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Management of Spinal Injuries Secondary to Rockfall in Traditional Mines

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Abstract

Introduction: Spinal injuries represent the whole of the mechanisms responsible for vertebral, disco-ligamentary and spinal cord injuries. Spinal cord injury is life-threatening and is responsible for functional consequences that make the subsequent socio-economic integration of victims difficult. In developing countries, spinal injuries in traditional gold mining are becoming more and more frequent. Purpose: The purpose of this study was to describe the anatomopathological aspects and the results of surgical treatment of spinal injuries secondary to traditional mine collapses at the University Hospital of Kati. Patients and Methods: This was a prospective, descriptive study over 18 months, from November 2017 to May 2019. Included in this study were patients operated on for spinal trauma secondary to rockfall in traditional mines. The neurological status was assessed in each patient since admission to the department using the Fränkel score. Decompression by laminectomy combined with titanium device placement was preferred in lumbar, thoracic and thoraco-lumbar surgery. We performed an anterior cervical spine approach with SENEGAS plate placement in cervical injuries. Motor physiotherapy was associated whenever recovery was not complete. At a minimum follow-up of 6 months, all our patients were re-evaluated by the Fränkel score. Results: The mean age was 31 years with extremes of 10 and 49 years. The majority of patients were men, 95%. Twenty patients underwent surgery. According to the spinal segments, the cervical spine was affected in 05 cases, the thoracic spine in 08 cases and the lumbar spine in 17 cases. The neurological examination revealed tetraplegia (n = 5), paraplegia (n = 12) and paraparesis (n = 3). According to the types of lesions, we collected 12 cases of fractures, 4 cases of fracture-luxations and 04 cases of pure luxations. According to the site, the fracture was uni-articular (n = 3), corporal (n = 15)

and transverse apophyseal (n = 1). According to the type of line, the fracture was simple (n = 6), with compression (n = 11) and comminuted (n = 2). The dislocation was anterior in all 08 cases. The spinal cord injuries were concussion (n = 3), contusion (n = 6) and transection (n = 11). Sphincter disorders such as leakage or retention of urine were present in all our patients. At a minimum follow-up of 6 months, all our patients classified as Fränkel D and C had a complete motor recovery. Of the 5 patients classified as Fränkel B, 2 had complete motor recovery and one had partial recovery. Of 12 patients classified as Fränkel A, one patient had partial recovery. Conclusion: The severity of the neurological lesions in spinal injuries due to rockfalls in traditional gold mining is certain. These traumas are of high velocity and provide extensive spinal cord injuries. The dorsolumbar hinge is the most affected segment. Fractures of the first lumbar vertebra and the twelfth thoracic vertebra are the most frequent. Settling fractures are by far the most frequent fracture types. T12-L1 dislocation is the most frequent. Early osteosynthesis by spinal stabilization after reduction improves the Fränkel score. This study shows the need for public awareness of the dangers of traditional gold panning.

Keywords

Trauma, Spine, Traditional Gold Mining, Mali

1. Introduction

Spinal injuries include vertebral, disco-ligamentary and spinal cord injuries [1]. Spinal cord injury is life threatening and is responsible for functional consequences that make the subsequent socio-economic integration of victims difficult [2]. The young and active population is the most exposed to spinal injuries [3]. In France, the incidence of spinal cord injuries is about 2000 cases per year, often affecting men, thus generating a real public health impact [4]. Public road accidents are the most frequent circumstances for the occurrence of spinal injuries [5] [6] [7]. In developing countries such as Mali, spinal injuries in traditional gold mining are becoming more and more frequent [8]. In Mali, most of the studies carried out in the field of traumatic spinal injuries are generally faced with therapeutic difficulties [9] [10]. The management of this pathology is multidisciplinary and involves intensive care anesthetists, emergency physicians, surgeons and rehabilitation physicians. The aim of this work was to describe the anatomopathological aspects and the results of the surgical treatment of spinal trauma secondary to traditional mine collapses in our department.

2. Patients and Method

This study was carried out in the neurosurgery department of the BSS University Hospital in Kati. This was a prospective, descriptive study over 18 months, from November 2017 to May 2019. Included in this study were patients operated on

for spinal trauma secondary to rockfall in traditional mines. Patients with less than one year of follow-up and patients lost to follow-up were not included in this study. Neurological status was assessed in each patient since admission to the ward using Fränkel scores. On arrival at the hospital, there were twelve cases of Fränkel A, five cases of Fränkel B, and three cases of Fränkel C. pre- and postoperative sensitivomotor function and discharge were specified for each patient. Decompression by laminectomy combined with titanium device placement was preferred in lumbar, thoracic and thoraco-lumbar surgery (**Figure 1**). We performed an anterior cervical spine approach with SENEGAS plate placement in cervical injuries. Motor physiotherapy was associated whenever recovery was not complete. At a minimum follow-up of 6 months, all our patients were re-evaluated by the Fränkel score. The patients' files were exploited. Data were collected on individual survey sheets and then entered and analyzed on Microsoft Word 2016 and SPSS version 25 software.

