
<1.5cm	23	31.1%
1.5-2.5cm	6	8.1%
>2.5cm	6	8.1%
	74	100%

TABLE 5: OCCUPATION OF PATIENTS

OCCUPATION	FREQUENCY	PERCENTAGE
	74	100%

IV. Discussion

The advantage of external fixation in the management of type III open fractures is well established. (12,13,14,15).In our experience, 45(60.8%) patients had clinical and radiographic union within the expected time frame of twelve weeks. The initial six weeks was primarily to allow for wound care and secondarily to allow soft callus formation. This provides second opportunity to further correct residual deformity during subsequent immobilization with casting. 22(29.7 %) of the patients had the appliance beyond six weeks in order to achieve adequate wound cover and union. This ability for re-manipulation and adjustment of the frame ensures its usefulness in deformity correction, muculoskeletal oncology, congenital anomaly, infections, rheumatology, burns, arthrodesis and salvage procedures (16).Despite the underlying pathology at presentation, infection 40(54%), extensive soft tissue loss 58(78.4%),vascular compromise1(1.3%), bone loss 35(42.3%) and late presentation 49(66.2%), we achieved fracture union in all. Although non unions and delayed unions after conversion to intramedulary nail have beenreported albeit with good overall union rates,(17) we did not employ conversion to intramedullary nails due to existing infection. Its versatility allowed us to stabilize the fracture in type IIIC while vascular repair was ongoing in one of the patients. The importance of early wound cover as seen the patients with type IIIA and some with IIIB fractures was early removal of frames and attainment of union within the expected 12 weeks. Early removal of external fixators also prevents colonization of pin tracts hence

lowers risk of infection (17).These patients had early wound cover and no infections associated with Tchanz screws.

Late presentation was quite common, with only 25(33.7%) patients presenting early. Some studies in Nigeria noted incidence of late presentation between 64% and 90% among open fracture victims in urban trauma centers (18).The late presentation in our study was related to access to other peripheral hospitals where early care was offered while some delays were also caused by initial presentation to traditional bone setters (28) .The length of time taken from injury to debridement increases the complication rate as seen in Ife (19). Incidentally, victims of gunshots presented early. This might have been due to fear and legal implication associated with harboring victims of firearms in our setting.

The period of usage of the appliance reflects the duration of time taken to achieve wound cover particularly for infected wounds which takes a longer period. This is not unconnected to the extensive soft tissue loss and preponderance of infection associated with fractures with extensive soft tissue loss. Some studies have reported 24 .6 months in Ilizarov type (20). However, Ilizarov technique uses k-wires which are less traumatic than the 4.5mm of Schanz screws used in monolateral external fixators. The consequence of this is the increased risk of developing pin-tract infection. Although this might respond to both local and systemic care, significant numbers may develop ring sequestrum and subsequent chronic osteomyelitis as occurred in 40(50%) of our patients.

Bone loss may arise from extrusion of free fragments during trauma, from comminution and sequestrectomy of portions of infected bone ends. However, bone loss was observed in 11.4% of all open fractures (21) and was most commonly associated with type IIIB and IIIC injuries (22). We recorded 35(47.3%) cases with bone loss, this number was due to sequestrectomy of desiccated, infected and exposed bone fragments that were not properly reduced and covered at presentation or presented as such. Pin tract infectionwas found in11(14.6%) patients. This is similar to the 0.5 to 30% reported in the literature (23).Type and nature of pins, technique of application, stability of pins, post operative care have been alluded to be contributory factors in such infections(16)

Other factors that can lead to increasing morbidity in type III fractures include massive soft tissue damage, degree of contamination and compromised vascular perfusion of the injury. Late presentation (1to 180 days), established infection and extensive wounds were responsible for prolonged use of the appliance for up to 43 weeks in some instances. This prolonged use of the appliance was seen in Zaria and Ife where it was used for one year (4,19).The same reasons is adduced to the development of chronic osteomyelitis in 22(29.7%) and 7(9.4%) with ring sequestrum. Other co-morbid conditions as diabetics, sickle cell disease and those with chronic liver diseases found among 16(21.6%) of our patients are believed to be contributory.

Tibia fractures are the most common long bone fractures and three times commoner in the males than in the females (15,19.24).This was buttressed in our observation as there were over five times more males with fractured tibia compared to females. Open tibia fractures tend to have high rate of infection, delayed union and non union because of weak perfusion and high density of cortical bone substance(19). The exposed nature of the location and the relative absent soft tissue cushion to absorb traumatic impact increases the vulnerability of the bone to direct traumatic insult.

Occupations embarked on by the male gender is believed to render them more vulnerable. In Ife however, traders and students constituted a high number of cases (10). The role played by automobile crash is shown by over three quarters of our patients involved in road traffic crash. Over 92% of severe injuries were due to road traffic crash as reported in Lagos (25).

Artisans were the single largest occupation affected with 18(24.3%) in this study. This was closely followed by civil servants and students with 11(14.9%) and 12(16.2%) respectively. Artisans were involved relatively more than other professions, presumably because their daily routines exposed them to automobile hazards. Furthermore ,motorcycle accidents accounted for 25(33.8%) of all the injuries further buttressing the fact that exposure may be the most underlying immediate risk of sustaining extensive open fracture of the extremity. While poor training may be a cause, lack of adherence to safety precautions or other reasons yet to be unraveled might have accounted for this. Minimal exposure to traumatic events must be protective as it accounted for a low number 2(2.7%)among housewives as most domestic chores are often indoors.

Injury-presenting time featured prominently as determinant of outcome. Only a third of patients presented on the day of injury, a low infection rate in this group and early fracture healing was noticed. This is in tandem with Nanchahal et al who noticed no increase in infection rate among patients that had debridement within six hours of injury (18).Early presentation and intervention may confer an advantage and ensures predictable outcomes since infection had not ensued, while the role of antimicrobial prophylaxis was also of advantage. The advantage of early operative intervention in the management of fractures as a means of curbing morbidity has also been emphasized by Solagberu et al (26)

V. Conclusion

This method facilitates sustenance of fracture reduction despite extensive soft tissue loss and in multiply injured patients. The aspect of predictable stabilization of the fixation, unobtrusive access to the wound, abundant freedom of mobilization of the patient with their intact extremity has proved beneficial.External fixation devices are useful in the management of open fractures of Gustilo& Anderson type III. This has improved the outcome of care in our patients and has proven to be averitable tool for tackling open fractures with multiple comorbidities and complications arising simultaneously from trauma.

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