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Scalp closure without fracture elevation does not reduce the risk of infection in patients with compound depressed skull fractures

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Summary
We conducted this study in order to determine whether suturing the scalp wound prior to referral for definitive surgery reduces the rate of wound infection in patients with compound depressed skull fracture and to propose guidelines for the initial management of the wound. We conducted a retrospective analysis of 79 patients with compound depressed skull fractures treated surgically in our unit between January, 1987 and August,1998 and compared the rate of infection in patients who presented with open wounds with the rate in patients whose scalps were sutured prior to presentation to us. Adults and children were nearly equally represented in this study group. The male to female ratio was 3.6 : 1. Majority (49/79) of the fractures resulted from vehicular accidents. A total of 27 wounds were infected giving a rate of infection of 34%. Nine of the infections were present pre-operatively while the remaining 18 occurred post-operatively. Of the 52 patients with open wounds (OW) at presentation, 15 had wound infection. In the remaining 27 patients in whom the scalp had been sutured prior to referral (SW), there were 12 wound infections. There was no significant difference in the proportions of infected wounds between the two groups (X^2=1.92, $P > 0.5$). In compound depressed skull fractures, suturing the scalp laceration alone prior to referral for definitive surgery did not reduce the rate of infection of the cranial wound. We recommend haemostasis, thorough irrigation of the scalp wound and application of sterile dressings prior to transfer for definitive management, in patients who do not have immediate access to neurosurgical care. Prospective studies are required to validate these findings.

Keywords: *Scalp, skull, fracture, compound depressed, infection,*

Résumé
L' objectif est de determiner si oui on non la suture des blessures du cuir chevelu preadable a la chirurgic definitive redent la taux d'infection chez les patients ayant une fracture complexe du squelette et de proposer la lique de conduite de la gestion initiale de al blessure.Nous avons effectue une anlayse retrospective de 79 patients avec fracture complexe du squelette, traites chiourgicallement par motre equipe entre Janvier 1987 et Aout 1998, et compare le taux d'infection chez les malades qui se sont presentes avec des blessures onvertes avec le taux chez les malades dont le cuir chevelu a ete suture prealable a leur presentation dans notre centre.
Les adultes et les enfants etaient presque egalement representes dans le groupe d'etude. La proportion homme - femme etait de 3, 6 : 1. La majorite des fractures (49/79) resultait des accidents de voiture. Un total de 27 blessures ont ete infectees, soit un taux d'infection de 34%. Neuf des infections etaient presentent pre-operation alors les 18 autres sont arrivees post-operation. Sur les 52 patients aux blessures ouvertes (BO) a l'arrivee, 15 etaient infectees. Le reste des 27 patient chez qui le cuir chevelu avait ete suture prealable an refere (BS), il y avait 12 cas d'infection. Il n' yavait pas de difference significative dans la proportion des blessures infectees entre les deux groupes (X^2 = 1,92; $P > 0,0$). Dans les fractures complexe du crane, suture le cuir chevelu par laceration seulement comme chirurgie definitive n'a pas du reduire le taux d'infection des blessures craniennes. Nous recommendous l'haemostasie, irrigation immitienuse des blessures du chir chevelu et les bandages sterilises prealable au transfer pour une gestion definitive, chez les patients qui n'ont pas acces immediat au traitement neurochinurgical. Des etuoles prosepctives sont necessaires pour valider ces deconvertes.

Introduction

Compound Depressed Skull Fractures (CDSF) are cranial wounds requiring urgent debridement. They comprise 80% of all depressed skull fractures seen in our centre[1]. Infection, which can occur surprisingly early[2] is a major factor for long-term mortality and morbidity in patients with this injury[3]. The risk of intracranial sepsis is greatly reduced if the continuity of lacerated dura is restored [4] while morbidity is significantly worsened by intradural sepsis [5].

