Original article

Outcome of fixation surgery in traumatic cervical injuries

Resultado de la cirugía de fijación en lesiones cervicales traumáticas

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ABSTRACT

Introduction: In a context of limited resources, the surgical treatment of traumatic cervical injuries is demanding.

Objective: To describe the initial experience of decompression and stabilization surgery in traumatic cervical injuries, in a single Nigerien hospital.

Methods: A retrospective observational study was conducted. All patients admitted with traumatic cervical injuries from September 2022 to March 2023, at *Hôpital de Référence de Maradi*, Niger, were included. A non-random,

intentional sampling was used, through inclusion and exclusion criteria.

Results: Eleven cases were included. Automobile accidents represented the cause in 72.7 %. Five patients presented ASIA A and three ASIA B. Nine cases (81.8 %) showed type C fractures. The average time from admission and imaging diagnosis was 22 hours. The most injured anatomical level was C5-6 (63.6 %). The time from diagnosis and surgery averaged 11 days. All cases were operated using a single anterior approach. Only four patients did not show complications during their hospital stay. Five patients (45.4 %) received follow-up.

Conclusions: Surgical treatment of cervical fractures can be by a single anterior approach in scenarios with limited resources. Late surgery, due to logistical causes, showed higher incidence of hospital complications. Loss of follow-up makes it difficult to obtain data on the post-surgical evolution.

Keywords: spinal trauma; subaxial cervical fracture; surgical treatment; fixation; low-income countries.

RESUMEN

Introducción: En un contexto de recursos limitados, el tratamiento quirúrgico de las lesiones cervicales traumáticas es demandante.

Objetivo: Describir la experiencia inicial de la cirugía de descompresión y estabilización en lesiones cervicales traumáticas, en un centro hospitalario nigerino.

Métodos: Se realizó un estudio observacional retrospectivo. Se incluyeron todos los pacientes ingresados con lesiones cervicales traumáticas entre septiembre de 2022 y marzo de 2023, en el *Hôpital de Référence de Maradi,* Niger. Se utilizó un muestreo no aleatorio, intencional, a través de criterios de inclusión y exclusión.

Resultados: Se incluyeron 11 casos. Los accidentes automovilísticos representaron la causa en el 72,7 %. Cinco pacientes presentaron ASIA A y tres ASIA B. Nueve casos (81,8 %) mostraron fracturas tipo C. El tiempo promedio entre la admisión y la realización del diagnóstico imagenológico fue de 22 horas. El nivel anatómico más lesionado resultó C5-6 (63,6 %). Promediaron 11 días entre el diagnóstico y la cirugía. Todos los casos se operaron por vía anterior única. Cuatro pacientes no mostraron complicaciones durante su

estadía hospitalaria y cinco recibieron seguimiento.

Conclusiones: El tratamiento quirúrgico de las fracturas cervicales puede ser por vía anterior única en escenarios con recursos limitados. La cirugía tardía, por motivo de causas logísticas, mostró una mayor incidencia de complicaciones hospitalarias. La pérdida de seguimiento dificulta la obtención de datos sobre la evolución posquirúrgica.

Palabras clave: trauma espinal; fractura cervical subaxial; tratamiento quirúrgico; fijación; países de bajos ingresos.

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Introduction

Traumatic cervical injuries often result in permanent disability or death. They have a high physical, emotional and economic cost for the people affected, their families and society.[1]

Some authors from developing countries have recommended non-surgical treatment for tetraplegic patients resulting from traumatic cervical injuries, due to the higher incidence of complications and mortality.[2,3,4] However, these results have not been replicated uniformly in other locations.[5,6,7,8] For this reason, up to now there is no consensus on the management of this group in low-resource settings.

Surgical decompression and stabilization can limit complications and facilitate early rehabilitation, and is a common practice in first world countries.[9] Outcomes after traumatic spinal injury are significantly better in these countries than in non-first world nations, due to the availability of resources and infrastructure for pre-hospital management, treatment, and long-term support for patients with disabilities.[10,11,12] Developing countries have limited resources, which make it difficult to apply the clinical practice guidelines, prepared mostly for contexts with greater availability.[13]

Establishing adequate strategies for prevention and organization of health services by local governments requires having information on the behavior of this entity. However, scientific publication is scarce in low-income countries, where it is estimated, however, that the highest proportion of traumatic spinal cord injuries occurs.[14,15] In addition, recent epidemiological studies show that these countries have the highest rates of mortality per year.[12,15]

There is very little in the literature on the management of patients with cervical fractures in Niger, a French-speaking nation in North Africa with more than 20 million inhabitants. For the most part, the cases were handled conservatively throughout the country, except in the capital. The surgical approach to this type of injury in other urban centers was anecdotal. The management of spinal trauma in the Maradi region underwent a change with the arrival of two neurosurgeons, interested in providing surgical treatment as soon as possible to these patients. The service began operating in July 2022. The patients in this report were operated on consecutively, starting in September of that year.

