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External fixators usage in two hospitals in Delta State south-south Nigeria

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Abstract

Objective: To present our experience in the use of various types of external fixators in two government owned hospitals in Delta State, Nigeria.

Methods: A retrospective review of patients managed with external fixators over a period of 8 years – January 2012 to December 2019, in two government owned hospitals in Delta State, Nigeria. Relevant information including bio-data, indications for external fixation, types of external fixator applied, length of time fixators were applied, *etc* were collected and analysed using IBM SPSS version 22.

Results: A total of 94 patients (56 males and 38 females) were included in this study giving a male: female ratio of 1.5 : 1. The mean age of patients was 33.7± 15.9 years. Four types / designs of external fixators were used, the mono-planar AO design were the ones most commonly used (67.7%), followed by the linear rail system (LRS) type (17.2%). The most common indication for external fixator application was open fractures in 67.7% of cases, followed by bone gaps resulting from bone loss (11.1%). External fixators were used as adjunct to other treatment modalities in 59 applications (59.6%) and as the definitive treatment method in 40 applications (40.4%). The commonest solution used for pin site care was Povidone iodine in 53 patients (56.4%). The mean length of time patients were on external fixators was 124.8 days (17.8 weeks). Pin tract infection was the commonest complication encountered (26.6%). The commonest indication for removal of external fixators was the healing of the wounds in open fractures with conversion to other forms of treatment, commonly cast application (42.6%). The initial aim of applying the external fixator was achieved in 75% of cases.

Conclusion: External fixators have become indispensable tools in the armamentarium of modern day Orthopaedic and trauma care. Our health facilities have also effectively keyed into this.

Key words: External Fixators, Indications, Open fractures, pin tract infection.

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Utilisation de fixateurs externes dans deux hôpitaux de l'état de Delta au sud-sud du Nigéria

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Résumé

Objectif de l'étude : Présenter notre expérience dans l'utilisation de différents types de fixateurs externes dans deux hôpitaux publics de l'état du Delta, au Nigéria.

Méthode de l'étude : Une revue rétrospective de patients pris en charge avec des fixateurs externes sur une période de 8 ans - de janvier 2012 à décembre 2019, dans deux hôpitaux publics de l'état du Delta, au Nigéria. Les informations pertinentes, y compris les données biologiques, les indications de fixation externe, les types de fixateurs externes appliqués, la durée d'application des fixateurs, *etc.* ont été collectées et analysées à l'aide d'IBM SPSS version 22.

Résultat de l'étude : Un total de 94 patients (56 hommes et 38 femmes) ont été inclus dans cette étude soit un ratio hommes/femmes de 1,5 : 1. L'âge moyen des patients était de 33,7 $\pm$ 15,9 ans. Quatre types/modèles de fixateurs externes ont été utilisés, le modèle AO monoplanaire étant le plus couramment utilisé (67,7 %), suivi du type à système de rail linéaire (LRS) (17,2 %). L'indication la plus fréquente pour l'application d'un fixateur externe était les fractures ouvertes dans 67,7 % des cas, suivies des lacunes osseuses résultant de la perte osseuse (11,1%). Les fixateurs externes ont été utilisés en complément d'autres modalités de traitement dans 59 applications (59,6 %) et comme méthode de traitement définitive dans 40 applications (40,4 %). La solution la plus couramment utilisée pour les soins du site de la broche était la povidone iodée chez 53 patients (56,4 %). La durée moyenne de présence des patients sous fixateurs externes était de 124,8 jours (17,8 semaines). L'infection du tractus pin était la complication la plus fréquemment rencontrée (26,6 %). L'indication la plus courante pour le retrait des fixateurs externes était la cicatrisation des plaies dans les fractures ouvertes avec conversion vers d'autres formes de traitement, généralement l'application d'un plâtre (42,6 %). L'objectif initial de pose du fixateur externe a été atteint dans 75 % des cas.