In our experience thorough, debridement of a CDSF is difficult without elevation of the depressed fragments because, beneath them can be concealed a surprising amount of foreign debris and devitalized tissues. The shortage of trained manpower required for proper management of this injury necessitates referral of most patients to specialized units quite distant from the site of rescucitation and initial care . For many patients in the developing world, initial management often consists of debridement of the scalp and closure [6]. Definitive treatment is frequently delayed. Patients may fail to present as soon as referred for further surgical treatment after closure of scalp wound, some of them thinking that fracture fragment elevation was not urgent once the scalp wound was closed. Generally therefore, there are usually two categories of patients presenting to us, both with unelevated fractures: a) patients with open wounds (OW) and patients with already sutured wounds (SW).

This unique clinical background led us to conduct a retrospective analysis of the patients with compound depressed fractures who presented to us between January 1987 and August 1996 and whose fractures were elevated. The purpose of this analysis is three-fold: a) to determine the pre- and post-operative rates of infection in these patients; b) to compare the rate between patients with open and sutured wounds and c) to propose guidelines for the initial management of the scalp wounds prior to referral.

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tion. These 8 patients were in the SW group.

Of the 63 patients who did not receive antibiotics, 6 developed infection pre-operativley, while 13 developed fresh post-operative infection.

The distribution, by pre-operative antibiotic status, of the patients with wound infection is summarized in Table 4. This distribution did not significantly differ between the two groups (X^2 with Yates's correction 0.022, $P > 0.5$).

Table 4: Distribution, by antibiotic usage, of patients with wound infection after CDSF

Infection	Antibiotics	No antibiotics	Total
Pre-op	3	6	9
Post-op	5	13	18
Total	8	19	27

X^2 (Yates's correction) =0.022, $P > 0.5$

Interval between injury and fracture elevation

The average interval between sustenance of injury and elevation of the fracture was 24days (range: 0.25-425 days,). When analyzed according to wound status, there was a striking difference in the interval between wounding and fracture elevation. The average interval in patients with sutured wounds was 57 days (range: 1-780 days), while in those with open wounds, the interval was 7 days (range: 6-31 days).

We classified patients according to the interval between injury and fracture elevation and the occurrence of wound infection (Table 5). The following are apparent from the table: most (two thirds) of the patients presented after the first 48 hours; the distribution of the interval to definitive treatment did not differ significantly between the infected and non-infected groups.

Table 5: Internal between injury and fracture elevation and wound infection in patients with CDSF

Interval to fracture elevation(days)	Infection	No Infection	Total
0-2	8	17	25
2-7	8	22	30
7-30	9	10	19
>30	2	3	5
Total	27	52	79

X^2 =1.92, $P > 0.5$

Discussion

Our results show that among Nigerians, compound depressed skull fracture is a disease of children and young adults caused by vehicular accidents and with a special predilection for males. The low incidence of missile causation reflects the relative low incidence of civilian gun shot injuries to the head in our practice setting during the period covered by the study. Unlike in East and Central Africa [6], assault was not a prominent cause of Compound depressed skull fracture.

Compound depressed skull fractures (CDSF) comprise approximately 2.5% of head injuries in our practice setting [7,8]. They however constitute an important pathologic subset because they usually result from significant trauma and are associated with a high risk of dural laceration [9], have a high yield of intracranial lesions [10,11] and therefore pose a high risk of focal neurological deficits. Fortunately, the neurologic morbidity arising from the primary brain injury runs a benign course in the vast majority of patients [1,12], provided infection does not supervene.

We have demonstrated a substantially high rate (34%) of wound sepsis in patients with this lesion. This exceeds the rate (16%) from a previously published sample from this region [1]. The wound infections were manifest in the pre- and post-operative periods respectively in a ratio of 1:2. A comparison of the interval between injury and fracture elevation in the two series suggests a clue. This interval exceeded 48 hours in a much higher proportion of patients in the present study than in the historical comparison. We have identified three levels of delay: a) delay in patient presentation to the health care system; b) delay in referral to specialized centre; c) delay in performing the definitive surgical procedure at our centre. With respect to the latter, it is important to mention that in real terms, fiscal subvention to tertiary care facilities in Nigeria over the last decade have declined [13]. The adverse impact of this decline on the delivery of surgical care has been severe.