Based on the existing need, the initial experience of decompression and stabilization surgery in traumatic cervical injuries, at the *Hôpital de Référence de Maradi*, Niger, in sub-Saharan Africa, is described.

Methods

A retrospective observational study was conducted. All patients admitted with traumatic cervical injuries in the period from September 2022 to March 2023, at the *Hôpital de Référence de Maradi*, were included. A non-random, intentional sampling was used, through inclusion and exclusion criteria.

Inclusion criteria:

- Operated for unstable traumatic cervical lesions.
- Consent to participate in the study.

Exclusion criteria:

- Patients whose medical records were not accessed.

The variables recorded were sex, age, time elapsed from the trauma to hospital admission, type of fracture according to the AO classification, neurological evaluation and the American Spinal Injury Association (ASIA) Impairment Scale on admission, time elapsed between admission and diagnostic imaging, and lesion level. The time elapsed between diagnostic imaging and fixation and decompression surgery, surgical technique, in-hospital complications, and follow-up time were also collected.

The information was obtained from medical records. Data were obtained with prior informed consent from the patients, or if not possible, from their relatives at the time of admission. The Ethics Committee of the institution issued the approval of the study. Ethical principles were complied with in accordance with the provisions of the Declaration of Helsinki.

Description of procedures

Patients with suspected traumatic cervical injuries underwent computed tomography of the cervical spine, to confirm the level of injury. If this was not possible, conventional radiographs were taken. Magnetic resonance imaging is not available at our center. The promptness of performing the imaging tests depended on the stability of the patient and the payment of their cost.

Surgical treatment was scheduled as soon as possible depending on the clinical situation of the patient, cost and the availability of personnel anesthetic and implants. All patients received steroid treatment in the first 48-72 hours (according to the institution's protocol) and antithrombotic prophylaxis with Enoxaparin (Lovenox). In the case of not being able to afford low molecular weight heparin, ASA (usual dose antiplatelet agent) was used, because unfractionated sodium heparin is not available. A prophylactic antibiotic scheme with second-generation cephalosporins was used during anesthesia and 24 hours later. Decompression and fixation surgery was performed using a conventional anterior approach. Posterior instrumentation systems, despite being available, have a much higher cost, which is why they were taken into account when selecting the approach.

Cervical traction was not used prior to or during surgery. In all cases except the first, fluoroscopic support was used. After the discectomy, muscle relaxants were administered to facilitate manual manipulation and vertebral

alignment. Discectomies and/or corporectomies were performed with rongeurs and curettes. No microscope or drill was used. Once decompression was achieved, the autologous tricortical graft from the iliac crest was extracted, shaped, and placed in the interbody position. The anterior cervical plate was then positioned with 18 mm titanium screws. Fluoroscopic control was performed at the end of surgery; for economic reasons, post-surgical serial controls were not performed. The patients were discharged after 48 hours in the absence of complications, and were scheduled for consultation after 15 and 30 days.

Results

A total of 14 cases were operated, but only 11 patients' medical records were accessed, which are presented consecutively in table. There was a predominance of males with seven cases. Automobile accidents were the cause in 72.7 %, and in only three patients the history of falls from height was collected. Only four cases (36.4 %) were admitted to the emergency department with cervical immobilization (in all of them rudimentary alternatives). Three patients were transferred within 8 hours of the trauma, and one case was collected that was initially managed non-surgically at another institution (case 11 in table), and presented late.

Five patients presented ASIA A and three ASIA B, together representing 72.7 % of the sample. In three cases the diagnosis was made using conventional radiographs, in one of them the initial CT showed no alterations, but in the presence of neurological deficit, the dynamic radiographs showed translation of more than 25% at the C7-T1 level (case 5 of table). In the rest, multi-slice CT was performed with reconstructions in the three planes.

