Original Article

Skull traction for cervical spinal injury in Enugu: A 5-year retrospective multicenter analysis of the clinical outcomes of patients treated with two common devices

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Abstract

Background: Treatment of cervical spine injury is the most challenging of all the injuries of the spine, and there is yet no agreement on the best method of care.

Objective: We studied the complications and outcome of two skull traction devices used to treat cases of cervical spine injury in three centers in Enugu, South East Nigeria.

Patients and Methods: A retrospective analysis of patients with cervical spine injury managed with skull traction as the definitive treatment using either Crutchfield or Gardner-Wells tongs over a 5-year period (April 2008–March 2013). The traction was applied for 6 weeks, and the patient was subsequently mobilized with either hard cervical collar or Minerva jacket for another 6 weeks.

Results: One hundred and five patients with complete records out of 127 cervical spinal injured patients treated were studied. Forty-one had the American Spinal Injury Association (ASIA) Grade A whereas 64 had incomplete cord injury of ASIA Grades B–E. Forty-eight had Crutchfield traction whereas 57 had Gardner-Wells traction. At the end of treatment, no patient improved among those with ASIA Grades A and B. All the 12 cases of mortality were recorded as well among ASIA A (n = 9) and B (n = 3) Grades. Over 50% of ASIA Grades C and D patients improved to Grade E. The complication profile varied significantly between the traction subgroups with those treated using Crutchfield tongs experiencing more events (χ^2 = 6.5, df = 1, P < 0.05). However, there was no significant statistical difference in the Association Impairment Scale (AIS) outcome (P = 0.55) as well as mortality rates (χ^2 = 0.97, DF = 1, P > 0.05) between those treated with Crutchfield and Gardner-Well traction.

Conclusion: Crutch field tong traction may be associated with more complications when compared with Gardner-Wells traction. However, from our study, the final American Spinal Injury AIS outcome, as well as the overall mortality rates associated with the two traction techniques, did not vary significantly.

Key words: Cervical spine injury, conservative treatment, outcome, skull traction

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Introduction

Although operative reduction and spinal fusion, in general, has gained popularity in the treatment of cervical spine injuries, conservative treatment such as the use of skull traction still has an important role to play.[1] Skull traction can be used to restore sagittal plane alignment in patients with subaxial cervical spine injuries both in the initial stage of the management before arthrodesis as an adjunct to surgery or as the definitive treatment.[1-3] Cervical traction is also indicated in the reduction, stabilization, and realignment of the cervical spine in patients with unilateral or bilateral facet lock, fracture dislocations, and burst fractures.[1-3] In all the cases above, cervical spine realignment provides for indirect decompression of the spinal cord.[2] Some clinicians have also considered skull traction as the best treatment for unstable fractures of the cervical spine.[4]

Historically, as early as the 4th century BC, Hippocrates described spinal traction for the treatment of spinal deformity.[5] In 1929, Taylor introduced the halter device for the reduction of cervical injuries.[6] Crutchfield in 1933 introduced the use of cranial tongs for cervical traction.[7] These tongs required pin placement near the cranial vertex. In 1968, Nickel *et al*. developed the Halo device,[8] while, in 1973, Gardner improved on the system described by Crutchfield by creating tongs with cranial pin angulation for improved skeletal fixation.[9] Crutchfield, the first clinician to use skeletal traction in the form of cranial tongs to treat dislocation of the cervical spine, after over 22 years of experience in treatment of cervical trauma concluded thus, "When properly applied, skeletal traction is the safest, most effective, and simplest method of treating patients with acute injuries of the cervical spine."[10] With the introduction of Gardner-Well tongs (GWT) and Halo, most patients with cervical trauma, especially in the developed countries are currently treated with these newer devices.[2] However, Crutchfield tongs are still useful, especially in the developing countries, such as ours, although its requirement for pin placement near the vertex is thought to limit the amount of traction force that can be safely applied.[2] Contraindications to the application of skull traction in cervical spine injuries will include distractive injuries, associated skull fracture, local sepsis, and stable fractures, especially without neurological signs when only collar or other forms of bracing may suffice.[1,4]

Many devices are currently used for skeletal skull traction, each with its advantages as well as risks. Some of the devices use pins, whereas others have tongs, wires, or hooks.[1,4] Surgeons' choice of traction device is based on many considerations.[4] These considerations include patients' condition, surgeons' experience with the device, availability, and cost among others.

For our study, the choice of Crutchfield tongs and Gardener-Wells tongs was based on the surgeons' experience, preference, availability, and cost. The aim of this study is to evaluate the clinical outcome of cervical spinal injuries treated conservatively using two common devices for skull traction in three specialist centers, in Enugu, over a 5-year period.

