

Traditional Bone Setter's Gangrene of the Upper Extremity in Children: Experience from a Tertiary Health Institution

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Abstract Background: Traditional bone setting is an ancient healing art and is rife in sub-Saharan Africa. Traditional bone setter's gangrene of the upper extremity in children is a serious complication of fracture care by traditional bone setters. **Aim:** To document upper extremity gangrene in children resulting from the practice of traditional bone setting as seen in a tertiary health institution. **Methods:** A prospective study of children presenting with upper extremity gangrene from the care of traditional bone setters at the University of Port Harcourt Teaching Hospital from January 2006 to December 2018. Data obtained included the patients socio-demographics and relevant information related to the injury. Data was analysed with SPSS version 20. **Results:** Fifty-two children with upper extremity gangrene were seen. Their ages ranged from 1.5 to 14 years and most were males. Their parents mostly had primary and secondary levels of education and majority were married. The most common injury was humeral supracondylar fractures. These injuries were majorly from falls. Duration before presentation ranged from 2 to 5 weeks. Majority had massage, splinting and bandaging from the bone setter. Most common associated complication at presentation was sepsis. They all had provisional amputation. Most common amputation level was above elbow. The amputation stumps were refashioned from 5 to 35 days. Four had split skin grafting. Duration of hospital stay ranged from 9 to 108 days. There was no mortality. **Conclusion:** Upper extremity gangrene in children is a preventable sequelae of traditional bone setting. Parental health education is necessary to discourage their patronizing traditional bone setters.

Keywords: traditional bone setters, children, upper extremity, gangrene, fracture, management

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1. Introduction

Traditional bone setting is an ancient healing art that exists in all societies of the world. [1,2,3,4,5,6] Traditional bone setters are persons recognized by the community in which they live as having competence to set bones and manipulate joints. [2,5] They are "unqualified practitioners" who take up the art of healing without having any formal training in accepted medical procedures. [1,2,3] In every culture, certain individuals acquire the skill and the courage needed to approach a person in obvious pain for the purpose of realigning a recent fracture deformity or joint dislocation. [1,7]

The practice of traditional bone setting is rife in developing countries of the world and especially in sub-Saharan Africa. [1,2,5,6,8,9] In most developing countries, the accurate statistics of traditional bone setters' distribution or numbers are not available. [2] In India, it is estimated that there are 70,000 traditional healers and

bone setters. [2] These bone setters enjoy high patronage from the communities they practice in. [2,5,10,11] Worldwide, it is estimated that between 10% and 40% of patients with fractures and dislocations are cared for by these unorthodox practitioners. [1,2] In India, it is estimated that these practitioners treat 60% of all trauma [2] while in Nigeria, it is estimated that over 70% of the rural population depend on these practitioners for primary fracture care. [5] The percentage of patients with fractures who visit the traditional bone setters before presenting to the hospital can be up to 85%. [6,12] Hence, this mode of care delivery is of importance when considering care for patients after trauma.

Traditional bone setter's gangrene is one of the most widely reported complications of traditional bone setting. It is a coinage used to describe iatrogenic extremity gangrene, largely avoidable, arising from activities of traditional bone setters attempting to manage fractures. [13,14,15,16,17,18] The aim of this study was to document upper extremity gangrene in children resulting from the practice of traditional bone setting as seen in a tertiary health institution in southern Nigeria.

2. Patients and Methods

This was a prospective study of consecutive children aged 16 years or less presenting with upper extremity gangrene from the care of traditional bone setters at the University of Port Harcourt Teaching Hospital, Port Harcourt, Rivers State, Nigeria from January 2006 to December 2018.

The patients with traditional bone setters' gangrene of the upper extremity were assessed clinically, admitted and resuscitated with intravenous fluids and given broad spectrum antibiotics and tetanus prophylaxis. Relevant investigations included full blood count, serum electrolytes, urea and creatinine levels and grouping and cross-matching of blood. Plain radiographs of the affected extremities were reviewed for those who presented with them. Those who required blood transfusion were given.