Joint dislocations (type C of the AO Classification) represented 81.8 % of the sample, with nine cases. The average time between admission and diagnostic imaging was 22 hours. The most injured anatomical level was C5-6 (63.6 %). The time between diagnosis and surgery averaged 11 days. Seven corporectomies were performed (63.6 % of the cases), in those patients who exhibited vertebral body fracture associated with listhesis (figs. 1 and 2), in the rest discectomy was performed (fig. 3), both techniques followed by fusion. In all cases, the screws used were 18 mm, reaching the posterior vertebral line in

only three (fig. 2), so that in 72.7 % the fixation achieved was monocortical. The graft did not receive fixation (fig. 1), using only four screws for the plate exclusively, for economic reasons.

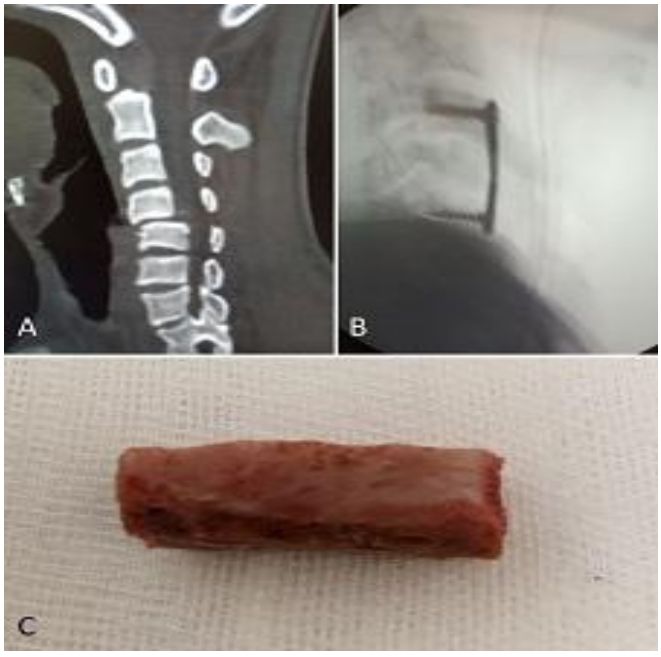

Fig. 1 - A) C4/5 dislocation in CT in sagittal reconstruction. B) Fluoroscopic control at the end of surgery (C5 corporectomy and fixation with plate and C4-6 screws). C) Autologous graft extracted from the iliac crest, modeled, and ready for interbody placement. No screws are placed in the graft; only plate screws are available for economic reasons.

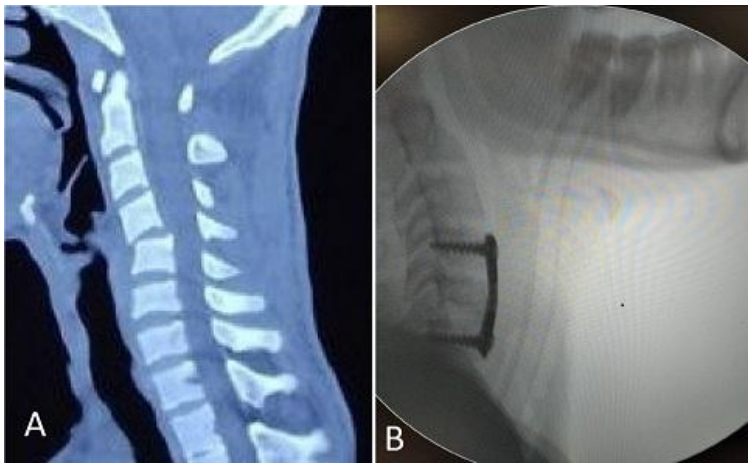

Fig. 2 - A) C4/5 dislocation in CT in sagittal reconstruction. B) Fluoroscopic control at the end of surgery (C5 corporectomy and fixation with plate and C4-6 screws). The screws reach the posterior vertebral line, achieving bicortical instrumentation.