Conclusion : Les fixateurs externes sont devenus des outils indispensables dans l'arsenal des soins orthopédiques et traumatologiques modernes. Nos établissements de santé s'y sont également bien intégrés.

Mots-clés : Fixateurs externes, indications, fractures ouvertes, pin-infection des voies.

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INTRODUCTION

An external fixator is a device placed outside the skin which stabilizes bone fragments through pins and wires connected to one or more longitudinal bars / tubes. Fractures are stabilized by connecting pins / wires that transfix bone fragments to external bars or frames (1,2,3,4). The use of external fixation in fracture treatment dates back to the time of Hippocrates, several years BC. (3,5,6). In 1853 Malgaigne described / applied a claw like external fixator he used to immobilize and compress fragments of a patella fracture (5,7). Though, external fixators usage for various musculoskeletal conditions became popular in the 1950s, its usage in Orthopaedic practice in Nigeria started in the early 1980s (8).

The designs and uses of external fixators in Orthopaedics and in trauma has evolved and multiplied over the years. Various designs of the linear type with distraction and compression components including the "linear rail system (LRS), Circular types including the Ilizarov" and "Taylor spatial Frame (TSF), and hybrid designs that incorporate both linear and circular components are now in use for a variety of indications (1,5,7,9). The indications for use of these variety of external fixators designs have also multiplied ranging from open fractures to infected fractures, peri-articfular fractures, pelvic fractures, damage control Orthopaedics, temporary fixation of fractures for later conversion to internal fixation, limb deformity correction, limb lengthening, management of bone loss, *etc* (5,6,8,10-18).

To the best of our knowledge, a study on the clinical use of external fixators has not been done in Delta State to contribute to the literature on local experience in Nigeria. The aim of this study is to present our clinical experience with the use of the different of types of external fixators in two government owned health facilities in Delta state, Nigeria.

Federal Medical, Asaba (one of the hospitals where this study took place) is a 320 bed hospital owned by the federal government of Nigeria. The second hospital, Delta State University Teaching Hospital, Oghara, Delta State, Nigeria is a 260 bed tertiary health facility owned by the Delta state government, in Nigeria.

MATERIALS AND METHODS

This was a retrospective analysis of patients who were managed with musculo-skeletal external fixation for various indications over a period of 8 years (January 2012 to December 2019) in two hospitals in Delta State, Nigeria. The hospitals were the Delta State University Teaching hospital, Oghara (owned by Delta state government) and the Federal Medical Centre, Asaba (owned by the federal government of Nigeria).

Ethical clearance was obtained from the Health Research Ethics Committee of the Delta State University Teaching Hospital, Oghara, Delta State, Nigeria.

A form purpose-designed by the lead author was used to gather relevant data by resident doctors in the Orthopaedics departments of the two hospitals from patients' case notes, theatre and ward records. These included information on patients' bio-data, indications and types of external fixators applied, duration of hospital stay, length of time fixators were applied, complications, indications for removal / outcome and follow-up. Patients whose case notes could not be located and those with incomplete information in their case notes were excluded from the study.

Data were collated and analysed with IBM SPSS version 22 and presented in form of tables, charts, frequencies, percentages, ratios, means, median and standard deviation.

RESULTS

A total of 94 patients were included in this study, made up of 56 males (59.6%) and 38 females (40.4%) giving a male: female ratio of about 1.5:1.

Fifty eight of the patients (61.7%) were from the Delta State University Teaching Hospital, Oghara, while the remaining 36 patients (38.3%) were from the Federal Medical Centre Asaba.

The average age of the patients was 33.7$\pm$15.9 (range = 6 to 80 years). Median age was 32 years. The most frequently affected age group fell between ages 20 and 40 years (54.26%). (table 1).

Most of the patients were married (51%) – table 1. Twenty eight patients (29.8%) had tertiary education. Traders were the occupational group most frequently treated with external fixators. Table 1.