All the patients had provisional amputations and stump refashioning or other relevant procedures subsequently.

The inclusion criteria were those aged 16 years or less, presenting with upper extremity gangrene from the care of traditional bone setters. Excluded were patients whose upper extremity gangrene were due to crush injury from trauma and those who were older than 16 years.

Data was collected through a structured proforma and included their age, sex, parents highest educational level, parents marital status, affected side, dominant hand, primary injury, cause of injury, duration before presentation, mode of traditional bone setters care, traditional bone setters treatment, duration of traditional bone setters treatment, associated complications of traditional bone setters treatment at presentation, type and level of amputation, duration before stump refashioning, other additional procedures carried out, duration of hospital stay, mortality and duration of follow up.

Data was analysed using Statistical Package for Social Sciences (SPSS) version 20 (IBM Inc., Armonk, NY, USA). Mean, standard deviation and median were used for descriptive statistics while categorical variables were expressed in absolute frequencies. Spearman's correlation was used to determine association between sociodemographic characteristics and the amputation level. A p value of ≤ 0.05 was considered significant.

Ethical approval was obtained from the Research and Ethics Committee of the University of Port Harcourt Teaching Hospital.

3. Results

In the 13-year period, 52 children who were 16 years or less were seen with traditional bone setter's gangrene of the upper extremity and averaging four per year. This constituted 8.7% of the total admissions into the children orthopaedic ward and 1.2% of the total admissions into the children surgical wards.

The patients' ages ranged from 1.5 to 14 years with a mean of 6.62 ± 2.92 years. There were 33 males and 19 females giving a male to female ratio of 1.7: 1. The parents' highest educational level were mostly primary (50.0%) and secondary (46.2%). There was no parent with

tertiary level of education. Majority of the parents were married (80.8%) although 11.5% were divorced. (Table 1)

Table 1. Socio-demographic characteristics of patients

Variables	Frequency (n=52)	Percentage (%)
Age		
1-5 years	19	36.5
6-10 years	28	53.8
11-15 years	5	9.6
Mean(\pmSD), Median	6.62(\pm2.92), 6.00	
Range	1.5-14.0 years	
Sex		
Female	19	36.5
Male	33	63.5
Educational status of parents		
None	2	3.8
Primary	26	50.0
Secondary	24	46.2
Parents marital status		
Divorced	6	11.5
Married	42	80.8
Separated	4	7.7

Key: SD = Standard deviation.

The left upper extremity was affected by the gangrene in 27 patients (51.9%) and on the right in 25 patients (48.1%). Fifty (96.2%) of the patients were right hand dominant while two (3.8%) were left handed. The most frequent primary injuries were humeral supracondylar fractures (46.2%) and radius/ulna fractures (40.4%). The injuries were in the majority due to falls (92.3%). (Table 2) The duration before the patients presented ranged from two to five weeks. They all visited the traditional bone setters' and were all treated as out-patients. The traditional bone setters' treatment consisted of massage with herbal concoctions, splinting and bandaging. The duration of treatment by the traditional bone setter ranged from 10 to 35 days. (Table 2) Sepsis was noticed at presentation in 28 patients and was the most frequent complication at presentation. They all had provisional amputation, with five being auto-amputations and most of them had above elbow amputation (63.5%). The amputation stumps were refashioned five to 35 days after in 48 patients (92.3%) (Table 2) while four (7.7%) had split skin grafting of their amputation stump. Their duration of hospital stay ranged from nine to 108 days with a median of 24 days. (Table 2) Those who had split skin grafting spent a longer time in hospital. There was no mortality. Their duration of follow up ranged from two to 20 months with most being followed up for up to 10 months.

Table 3 shows the relationship between socio-demographic characteristics and the amputation level. There was a weak negative correlation between the age of the patients and the amputation level ($p=0.013$). There was no correlation between the sex of the patients, educational level and marital status of the parents with the amputation level.