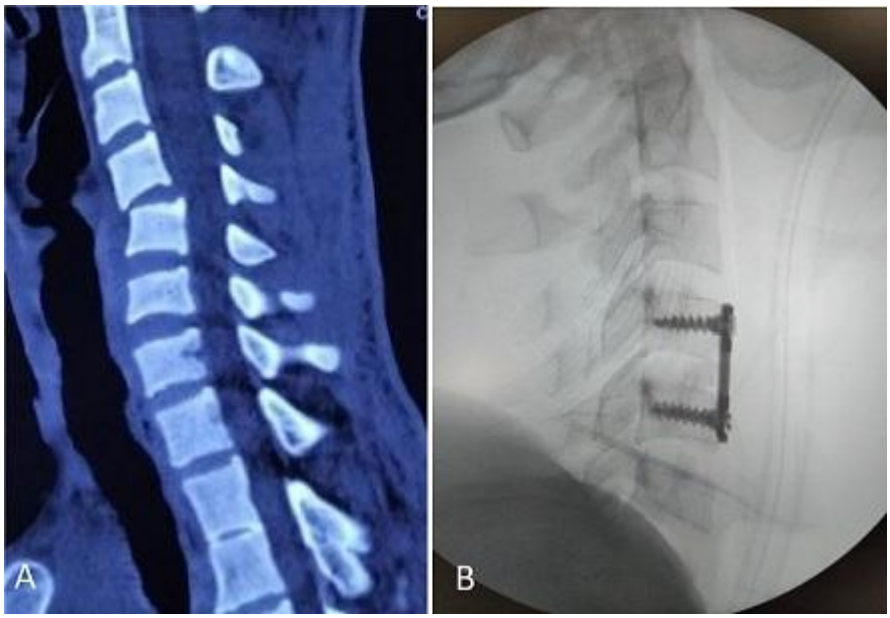

Fig. 3 - A) C4/5 dislocation in CT in sagittal reconstruction. B) Fluoroscopic control at the end of surgery (C5 discectomy, interbody autologous graft and fixation with C4-5 plate and screws).

Four patients showed no complications during their hospital stay. Five cases (45.4 %) received follow-up at discharge. The rest did not go back for consultation after discharge. Two deaths were recorded (cases 8 and 10 in table), the first of them institutional, associated with severe post-surgical respiratory distress. The second case was reported by the family by telephone. None of the deaths was directly related to the surgical technique.

Table - Characteristics of patients operated for subaxial cervical fractures

Case	Age/ Sex	Trauma-hospital time (hours)	AO	Neurological evaluation on admission	AS	Anatom. level of injury	CT/Rx-surgery time (days)	Surgical technique	Complications during admission	Follow up time (days)
1	62/ M	6	C	complete sensory-motor deficit at level C5. bradycardia	A	C4-5	6	ACDF C5-6	pressure ulcer bacterial pneumonia	-
2	42/ M	9	C	priapism Complete	A	C5-6	5	ACCF C6	-	30

				sensory-motor deficit at level C6						
3	12/F	12	C	brachial dysparesis flaccid paraplegia preserved proprioceptive sensation	B	C5-6	19	ACCF C5-6	paralytic ileus	-
4	20/ M	18	C	complete sensory-motor deficit at level C5	A	C5-6	12	ACDF C5-6	anemia	24
5	50/ M	19	C	partial sensory-motor deficit at level C4		C7-T1	8	ACDF C7-T1	pneumonia	36
6	33/F	35	C	brachial dysparesis flaccid paraplegia	B	C4-5	10	ACDF C4-5	-	-
7	38/F	7	C	pyramidalism left hemiplegia	C	C5-6	5	ACCF C5-6	-	-
8	31/ M	3	C	complete sensory-motor deficit at level C5.	A	C5-7	10	ACCF C6-7	paralytic ileus pneumonia pulmonary embolism	13 days (deceased)
9	35/ M	15	F 3	brachial monoparesis flaccid paraplegia hypoesthesia C7	C	C6	4	ACCF C5-7	-	-
10	18/F	20	A 4	complete sensory-motor deficit at level C5	A	C5	32	ACCF C5	pressure ulcer hemothorax pneumonia pulmonary embolism	28 days (deceased)
11	25/ M	82 days	C	complete sensory-motor deficit at level C5	B	C4-5	14	ACCF C5	pressure ulcer pneumonia pulmonary embolism anemia	-

Legend: AS: Asia Scale; ACCF: anterior cervical corporectomy and fusion; ACDF: anterior cervical discectomy and fusion.

Discussion

Cervical fractures are generally the result of high-impact accidents and are mostly associated with spinal cord injuries.[16] This study represents the first report of surgery for cervical fractures in Niger. In our series, traffic accidents were the most frequent cause; second falls. This is understandable given the high number of motorcycles on the road, and the absence of road regulations. In addition, the use of a protective helmet for motorcyclists is not mandatory in the Maradi region.