Four types of external fixators were used in the two hospitals during the study period. The most commonly used type was the linear AO type - 67.7% of times (figure 1). External fixators were applied 99 times in 94 patients - 3 patients had more than 1 fracture that needed external fixation while another 2 had exchanges of the linear AO type of fixator for either the Linear Rail System (LRS) or Ilizarov circular system for various

indications.

The commonest indication for application of external fixators was open fractures. Table 2.

External fixators were used as adjunct to other treatment modalities in 59 applications (59.6%) and as the definitive treatment method in 40 applications (40.4%).

The commonest solution used for pin site care was Povidone iodine in 53 patients (56.4%). Other solutions included: normal saline in 21 patients (22.34%), Methylated spirit in 14 patients (14.9%), Savlon in 5 patients (5.32%) and EUSOL in 1 patient (1.1%).The frequency of pin site care varied from daily (55 patients - 58.51% of cases), alternate days in 20 patients (21.28%), twice weekly in 16 patients (17.02%) to once weekly in 3 patients (3.2%).

The average length of hospital stay was 49.5 days (range 4 – 154 days). Forty one patients (43.6%) were discharged home with their external fixators in-situ while others had their external fixators removed either because the original indication for application had been corrected or fixator was removed and replaced with another form of treatment eg, cast application.

The average length of time patients were on the external fixators was 124.8 days (17.8 weeks) – ranging from 1 to 660 days. The shortest was a patient who died a day after application of the external fixator from complications of injuries sustained to other systems in the same road traffic accident that caused the open fracture, while the one with the longest application had bone transport, limb lengthening and consolidation for bone loss from trauma.

Pin tract infection was the commonest complication encountered while using external fixators for various indications in our study, occurring in 25 patients (26.6%). Other complications included: Osteomyelitis in 4 patient (4.3%); Pin loosening / pull out in 4 patients (4.3%); Wound dehiscence in 2 patients (2.1%) who had ankle fusion with Chanley's clamp; significant fracture mal-union in 2 patients(2.1%) with open tibial fractures that required osteoclasis and knee joint stiffness in a patient that had external fixator application across the knee. One of the patients died a day post operation while 3 (3.2%) other patients had amputations done for limb ischaemia resulting from type IIIC open fractures that resulted in limb gangrene few days post external fixator application.

The commonest indication for removal of external fixators was the healing of the wounds in open fractures with conversion to other forms of treatment, commonly cast application (42.6%) – table 3.

The original aim of applying external fixator was achieved in 75% of cases and partially achieved in another 6% of cases.

The average length of follow-up of patients was 12.3 months, range 2 months to 72 months.

Figures 2A – D are photographs and Xrays of an AO type linear external fixator used for the initial management of a Gustilo type IIIA open fractures of the right tibia and fibula.

DISCUSSION

External fixators have been used by Physicians for fracture treatment for over 2000 years since its first description by Hippocrates. In spite of the changes in designs, biomechanics, versatility and indications, the basic principles of application have remained the same (9). The basic designs in use currently include: i) the linear type which can be applied in the unilateral, bilateral or multiplaner fashion, ii) the circular type which the popular designs are the Ilizarov frame and the Taylor Spartial Frame, iii) the third basic design is the hybrid type that combines the features of both linear and circular type (6,8,13,19).

In this study, the commonest type of external fixator used was the linear AO type (about 68%) from various manufacturers. Similar findings have been reported by other authors – (8,12). The reason for this finding is not farfetched. The simple linear AO type design of external fixator is more readily available, cheaper, has a short surgical learning curve and can be used for most long bone open fractures especially that of the tibia which is the commonest indication for the use of external fixators (8,12,13). The second most frequently used type of external fixator in our centres is another more advanced form of monoplanar external fixator – the linear rail system (LRS). This was frequently used for cases of bone loss that needed bone transport and also cases that needed limb lengthening using the principle of distraction osteogenesis. In addition it is also more appealing for use in femoral fractures where its sturdiness is an advantage. It is costlier and less easily available. The Ilizarov circular frame comes handy in cases of deformity correction eg neglected club foot and also cases that needed bone transport and limb lengthening. The few cases of joint fusion were done using the

uniplanar bilateral Chanley's Clamp. The Taylor Spatial Frame (TSF) has not gained popularity in our centres due to unavailability, cost and lack of expertise.