It has been suggested that operating within 48 hours of the injury minimizes the risk of infection [3,4]. However, Curry and Frim [14] recently described a series of 7 patients with CDSF and moderate to severe head injury without mass lesion, in whom repair was deliberately delayed in order to optimize cerebral perfusion pressure. Despite the delay, there was no wound infection. This indicates that definitive treatment of a depressed skull fracture can be deferred for more urgent considerations of brain function without incurring an increased risk of infection, if the patients are placed on prophylactic antibiotics. Nevertheless, it is generally agreed that the best strategy to forestall infection is to recognize the lesion early and perform adequate debridement and dural closure (where necessary) as quickly as possible. A neglected CDSF is a principal cause of intracranial abscess [3,15].

Our study has revealed that in our patient population, CDSF is prone to neglect. There was a long time lag, about three weeks on the average, between sustenance of injury and definitive treatment. The interval was especially prolonged in patients whose wounds were sutured immediately after injury, before referral to us. It is of considerable interest that the rate of infection in this group was not significantly different from that in patients whose wounds remained open until the time of definitive treatment. This suggests that, given the tendency to long delay to definitive treatment, merely suturing the scalp wound does not confer protection against wound sepsis. It is possible that scalp wound closure, without adequate wound toiletting merely continued to incubate infective innoculum. and that the risk of infection in this group was enhanced by greater delay to definitive treatment. It is pertinent to note that patients whose wounds were immediately sutured (without fracture elevation) can be found in those presenting primarily to our centre as well as in the group referred from elsewhere.

Why was the interval to definitive surgery longer in patients with sutured wounds than in those with closed wounds? There are several empirical explanations for this: a) patients with sutured wounds often ignored advice, even after referral, believing that scalp closure was sufficient and that additional surgery was unnecessary; b) some referring doctors closed wounds in the expectation this measure would protect the patients, especially those far from this centre, from infection, in the interlude to surgery; c) and finally, in some cases, the depressed skull fractures was simply not recognised before the scalp was sutured. Clinical diagnosis of

Patients and methods

The hospital records of patients who underwent debridement and elevation of compound depressed skull fractures during the period between January 1987 and August 1996 were examined. Our practice during the study period was to discard fracture fragments if any of the following factors was present: wound older than 48 hours; gross wound contamination and; clinical evidence of infection.

The age, sex, cause of injury, location of fracture on the head and neurological status for each patient were recorded. In addition, the status of the wound (OW vs SW) and presence or otherwise of wound infection pre-operatively were noted. Finally, post-operative infective complications were noted. These were evaluated clinically by presence of wound hyperaemia, seropurulent discharge and evidence of intracranial suppuration and confirmed by ancillary laboratory tests. Between 1987 and 1990, radiological assessment of head injury was by means of skull-Xrays and cerebral angiography. Between 1990 and 1996, the patients were also assessed with computerized tomography of the brain. The duration of follow-up was 19-42 months.

We compared the rate of infection in patients who presented with open wounds with the rate in patients whose scalps were sutured prior to presentation to us. We applied X^2 tests(with Yates correction) and accepted a p value less than 0.05 as significant.

Results

Age, sex and causes

There were 79 patients in this series 62 (78%) of whom were males (Table 1a). Children were as nearly equally represented as adults. Thirty four (43%) of the patients were in the paediatric age group, defined in this study as 15 years of age and below. The remaining 45 patients (57%) were aged over 15 years. In this adult group, there was a pronounced male predominance (42/45, 93%).

Table 1a: Sex and age group distribution of patients with CDSF

Sex	<15yrs	>15yrs	Total (%)
Male	20	42	62
Female	14	3	17
Total	34	45	79

The frequency of compound depressed skull fractures diminished with age (Table 1b). Most (62/79) of the patients were in the first three decades of life. The frequency was low (1/79) after the fifth decade. The fractures were caused by vehicular accidents in 49 patients, assaults in 18, missiles in 8 and falls and sports in 2. The frontal and parietal bones were involved in 73(92%) of the patients.