There are multiple surgical techniques used in cervical spinal cord decompression. These include corporectomy, laminectomy with or without instrumentation, as well as a combination of both, followed by anterior and posterior fixation (circumferential approach or 360 degrees).[17] It is generally accepted that most subaxial cervical segment fractures are tributaries to surgical treatment by anterior approach.[6,16,18,19,20] The feasibility of the single anterior approach in a context of low resources, for the correction of alignment, decompression and fusion of the subaxial cervical spine, has been demonstrated in previous reports by *Horta-Tamayo* et al.[20]

The duration of spinal cord compression prior to surgery has a prognostic factor.[21] Current guidelines recommend that all cervical fractures be stabilized within 24-48 hours, with the exception of clinically unstable patients, in the interest of to reduce complications and achieve better clinical results and improve quality of life.[9,16,21,22] These recommendations are difficult to adapt to the African context.[10,13,23]

On the other hand, *Liu* et al.[4] postulated that delayed surgery has paradoxically better results due to the higher mortality rate observed in early surgery in his series. However, it must be taken into account that patients with concomitant injuries subsequently aggravated may receive early spinal surgery and then influence the analysis of overall mortality. In addition, as has been exposed by some authors, in a disadvantaged context, this group of cases generally dies in the field before going to hospital centers, or in the first hours[13,23], so that more stable patients can receive late surgery.

Other researchers in the region have not found statistically significant differences between early and late surgery.[2]

Retrospective studies have found that although complete sensorimotor injuries negatively influence neurologic recovery, early surgical decompression (< 24 h) appears to be independently associated with greater neurologic recovery in patients with traumatic spinal cord injury regardless of level and severity of the lesion.[9]

In a recent article, *Lee* and *Jeong*[21] state that early decompression has been associated with superior sensorimotor recovery in patients with acute spinal cord injury. In addition, early decompression has shown good clinical results in subpopulation analysis according to the degree of spinal cord injury and whether or not steroids were used before surgery.

Some researchers have come to propose conservative treatment in patients with complete lesions, prioritizing scarce resources towards patients with a better recovery prognosis.[2,3] However, the scenario throughout the continent is not homogeneous, and the recommendation it can be accurate only in a context totally absent from post-operative care. The same authors have recognized the influence of access to rehabilitation services on the survival of this group of patients.[2] On the other hand, spinal surgeons in training also benefit from maintaining a less restrictive surgical attitude with this group of cases.[3]

Unfortunately, all of the patients presented underwent late surgery. The reason for this is that our center is the only one in the west of the country with facilities for spinal surgery, added to the low availability of implants and their high cost. The cervical plates and screws must be requested from private agents in Niamey, the country's capital, more than 600 kilometers away. There is also a shortage of anesthetic personnel and supplies. All these factors threaten early surgical intervention. Other researchers on the continent have published very similar average times between the accident and the surgery.[2,5,7,19,24] Despite the small sample, it should be noted that those cases with longer stays presented greater number of complications.

However, there are optimistic reports showing good clinical results even when decompression is performed > 72 hours post-injury.[7,19,25] In Nigeria, a neighboring country, a neurological improvement was reported in 25.7 % of the patients who underwent surgery, where 48.6 % (17 patients) of the cases presented complete neurological lesion (ASIA A).[5] Other authors in the area show neurological recovery rates of 16 %.[2]

In our series, most of the patients presented a complete neurological lesion

(ASIA A), representing 45.5 %, which contrasts with other latitudes and with countries with greater resources.[9] We consider that these results are related to the precarious conditions of the transfer, which results in secondary injuries or worsening of the primary ones. It was impossible in our case to analyze this variable, due to a high loss of follow-up and the short observation period. In our hospital, consultations are not free, perhaps this influences the fact that many relatives do not consider the transfer of a disabled patient useful only for their postoperative evaluation. Despite having made efforts in telemedicine and obtaining a contact telephone number upon admission, rural areas often lack mobile coverage. In addition, the high telephone rate in the region is added. Other investigators have presented similar reports of loss to follow-up.[5,19,24]

Post-surgical complications in our study were more frequent in patients with complete neurological lesions, which coincides with other authors.[2] The two deceased in the serie showed ASIA A on admission.

The fundamental limitations of the present study were: the short observation period and the high loss of follow-up, together with the absence of serial radiological studies due to their high cost.

In conclusion, the surgical treatment of cervical fractures can be performed by a single anterior approach, in settings with limited resources. Late surgery showed a higher incidence of in-hospital complications. Loss of follow-up makes it difficult to obtain data on the post-surgical evolution of this group of patients, and prevents the development of clear recommendations for low-income regions.

We believe that the need to modify road regulations by local governments is evident, specifically the mandatory use of protective helmets for motorcyclists. Changes in the health infrastructure, with timely care at the accident site, adequate transport of these patients and greater availability of implants, require not only will and local initiatives but also international financial support.

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Conflict of interests

The authors deny any conflict of interest.

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