About 60% of patients managed with external fixators in this study were males. This is the trend in most of the studies on external fixators usage in the literature (3,5,8,14,16,17,20). The reason for this male preponderance is also glaring. Males are usually the most frequently traumatized group and by extension experience more fractures/ open fractures – the commonest indication for external fixator usage (5,8,10,11,21,22).

Persons between the ages of 21 and 40 years (54%) were the ones who had the most frequent need for external fixator application in our study. The ages ranged from 6 to 80 years with a mean of 33.7±15.9 years and a median age of 32 years. Abang *et al* (20) and Yinusa *et al* (8) observed similar means of 33.5 years and 34 years respectively in their studies while higher means of 38 years and 46.7 years have been reported by Ugwuovo *et al* (17) and Galubovic *et al* (14) respectively. These range of mean ages fall within the most active and productive group in any society and also happens to be the period of life in which trauma is most frequent and by extension fractures and open fractures for which external fixator applications are indicated (10,11,22). This finding is thus expected.

The commonest indication for external fixator usage in this study was open fractures making up about 68% of the indications. This is similar to the report by Yinusa *et al* (8) that open fractures made up 67% of the indications for external fixator application in their study. The advantages of using external fixators for the management of open fractures cannot be overemphasized. Availability and ease of application with minimal time wasting especially in unstable patients with multiple injuries, ease of access to wounds for dressing after application, minimal tissue invasiveness during application, reduced infection rate in contaminated open wounds etc, all make the use of external fixators in open fractures especially in Gustilo and Anderson types III fractures appealing. This has been alluded to in the literature by several authors (3,5,8,10,11,17,20,23).

The length of application of an external fixator usually depends on a number of factors including: the initial indication for application, whether it is intended for definitive or adjunct management of the condition, patient's response to treatment (how fast patient heals) and occurrence of complications among other considerations. The average of time external fixators were applied in this study was 124 days (17.85 weeks). The period of application ranged from 1 day to 94 weeks. The patient who had application for just 1 day died a day after application of fixator for open tibia/ fibula fracture from complications of injuries to other body systems sustained in the same accident. The patient that had external fixator applied for 94 weeks had post-traumatic large bone loss and non-union from open tibial shaft fracture for which he had LRS fixator applied for bone transport / limb lengthening and consolidation of regenerate. It is important to note that the patients who had external fixators applied for acute open fractures had an average length of application of 12 weeks. In a study on external fixator usage in which the bulk of the patients had open fractures (66.9%) and arthrodesis (22.6%), Yinusa *et al* (8) reported an average period of application of 10.3 weeks. In another study on the use of external fixators for the definitive management of open tibial fractures, Ugwuovo *et al* (17) recorded an average application time (time to union) of 15.2 weeks. It is pertinent to note that for most of the acute trauma (open fracture) patients in this study (40 out of 52 patients), external fixators were applied as adjunct to treatment. Fixators were removed and replaced with other forms of treatment (usually cast) once the wounds healed or are manageable in casts with a window.