3. Results

We collected 120 cases of trauma of the spine for all causes. We recorded 23 cases of trauma related to the collapse of traditional mines, *i.e.* 19.16% (**Figure 2**). Surgical management concerned 20 patients, *i.e.* 86.9% of cases. The majority of patients were between 20 and 40 years of age (34.8%). The average age was 31 years with extremes of 10 and 49 years. The majority of patients were male, 95%. The clinical examination revealed tetraplegia (n = 5), paraplegia (n = 12) and paraparesis (n = 3). The sphincter disorder by urinary retention was present in all our patients. According to the spinal segments, the cervical spine was affected in 05 cases, the thoracic spine in 08 cases and the lumbar spine in 17 cases. According to the types of lesions, we collected 12 cases of fractures, 04 cases of fracture-luxations and 04 cases of pure luxations. The lesions per vertebra are summarized in **Figure 2**. According to the site, the fracture was uni-articular (n = 3), corporal (n = 15) and transverse apophyseal (n = 1). According to the type of line, the fracture was simple (n = 6), with compression (n = 11) (**Figure 3**) and comminuted (n = 2). The dislocation was anterior in all 08 cases. The spinal cord injuries were concussion (n = 3), contusion (n = 6) and transection (n = 11). Sphincter disorders such as leakage or retention of urine were present in all

Figure 1. Placement of stems.

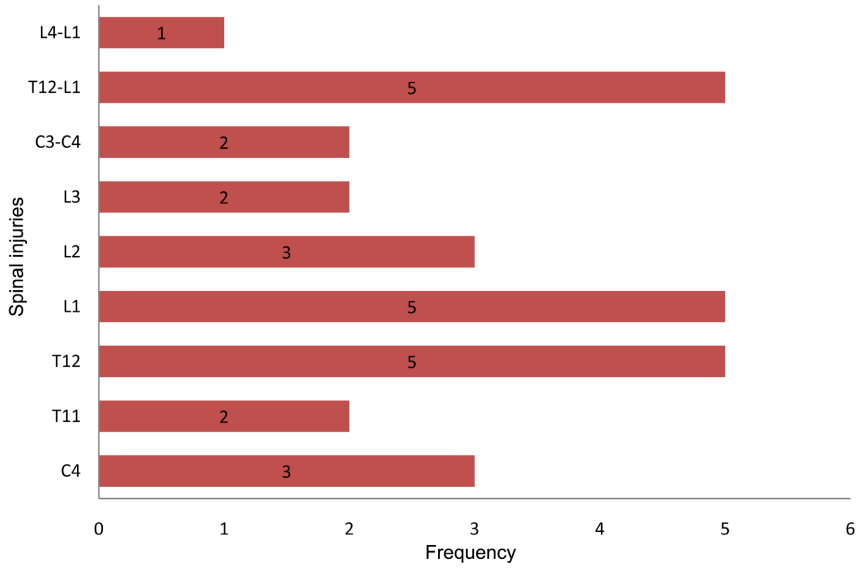

Figure 2. Spinal injuries (fractures and dislocations).

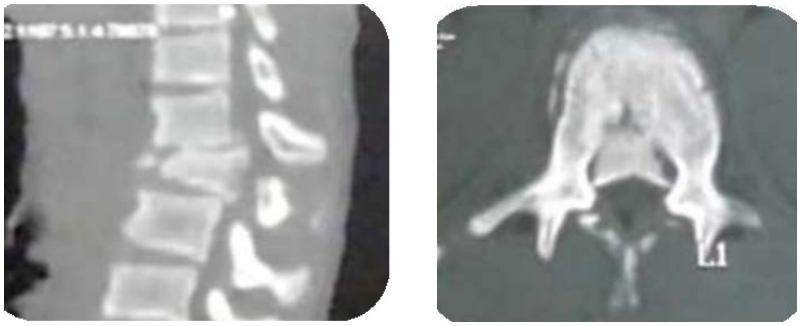

Figure 3. L1 compression fracture.

our patients. Disturbance of tactile sensitivity was noted in 20 patients, proprioceptive sensitivity in 18 patients. Osteo-tendon reflexes were abolished in 12 patients. Associated lesions were represented by femur fractures (n = 4), leg fracture (n = 1), arm fracture (n = 1) and abdominal contusion (n = 1). Postoperative complications were pressure sores (n = 5), debrication of the osteosynthesis material (n = 2) and death (n = 2). At the minimum 6-month follow-up, the Fränkel A score was (n = 10), Fränkel B (n = 2), Fränkel C (n = 1), Fränkel D (n = 3) and Fränkel E (n = 4). The distribution of patients according to Fränkel score in pre and late postoperative is summarized in **Table 1**. At the last recoil, all our patients classified as Fränkel D and C were able to recover completely. Of the 5 patients classified as Fränkel B, 2 had complete recovery and 1 had partial recovery. Of the 12 patients classified as Fränkel A, one patient had a partial recovery.