Patients and Methods

This is a retrospective analysis of cervical spinal trauma patients managed with skull traction as definitive treatment using either Crutchfield or GWT over a 5-year period (April 2008–March 2013) in three specialist hospitals, within Enugu, in South-East Nigeria. The traction device was applied for 6 weeks, and the patient was subsequently mobilized with either hard collar or Minerva jacket for another 6 weeks. We did not perform manipulative reduction of our cervical spine injuries due to the lack of C-arm imaging to monitor the procedure.

Inclusion criteria

All cervical trauma patients admitted and treated with either GWT traction or Crutchfield tongs traction (CTT) only at the University of Nigeria Teaching Hospital (UNTH), Ituku-Ozalla, Hilltop Hospital, and Annunciation Specialist Hospital, all in Enugu, within the period under study. Patients who had spinal fusion before completion of 6 weeks of traction were excluded. Traction procedures were performed by a consultant neurosurgeon or a senior registrar in neurosurgery for Gardner-Wells traction. For CTT, traction was performed by the orthopedic surgeon or the most senior resident in the orthopedic unit with adequate training and competence in performing the procedure. For serial traction reduction, traction weight was calculated using 2.3 kg per level of injury and is performed with incremental 5 kg weights under X-ray control till reduction is achieved. For cases with facet lock, we used weights up to a maximum of 40 kg but not exceeding 60% of the patient's weight. For maintenance of reduction, we applied 2.5 kg (allowing for the weight of the head) plus 1 kg per level of cervical injury.

Adequacy of traction was also periodically assessed with weekly cervical spine X-rays. At the end of traction duration, flexion and extension X-rays were obtained to assess cervical spine stability. Demographics, clinical records (including complications, outcome, and follow-up), and radiologic data were obtained from case notes, X-ray reports as well as computed tomography scan and magnetic resonance imaging reports.

Neurologic status on admission as well as the outcome at the end of treatment was assessed using the American Spinal Injury Association Impairment Scale (AIS). Patients were subclassified using the traction device they were treated with. The outcome of treatment and profile of complications in the two subgroups were evaluated statistically using Chi-square and *t*-test statistical tests. Data acquisition and analysis were performed using the SPSS version 15 (Chicago IL, USA).

Results

One hundred and twenty-seven cervical spinal injured patients were treated with skull traction only within the period. However, 105 patients had complete records and were studied. The age range was between 17 and 79 years with a mean of 40.4 ± 1.1 years (95% confidence interval) [Table 1]. Patients within the age groups of 16–30, 31–45, and 46–60 were most commonly involved in 31, 36, and 20 cases, respectively [Table 1]. There were 87 males and 18 females with an M:F ratio = 4.8:1. The distribution of patients by care facility is depicted in Figure 1.

Twenty-nine patients were treated at Hilltop Hospital, 25 patients received care at Annunciation Hospital, whereas 51 patients were cared for at the UNTH. The C5 spinal segment was the most commonly involved level in 38 cases followed by the C4 segment in 27 cases and the C6 segment in 20 cases, whereas the C1/C2 segments were the least commonly involved (n = 4). The spinal injury profiles of patients treated are shown in Table 2. Among 48 patients who were treated with CTT, 1 patient had a C1/C2 injury, 4 patients sustained injury at C3, 12 patients at C4, 17 at C5, 9 at C6, and 5 at C7. For the 57 patients treated with Gardner-Wells traction, 3 patients had C1/C2 injury, 5 at C3, 15 at C4, 21 at C5, 11 at C6, and 2 at C7 level. The pretreatment Asia Impairment Scale (AIS) distribution of the patients did not differ statistically between the 2 treatment subgroups ($P = 0.57$, $t = 0.62$, $P > 0.05$) [Table 2]. The mean traction duration was 59.3 ± 3.9 days for the Crutchfield group and 51.7 ± 3.1 days for the Gardner-Well subgroup, and there was no statistically significant difference between the two subgroups $P = 0.77$, $t = 0.30$, $P > 0.05$ with respect to the duration of traction [Table 3]. The complication profile is shown in Table 4. More patients experienced complications in the Crutchfield group (n = 38) when compared with those treated with Gardner-Wells traction (n = 25) and this was statistically significant using Chi-square test ($\chi^2 = 6.5$, df = 1, $P < 0.05$) [Table 4]. Following treatment in both groups, the AIS final outcome profiles were as follows:

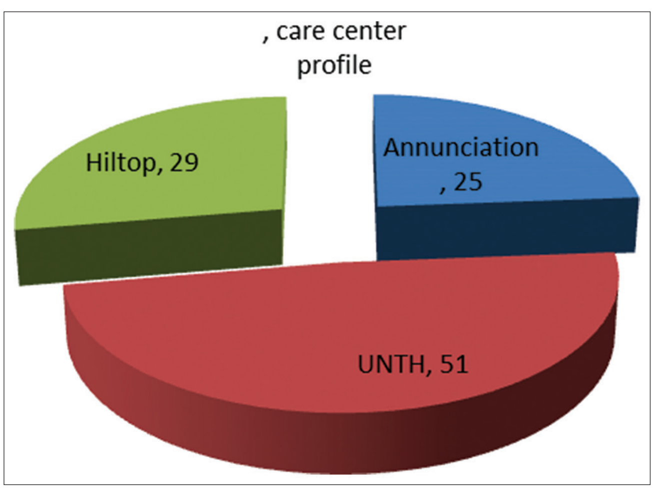

Figure 1: Care center profile

Table 1: Age distribution (years)

Age group	No (n)
1-15	3
16-30	31
31-46	36
46-60	20
61-75	11
≥76	4
Total (n)	105

Mean age: 40.4±1.1 years (95%CI), SD=5.5 years

Table 2: Cervical spine injury and traction comparative profiles

	Crutchfield traction	Gardner well traction
Institution		
Hilltop	25	4
Annunciation	0	25
UNTH	23	28
n	48	57
Spinal injury level		
C1/C2	1	3
C3	4	5
C4	12	15
C5	17	21
C6	9	11
C7	5	2
n	48	57
AIS (on admission)		
A	17	24
B	7	10
C	11	11
D	7	9
E	5	5
n	48	57
P value=0.57, t-value=0.62	P>0.05	

UNTH=University of Nigeria Teaching Hospital; AIS=ASIA Impairment Scale; ASIA=American Spinal Injury Association

Table 3: Duration of traction

Traction duration (days)	CTT	GWT
40-45	13	21
46-50	25	33
51-55	7	3
56-60	2	1
n	48	57
Mean	59.3±3.9	51.7±3.1

P=0.77, t=0.30, P>0.05. CTT=Crutchfield tong traction; GWT=Gardner wells traction

Table 4: Outcome

	CTT	GWT
AIS (outcome)		
A	12 (5 pts died)	20 (4 pts died)
B	5 (2 died)	9 (1 died)
C	3(8 improved, 5E,3D)	1 (10 improved, 7E, 3 D)
D	3 (3 from C,7 to E)	3 (3 from C,9 to E)
E	17 (5 from C, 7 from D, 5 unchanged)	21(5 from C,9 from D, 5 unchanged)
P value=0.55, t-value=0.34	$P>0.05$	
Complications		
Dislodgement	1	3
Infection	11	3
Cranial perforation	5	1
Intracranial hematoma	2	0
Failed traction	3	3
Cranial pressure ulcer	7	5
RTI	9	10
n	38	25
$\chi^2=6.5$, DF=1, $P<0.05$		
Mortality (%)	7 (14.9)	5 (8.6)
Overall series mortality=n (%)	12 (11.4%), $\chi^2=0.97$, DF=1, $P>0.05$	

CTT=Crutchfield tong traction; GWT=Gardner wells traction; AIS=ASIA Impairment Scale; ASIA=American Spinal Injury Association; RTI= Respiratoty Tract Infection

There was no improvement in all Grade A and B patients; whereas, among Grade C patients, 12 improved to E, while 6 improved to D; 10 patients of ASIA Grade D improved to Grade E whereas 6 remained the same. The AIS outcomes following treatment are shown in Table 4 ($P = 0.55$. $t = 0.34$, $P > 0.05$). There was no statistical difference in the outcome profiles between the two treatment groups The overall mortality rate in this series is 11.4% (12 patients). Seven deaths were recorded in the Crutchfield subgroup whereas 5 patients died in the Gardner-Wells group. The mortality profiles in the two groups were not statistically different based on the Chi-square test ($\chi^2 = 0.97$, df = 1, $P > 0.05$) results [Table 4]. The causes of death were respiratory complications in 8 patients (5 among the Crutchfield group, 3 among those treated with Gardner-Wells traction). Three patients died from pulmonary embolism (2 patients received CTT, 1 patient GWT). One death occurred from sepsis in a patient treated with CTT.