The use of external fixators can be associated with numerous complications which may vary from pin tract infections (PTI) to neurovascular injuries, pin loosening and pull out, osteomyelitis and sequestrum formation, nonunion/ malunion of fractures, compartment syndrome etc (6,9,18,24,25). The commonest complication observed in this study was pin tract infection (PTI) occurring in about 27% of patients. This observation – that PTI is the commonest complication of external fixator usage - seems to be the general trend in the literature, though, percentage involvement varies from 0.9% to 100% (18,24-27). Ugwuovo *et al* (17), Yinusa *et al* (8) and Galubovic *et al* (14) reported a lower percentage PTI incidences of 6.6%, 14.8% and 19.2% respectively while higher percentage incidences of PTI – 87.7% and 96.6% - respectively have been reported by Mohammed et al (18) and Antoci et al (25). A number of factors may be responsible for the variations in the incidences of PTI observed in these different studies. These factors may include: type of external fixator applied (pins or

wires) (26,28); length of time fixator was applied (29); pin site care practices (26,28,30); co-morbid conditions in the patient (15,26,28), use of prophylactic antibiotics (25), etc.

The timing for removal of an external fixator usually depend on whether the original aim for the application has been achieved except in cases where complications arise that necessitate earlier removal or change to other forms of treatment. In this study, most of the external fixators applied for open fracture cases were used as adjunct to treatment to adequately manage the open wounds and were removed when wounds healed or were contracted enough to allow dressing through a window in a cast (38 of 59 patients). Another 14 of the 59 patients had fixators removed after fractures healed. Three of the open fracture cases had external fixators removed and amputations performed some days after application for Gustilo type IIIC injuries in which the extent of vascular injury was not clear cut at presentation and facilities for angiography were not available. One of the patients with open fractures died a day after external fixator application from associated severe injuries sustained to other systems. One hundred per cent fusion rate was observed for the 3 cases of ankle fusion performed with the Chanley's Clamp - uniplanar bilateral fixator.

Overall, the original aim for external fixation application (satisfactory results) was achieved in about 75% of cases and partially achieved in another 6% of cases. Yinusa *et al* (8) in their study, reported satisfactory results in 63% of their patients.

CONCLUSION

In conclusion, the use of external fixators has come to stay as an indispensable tool in the armamentarium of modern Orthopaedic surgeons especially in the area of managing open fractures. The high level of satisfactory results achieved in this study further gives credence to this. With the emergence of more complicated and versatile designs that have further increased the array of indications, the need for training and retraining in their use has also become more imperative in order to harness their full potentials and achieve greater results.

Conflict of Interest: The authors declare no Conflict of interest.

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Table 1. Socio-demographic characteristics of patients

STATUS	FREQUENCIES	PERCENTAGE
SEX DISTRIBUTION		
MALES	56	59.58 %
FEMALES	38	40.43 %
TOTAL	**94**	**~ 100%**
AGE DISTRIBUTION IN YEARS		
0 - 10	8	8.51
11 – 20	9	9.57
21 – 30	25	26.60
31 – 40	26	27.66
41 – 50	13	13.83
51 – 60	7	7.45
61 – 70	5	5.32
71 - 80	1	1.06
TOTAL	**94**	~ 100%
MARITAL STATUS OF PATIENTS		
MARRIED	48	51.06 %
SINGLE	42	44.68 %
DIVORCED / WIDOWED	4	4.26 %
TOTAL	**94**	**~100 5**
EDUCATIONAL STATUS		
NO FORMAL EDUCTAION	13	13.83 %
PRIMARY	20	21.28 %
SECONDARY	25	26.60 %
TERTIARY	28	29.79 %
NOT INDICATED	8	8.51 %
TOTAL	**94**	**~ 100 %**
OCCUPATIONAL DISTRIBUTION		
TRADERS	30	31.91 %
SCHOOLING	23	24.47 %
CIVIL SERVANTS	9	9.57 %
FARMERS	7	7.45 %
ARTISAN	5	5.32 %
STATE SECURITY	3	3.19 %
RETIRED PERSONS	3	3.19%
OTHERS	14	14.89 %
TOTAL	**94**	**~100 %**