Table 1b: Distribution, by age, of patients with CDSF

Age (years)	no. of patients	%
0-10	24	30.4
11-20	16	20.3
21-30	22	27.8
30-40	13	1606
41-50	3	3.8
51-60	0	0
61-70	1	1.2
>70	0	0
Total	79	100

Wound status and wound infection

In 27 patients, the scalp wounds were sutured prior to presentation to us (SW group). The remaining 52 patients had open wounds on arrival (OW group). As shown in table 2, there were more sutured wounds among referred patients than those who presented primarily to our centre (17/31 vs 10/48; X^2=8.23, $0.01>P>0.001$). The latter received initial care from the medical officer at the emergency room.

Table 2: Wound status and mode of presentation

Wound Status	Primary Presentation	Referral	Total
Sutured Wound	10	17	27
Open Wound	38	14	52
Total	48	31	79

X^2 (Yates correction) =8.23, $0.01 > P > 0.001$Table 3

A total of twenty seven patients (34%) developed wound infection. The infection was evident in 9 (11%) of these patients before elevation of the fracture but occurred post operatively in the remaining 18 (23%). The pre-operative infections were restricted to the extracranial space in all the 9 affected patients. Of the 18 patients with fresh post-operative infection, it was restricted to the extracranial space in 15. Two patients had meningitis and the remainder osteomyelitis. The rate of intracranial infective complication was 11%.

The distribution by wound groups, SW and OW, of patients with and without wound infection is summarized in table 3a. This distribution did not significantly differ between the two groups (X^2 with Yates's correction 1.29, $P>0.5$). Furthermore, the distribution of pre- and post-operative wound infections also did not significantly differ between patients with sutured and open wounds(X^2 =0.168, $P>0.5$; Table 3b)

Table 3a: Distribution, by wound status, of patients with and without wound infection following CDSF

Infection	Sutured Wound	Open Wound	Total
Present	12	15	27
Absent	15	37	52
Total	27	52	79

X^2 (Yates's correction) =1.92, $P > 0.5$

Table 3b: Distribution, by wound status, of pre- and post-operative infection in patients with CDSF

Infection	Sutured wound	Open wound	Total
+0.			
re-op	5	4	9
Post-op	7	11	18
Total	12	15	27

X^2 (Yates correction) = 0.168, $P > 0.5$

Antibiotic use and wound infection

A total of 16 patients received antibiotics prior to presentation. In three of these patients, there was an established infection prior to elevation of the depressed fracture fragments while 5 more patients developed fresh infections post-eleva-

CDSF is possible in 70% of cases [16] . The addition of plain radiographs with tangential views should increase the diagnostic yield and the use of computer tomography should ensure the detection of all cases provided the gantry is positioned to permit a view of the vertex and the attention is paid to the lateral scout film [17].

There are advocates for the use of prophylactic antibiotics as a measure for reducing infections in patients with CDSF. Kolodziejczyk and Hirsch [18] for example have proposed the intraoperative placement of an antibiotic-impregnated epidural implant, while Wylen, Willis and Nanda [19] have stated that immediate bone replacement (within 72 hours) is possible with the use of antibiotics.

It is instructive that all the patients in our study who received antibiotics prior to presentation and also developed wound infection were in the SW category and that the use of antibiotics did not confer an advantage towards prevention of wound infection in our sample of patients with CDSF (Table 4). This underscores the primacy of adequate wound toiletting in the prevention of wound infection in patients with CDSF.

Our study has revealed that in our patients with CDSF, definitive treatment, which is the only guarantee of adequate debridement, is commonly delayed and that the use of antibiotics and simple scalp closure did not reduce the rate of wound infection. Our data suggests that simple scalp closure is a risk factor for delay to definitive treatment. Therefore, we recommend the application of a sterile dressing, rather than sutures to the scalp wound, in patients with suspected compound depressed skull fractures who are not likely to have immediate access to definitive care.

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