Table 2. Clinical characteristics of patients

Variables	Frequency (n=52)	Percentage (%)
Primary injury		
Humeral supracondylar fracture	24	46.2
Radius/Ulna fracture	21	40.4
Proximal Humeral fracture	3	5.8
Humeral Midshaft fracture	4	7.7
Cause of injury		
RTC	4	7.7
Fall	48	92.3
Duration before presentation		
1-2 weeks	6	11.5
3-4 weeks	35	67.3
>4 weeks	11	21.2
Mean(\pmSD), Median	3.56(\pm0.96), 3.00	
Range	2-5 weeks	
TBS Treatment		
Massage + Splinting + Bandaging	44	84.6
Massage + Splinting + Bandaging + Incision	8	15.4
Duration of TBS Treatment		
<11 days	1	1.9
11-15 days	15	28.8
21-25 days	20	38.5
26-30 days	14	26.9
31-35 days	2	3.8
Mean(\pmSD), Median	21.15(\pm6.21), 21.00	
Range	10-35 days	
Associated complication of TBS treatment (n=32)		
Osteomyelitis	2	6.3
Sepsis	28	87.5
Septic shock	1	3.1
Septicaemia	1	3.1
Amputation level		
Above elbow	33	63.5
Below elbow	19	36.5
Duration before stump refashioning (n=48)		
1-5 days	2	4.2
6-10 days	29	60.4
11-15 days	5	10.4
16-20 days	4	8.3
21-25 days	3	6.3
>25 days	5	10.4
Mean(\pmSD), Median	12.98(\pm7.97), 10.00	
Range	5-35 days	
Duration of stay in hospital		
1-30 days	35	67.3
31-60 days	12	23.1
61-90 days	3	5.8
>90 days	2	3.8
Mean(\pmSD), Median	32.21(\pm20.20), 24.00	
Range	9-108 days	
Follow up duration (n=52)		
1-5 months	22	42.3
6-10 months	18	34.6
11-15 months	5	9.6
16-20 months	7	13.5
Mean(\pmSD), Median	7.78(\pm5.19), 6.00	
Range	2-20 months	

Key: RTC = Road traffic crash, SD = Standard deviation, TBS = Traditional bone setter.

Table 3. Relationship between socio-demographic characteristics and level of amputation

Variables	Spearman's rho (r)	Grading	p-value
Age at presentation	-0.343	Weak	0.013
Sex	-0.078	Very weak	0.582
Educational level of Parent	0.048	Very weak	0.734
Marital Status of parent	-0.035	Very weak	0.805



1a

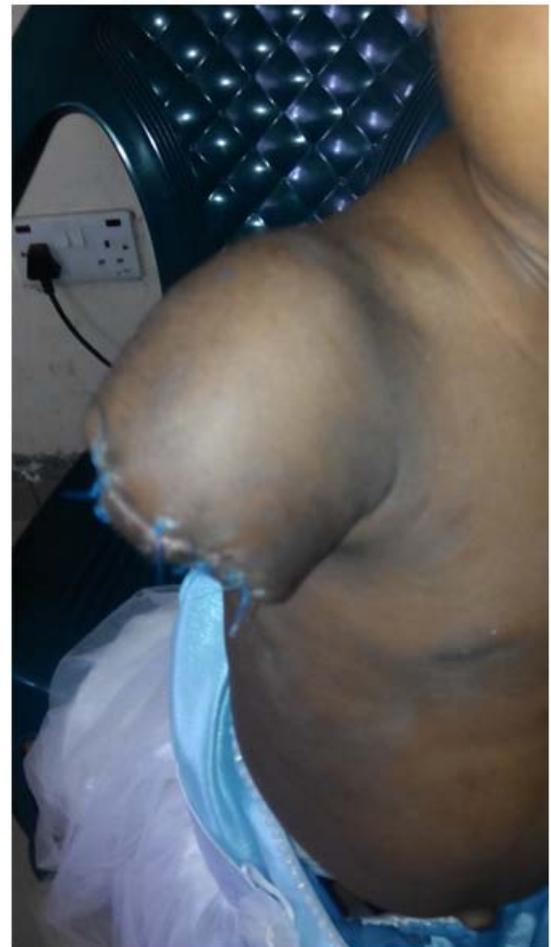


1b

Figure 1. Clinical photograph of a child with left upper extremity gangrene from the care of traditional bone setters at presentation in hospital (1a) and while on ward care (1b)