Table 2. Indications for external fixation

INDICATION	FREQUENCIES	PERCENTAGES
Open Fractures		
(Gustilo & Anderson Class)	67	67.7%
I	0	0
II	6	6.1
IIIA	24	24.2
IIIB	36	36.4
IIIC	1	1.0
Bone		
(Bone Gap Treatment Post Traumatic)	11	11.1
Infected Fractures / Non Unions	6	6.1
Deformity Correction	5	5.1
Joint Fusion (Ankle)	3	3.0
Congenital Pseudoarthrosis	3	3.0
Pelvic fractures (Closed)	2	2.0
Limb Lengthening	2	2.0
TOTAL	**99**	**100%**

Table 3. Indications for external fixators removal / outcome

INDICATIONS	FREQUENCY	PERCENTAGE
WOUND HEALED (exchange for cast as further treatment)	38	40.43
FRACTURE HEALED	14	14.89
LIMB LENGTHENING:– FULLY ACHIEVED	2	2.13
" – PARTIALLY ACHIEVED	2	2.13
BONE TRANSPORT: – FULLY ACHIEVED	6	6.38
– PARTIALLY ACHIEVED	2	2.13
– FAILED ATTEMPT AT BONE TRANSPORT	2	2.13
EXCHANGE FOR ORIF	5	5.32
DEFORMITY CORRECTION:- FULL CORRECTION ACHIEVED	4	4.26
- PARTIAL CORRECTION	2	2.13
JOINT FUSION (ANKLE) - ACHIEVED	3	3.19
AMPUTATION (VASCULAR INSUFFICIENCY FROM ORIGINAL TRAUMA)	3	3.19
DIED	1	1.06
REFERRED WITH EX.FIX/ DAMA & LOSS TO FOLLOW-UP	10	10.64
TOTAL	94	~100 %

*DAMA – Discharged against medical advice.

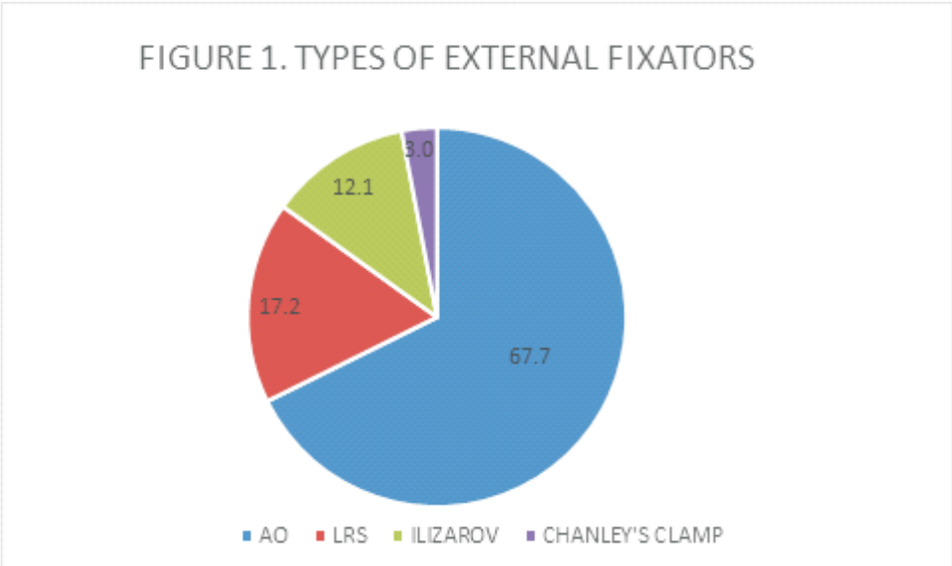

Figure 1. Frequency of Use (Percentage) of the 4 Types of External Fixators

Figure. 2A Gustilo Type IIIA Open fracture of Right Tibai & fibula

Figure 2B – After Wound Debridement and External fixation of Limb in 2A.