Discussion

Spinal traction utilizes a tensile force to achieve improved spinal alignment and stabilization.[2] Even though there are more guidelines currently available for the treatment of cervical trauma with or without spinal cord injury, there are still several controversies on the best treatment strategy.[1,11] Advocates of conservative treatment claim results comparable to those treated surgically including a low incidence of neurological deterioration as well as low rates of delayed instability.[10-12] Among those who treat conservatively with skull traction, there is also no agreement on the best traction device to use.[1,4,13] However, for every case, the type of injury and the neurological status of the patient as well as surgeon's experience are the key determinants of the most appropriate therapeutic strategy.[1]

In the application of skull traction, beyond the consideration of the patient's injury type and neurological status, other factors that influence choice of the appropriate traction device include age of the patient as many will prefer to use Halo traction in children to reduce the pullout force and allow for a lower torque applied to the pins.[1,13-15] Halo device is also considered in cases where a halo vest is to be used as definitive treatment.[1] When turning a patient's head while on traction is considered very necessary to prevent cranial pressure ulcers. Crutchfield tongs or Cone's calipers which can be fitted higher on the skull vault and allow for easier turning of the head should be preferred. GWT is, however, advocated for the ease of its application and more significantly because it offers a lower risk of skull penetration which may be associated with meningitis, intracranial hematoma, intracranial abscess as well as damage to intracranial structures. These complications are more commonly observed with the application of other traction tongs[13] as it was equally observed in our current study [Table 4]. The low risk of skull penetration observed with the application of Gardner-Wells traction is thought to result both from an inbuilt safety mechanism that limits the extent of pin penetration as well as superior pin angulation and contouring mechanism that reduces pressure at the pin cranium junction.[4,13]

In our study, once skull traction was selected as the method of treatment, the main determinant of choice of traction device is availability, and to some extent, surgeons' preference as demonstrated by the use of Crutchfield tongs in almost all the cases in Hilltop clinics and GWT in Annunciation Hospital, whereas at the UNTH, two of the devices were used almost equally. The variation in practice among the centers of study is reflective of the patterns of surgeons' choice for traction devices. In the Annunciation hospital, the traction device preferred by the contributing author is Gardner-Wells traction, whereas Crutchfield tongs were preferred by the surgeon at the Hilltop hospital. At the UNTH, both devices were used. A larger number of patients in our study were treated with GWT traction. This may be explained partly by the increased availability of new, simple, and more affordable adult cervical traction device—a locally made low-cost GWT developed in a center within our subregion[14] and also by patients/caregiver traffic flow dynamics which may have favored patient referrals to surgeons applying GWT for cervical traction. The preinjury functional impairment (AIS) was similar among the two traction subgroups indicating that the groups were comparable statistically [Table 2].

At the end of treatment in both patients treated with Crutchfield and GWT, there was an appreciable improvement of over 50% in the AIS of patients with incomplete cord injury particularly in the C and D Grades. However, the improvement was not observed in ASIA Grade A (complete cord injury) and Grade B (incomplete injury with only sensory but no motor function below the level of injury). This has shown that the more severe the initial injury (AIS A and B), the less likely the chances of any useful recovery for the spinal cord injured patient. Some previous studies have also made similar observations.[16,17]

When the outcome of the two skull traction devices were observed at the end of treatment, although the number of patients treated with GWT traction ($n = 57$) was more than those of them treated with Crutchfield tongs ($n = 48$), the difference in the AIS between the two groups was not statistically significant and therefore, did not influence the final outcome [Table 4].

However, there was an obvious difference in the rate of complications experienced by the two subgroups. Those treated with Crutchfield tongs experienced more complications, especially cranial perforation, intracranial hematoma, and infection which was statistically significant [Table 4]. Apart from differences in the rate of complications, one complication type-intracranial hematoma occurred exclusively among patients treated with Crutchfield traction. These findings agree also with the observation of other workers.[4,13]

The mortality of 11.4% recorded in our study is high when compared with no mortality recorded by Katoh and el Masry in their series in the developed world.[11] Most of the mortality, 92% is from respiratory complications; this underscores the challenges of optimally managing the serious respiratory problems associated with high cervical cord injuries.

Conclusion

Conservative treatment of cervical spine injury with skull traction is effective when appropriately applied. Its affordability, as well, has made it an important strategy for the treatment of acute injuries of the cervical spine when indicated, especially in resource-constrained developing countries. Although complication type and rate experienced by patients with cervical spine injury treated with GWT and CTT may vary between the two traction devices, we have found no significant variation in the overall functional (AIS) outcome as well as mortality rates between the two devices.

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Conflicts of interest
There are no conflicts of interest.

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