2a



2b

Figure 2. Clinical photograph of right upper extremity gangrene in a child following care of a traditional bone setter at presentation in hospital (2a) and after stump refashioning (2b)



Figure 3. Clinical photograph of a child with right upper extremity gangrene from care of a traditional bone setter at presentation in hospital (3a), the below elbow stump during ward care (3b), after granulation of the stump (3c) and immediately after split skin grafting (3d). Extensor (3e) and flexor (3f) views of the stump after graft maturation

Figure 1 shows the clinical photograph of a child with left upper extremity gangrene at presentation (1a) and while on ward care (1b). Clinical photograph in Figure 2 is that of right upper extremity gangrene in a child following care of a traditional bone setter, at presentation in hospital (2a) and after stump refashioning (2b). Figure 3 shows the clinical photograph of a child with right upper extremity gangrene from care of a traditional bone setter, at presentation in hospital (3a), during ward care (3b), after granulation of the stump (3c) and immediately after split skin grafting (3d). The extensor and flexor views of the stump after graft maturation are shown (Figure 3 e and f respectively).

4. Discussion

This study has shown that children at any age can develop upper extremity gangrene from treatment of injuries by traditional bone setters, males are more commonly affected, the parents of these children being mostly of lower educational level, the non-dominant upper extremity predominating, humeral supracondylar fractures being the frequent injury and arising mostly from falls. The traditional bone setters' treatment consisted majorly of massage, splinting and bandaging with sepsis frequently complicating their treatment and the children were treated by amputation in two stages with excellent outcome.

Published literature highlighting traditional bone setter's gangrene of the upper extremity in children appear as case reports, case series or other research reports. [6,8,13,14,15,18,19-61] Some of the publications highlight the extremity gangrene as a separate entity while others do so in discussions on extremity amputations or complications of traditional bone setters treatment of orthopaedic injuries/conditions. The characteristics of upper extremity gangrene in children were not highlighted distinctly in a greater number of the publications but those from which relevant characteristics could be extracted will be utilized to discuss the findings of the present study. In some reports, the figures for the extremity gangrene were high [13,16,20,21,27,28,33,36,37,41,42,45,49,51,57] but low in others.[25,46,47,53,58,59,60]

In the present study, traditional bone setter's gangrene of the upper extremity in children constituted 8.7% of the total admissions into the children orthopaedic ward and 1.2% of the total admissions into the children surgical wards. This is higher than the 0.5% of paediatric surgical admissions in The Gambia reported by Bickler and Sanno-Duanda. [14] Extremity gangrene is an important contributor to the burden of childhood surgical diseases in sub-Saharan Africa and disability in these children. [62,63] The average number of four patients per year in the present study compares with the report of Onuminya et al., [13] who over a period of three and half years had 15 children with upper extremity gangrene (4.3 per year) among the 25 patients with complications from traditional bone setters treatment of injuries.

Children with upper extremity gangrene who were seen in the present study had ages that ranged from 1.5 years to 14 years with a mean of 6.6 years. The most frequently affected age group was 6-10 years (53.8%) followed by the 1-5 years group (36.5%). The age range of the present study is comparable to those of Onuminya et al. [13] (5-10 years), Bickler and Sanno-Duanda [14] (5-14 years), Tekpa et al. [18] (5-15 years), and Doumi et al. [51] (5-15 years). However, the mean/average age for the present study (6.6 years) is lower than those for Onuminya et al. [13] (8.8 years), Bickler and Sanno-Duanda [14] (8.2 years), Tekpa et al. [18] (10 years) and Doumi et al. [51] (7.6 years). However, the report by Agaja [23] from Nigeria which had three children with upper extremity gangrene from treatment by traditional bone setters had a range of 3 to 7 years with an average of 5 years. This average is lower than that for the present study. In the Ethiopian study by Yasin et al. [49] the most frequent age bracket who had traditional bone setters gangrene was the 6-9 years group which is similar to that for the present study, followed by the 10-15 years group which is different from that for the present study which had the 1-5 years age group as the next most common.