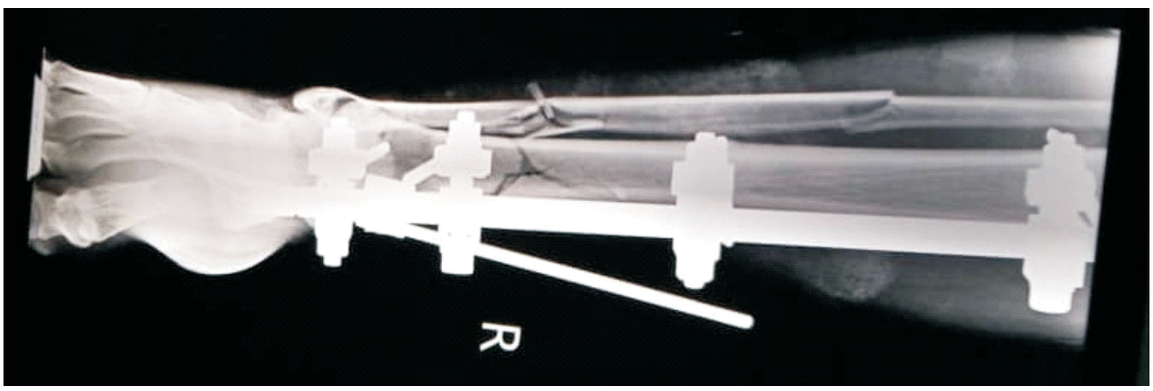

Figure 2C. Post-operation Xray (A/P view) of the limb of the Patient in 2A & B.

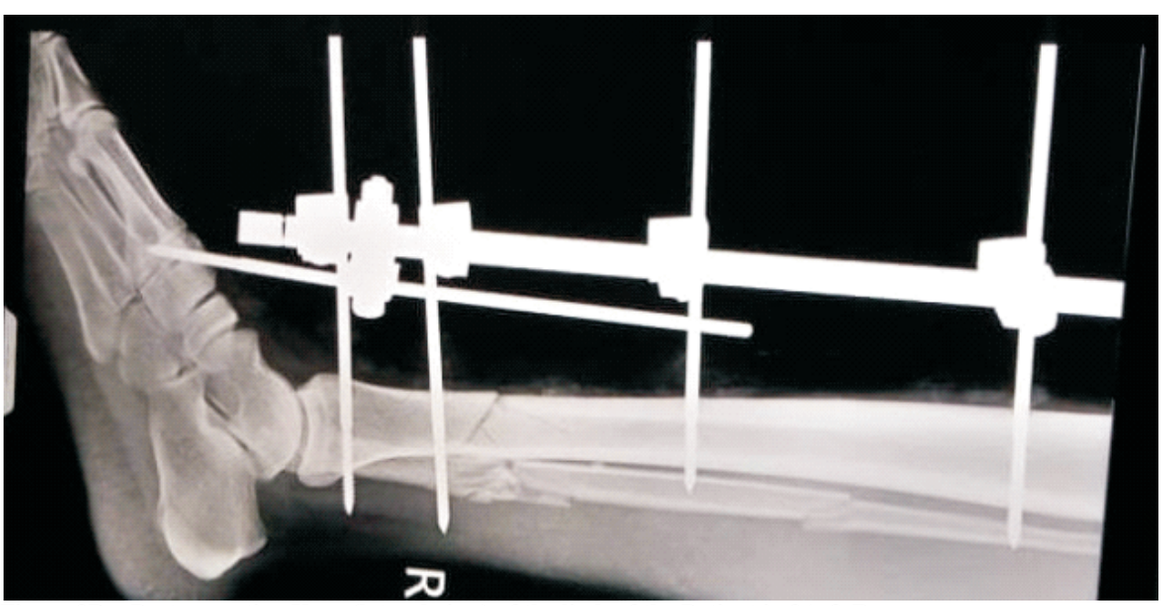

Figure 2D – Post-operation Xray (lateral view) of the limb of the Patient in 2A & B.