The studies of traditional bone setters gangrene of the upper extremity in children had a male preponderance. [13,14,18,51] The present study corroborates this male preponderance. The reasons adduced for the male preponderance in injuries include the tendency for males to explore and experiment with the environment, socialization, inherent behavioural differences and personality traits and greater freedom given to boys with the consequent greater exposure that this implies. [63,64]

In the present study, there was a slight preponderance in the involvement of the left side which was the

non-dominant hand in the majority. In Onuminya et al's study, [13] the right side was more affected than the left while the study by Bickler and Sanno-Duanda [14] revealed an almost equal occurrence in both upper extremity. The three children in the series by Agaja [23] all had upper extremity gangrene on the right.

The most frequent injury in the present study was humeral supracondylar fractures followed by radius/ulna fractures. This is similar to the findings of Onuminya et al. [13] where the majority of the children had supracondylar fractures. In the Zaria, Nigeria study by Garba and Deshi [21] most of those who had traditional bone setters gangrene of the upper extremity had supracondylar humeral fractures followed by forearm bone fractures. Doumi et al. [51] in Sudan reported supracondylar humeral fractures as the commonest followed by midshaft humeral fractures. However, Akinyoola et al's study [33] in Ife, Nigeria reported predominance of radius/ulna fractures followed by supracondylar humeral fractures. The three children with upper extremity gangrene reported by Agaja [23] all had radius/ulna fractures. Supracondylar fractures of the humerus are the most common elbow fractures in children [65,66] while the most common area involved in children fractures of the upper extremity is the forearm. [66] Hence it is not surprising that supracondylar humeral fractures and radius/ulna fractures are seen frequently in these children with upper extremity gangrene.

In children, the frequent causes of their injuries are falls and road accidents. [62,63,64,67] The most common cause in the Senegalese study by Tekpa et al. [18] was falls in the patients with traditional bone setters gangrene. Onuminya et al. [13] also reported as the major cause in the children in their study followed by road accidents. In the present study, falls were responsible for most of the injuries followed by road crashes.

In the present study, the duration before presentation to hospital ranged from two to five weeks with a median of three weeks. This is comparable to the findings of Tekpa et al. [18] where they presented seven to 21 days later. Delay in hospital presentation is common in these patients with extremity gangrene.

The method of treatment of fractures by the traditional bone setters is what encourages the extremity gangrene that results. The application of splints around the injured limb with tight bandaging is the reason for the gangrene. This immobilization is done without the knowledge of anatomy, physiology or radiography. [21,40,55] The tight splinting creates a tourniquet effect which leads to vascular compromise, compartment syndrome, ischaemia and limb gangrene. [13,15,16,27,28,29,33,40] Sometimes there is severe soft tissue loss with exposed necrotic bone in the vicinity of the applied splint. [13,14,27] Upper extremity gangrene was the case with children in the present study. Figure 3 (b and c) typifies the severe skin loss in the forearm which was allowed to granulate. Children are particularly at risk in the event of tight application of splints. This is because the children are dependent on adults (parents or guardians) for decisions and they are forced to endure the severe ischaemic pains that precede extremity gangrene until the extremity becomes gangrenous. [18,30,43,45]

Sepsis often complicates extremity gangrene from the treatment of traditional bone setters. [14,15,29,33,40] This

was the finding in the present study. The presence of sepsis often necessitates a two-stage procedure with initial provisional amputation and stump refashioning or other additional procedures later. The provisional amputation removes the source of the sepsis and reduces the inflammatory response. [40] All the patients in the present study had provisional amputation and the stump were refashioned five to 35 days later. Four patients had split skin grafting after their amputation stumps had adequate granulation (Figure 3c-f). Split skin grafting at a later time when the bed is adequately granulated reduces the occurrence of graft failure.

The most frequent amputation level in the present study was above elbow (63.5%). This corroborates the findings of others [13,14,18,51] who also reported more above elbow amputations. This is closely related to the frequent occurrence of supracondylar humeral fractures in these patients with upper extremity gangrene. However, Yasin et al. [49] reported equal number of above and below elbow amputations in their study.

The duration of hospital stay in the present study varied (9-108 days). Those who had split skin grafting spent a longer period to allow for adequate granulation of their wounds before the grafting.

There was no mortality in the present study. Other workers [13,40,51] have also reported similar findings. Where mortalities have occurred they have been related to the occurrence of overwhelming sepsis. [14,16,33,40]

The duration of follow up in the present study varied from two to 20 months. However, a significant number were followed up for up to 10 months before being lost to follow up. Loss to follow up is common among patients in developing countries. [33]

In the present study, there was no correlation between the educational level of the parents and the level of the amputation. However, strikingly none of the parents had obtained tertiary level of education. Traditional bone setters are patronized by all educational strata [10,11,17,30,34], although it is higher among those with lower educational level.[30] In the application of tight splints by traditional bone setters, the parent/guardians are most times pre-instructed not to remove the splints on any account and that the pain is usually a sign of effectiveness of the treatment and part of the healing process. [43] Therefore, when the children complain of pain from the uncomfortable splint or cry persistently, this being due to the ischaemia caused by the tight splint, they are usually ignored by their parents/guardians based on the traditional bone setters instruction. We believe that parents/guardians with tertiary level of education remove the tight splint when the children complain or cry persistently, hence breaking the vicious cycle that will culminate in extremity gangrene and thereby save the limb. The educational level of parents of children with extremity gangrene from traditional bone setting has been shown to be low.[18]

The marital status of the parents in the present study, did not correlate with the amputation level. Although majority of the parents were married, 19.2% were either divorced or separated. There has been a growing concern about the relationship of the family structure to the occurrence of traditional bone setter's gangrene. It has been shown that children raised in unstable homes appear prone to both traumatic injuries and being taken to

traditional bone setters for care and ultimately developing extremity gangrene. [8]

Traditional bone setter's gangrene is a major contributor to amputation in developing countries and especially in children. [8,13-18,20,21,27-29,33,36,37,40-42,45,49,51] The limb loss that results from this is completely unnecessary. Limb loss in the upper extremity can result in significant morbidity, disability and profound economic, social and psychological effects on the patient and family especially in developing countries where prostheses may not be readily available. [26,45,49] The children affected by this would have to learn the use of the non-dominant hand for their activities if the dominant extremity was involved and there is a limit to the kind of jobs the individuals can take up. At the other extreme, these children can end up in the streets as beggars. [26]

From the foregoing, it becomes obvious that there is a need to prevent this unnecessary and avoidable limb loss. Various workers have proposed preventive measures which include public health education and enlightenment, education and training of traditional bone setters, prohibition of advertisement by traditional bone setters in print and electronic media, regulation of the practice of traditional bone setters, government subsidy of hospital treatment costs, expansion of the National Health Insurance Scheme to cover fracture treatment procedures and strengthening of the traditional family system. [2.8.11.12.13.16.20.21.22.27.33.34.40]

Limitations of the present study include the fact that it is a hospital-based study and is the experience of a single centre.

5. Conclusion

Children, both the very young and those older, can develop upper extremity gangrene from the practice of traditional bone setting. There was a male preponderance with parents of these children being mostly of lower educational level. The upper extremity gangrene were associated with humeral supracondylar fractures and falls. A two-stage process involving initial provisional amputation followed later by stump refashioning was utilized with excellent outcome. Upper extremity gangrene in children is a preventable sequelae of traditional bone setting. Parental health education among other measures are necessary to discourage the patronage of traditional bone setters.

Statement of Competing Interest

The authors have no competing interest

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