4. Discussion

Trauma to the spine in traditional gold mining operations is becoming increasingly frequent in developing countries [8]. The injuries caused by these traumas

Table 1. Distribution of patients according to the Fränkel score pre and postoperative.

Fränkel Preoperative	Number (n)	Fränkel Late postoperative	Number (n)
Fränkel A: sensory-motor deficit complete	12	A	10
Fränkel B: complete motor deficit presence of some sensory functions	5	B	2
Fränkel C: presence of some motor functions motor functions present and unusable	3	C	1
Fränkel D: Motor function present and usable, walking with assistance	0	D	3
Fränkel E: No sensory and sphincter disorders sphincter	0	E	4
Total	20	Total	20

are diverse, ranging from a simple fracture to a real spinal cord section. These traumas almost exclusively concern men. Only one woman was present in our sample. A male predominance with a rate of 97% and 100% have been reported [11] [12]. The socio-economic consequences of these injuries are enormous, as the youngest segment of the population is the most affected. The most affected age group in our study was 20 to 40 years. This observation has been made by several authors [11] [13]. According to the level of injury, the lumbar spine was most frequently affected in our series (56.6%), followed by the thoracic spine (26.6%). This high frequency of lumbar and dorsal injuries is explained by the position in which the victims were at the time of the trauma. Mangané M *et al.* [14] noted a predominance of back injuries. In traumas of the spine caused by traditional gold mining, the severity of neurological lesions has been reported by several authors [15] [16]. The majority of our patients (60%) had a Fränkel A score where sensitivomotor paralysis was total. The dorsolumbar hinge was the most exposed area (53.6%). This is explained by the fact that spinal trauma classically involves two segments that are more fragile because they are more mobile: the dorsolumbar hinge and the cervical-dorsal hinge. Settling fractures were by far the most frequent fracture types. This can be explained by the compression mechanism of injury, which is frequently seen in traditional mine collapses. We noted 11 cases of medullary section, *i.e.* 55% of cases. All our patients received corticosteroid therapy, rehydration with 0.9% saline, low molecular weight heparin and analgesics. The effectiveness of corticosteroid therapy in spinal cord injury is debatable: beneficial for some [17], ineffective or even harmful for others [18]. The approach was posterior in 17 cases (85%) and anterior in 3 cases (15%). The anterior approach concerned only the cervical spine. Laminectomy combined with titanium rod osteosynthesis for thoracolumbar lesions was performed in 17 cases (85%). Dissectomy followed by arthrodesis and fixation with a Senegas-type plate was performed in 3 cases, *i.e.* 15% of cases. Postoperative complications included pressure sores, debriculation of the osteosynthesis ma-

terial and death. At the end of our study, all our patients classified as Fränkel D and C were able to make a full recovery. Of the 5 patients classified as Fränkel B, 2 recovered fully and 1 partially. Of 12 patients classified as Fränkel A, one patient recovered partially. Mangané M *et al.* [8] made the same finding in a similar study.

5. Conclusion

The severity of neurological lesions in spinal injuries due to rockfalls in traditional gold mining is certain. These traumas are of high velocity and provide extensive spinal cord injuries. The dorsolumbar hinge is the most affected segment. Fractures of the first lumbar vertebra and the twelfth thoracic vertebra are the most frequent. Settling fractures are by far the most frequent fracture types. T12-L1 dislocation is the most frequent. Early osteosynthesis by spinal stabilization after reduction improves the Fränkel score. In this study, the need for public awareness of the dangers of traditional gold panning and professionalization of this informal sector emerged.

Conflicts of Interest

The authors declare no conflict of interest regarding the publication of this article.

References

[1] Christophe, P. (1990) Traumatismes du rachis diagnostique évolution et pronostic, principe du traitement. *Revue du Praticien*, **40**, 2839-2843.

[2] Anderson, D.G. (1995) No Surgical Treatment of Patient with Thoracolumbar Fracture. *Instructional Course Lectures*, **44**, 57-65.

[3] Beyiha, G., Minkande, Z.E.J., Binam, F., Ibrahima, F., Nda Mefo'o, J.P. and Sosso, M.A. (2008) Aspects épidémiologiques des traumatisme du rachis au Cameroun: à propos de 30 cas. *Journal Maghrébin d'Anesthésie-Réanimation et de Médecine d'Urgence*, **15**, 258-261.

[4] Roquilly, A., Vigué, B., Boutonnet, M., Bouzat, P., Buffenoir, K., Cesareo, E., *et al.* (2019) Prise en charge des patients présentant, ou à risque, de traumatisme vertébro-médullaire. *SFAR-Société Française d'Anesthésie et de Réanimation*, **1**, 1-20.

[5] Albanèse, J. (2005) Traumatismes du rachis. In: Pourriat, J.L. and Martin, C., Eds., *Principes de réanimation chirurgicale*, Arnette, Paris, 1325-1334.

[6] Barouk, D., Boccheciampe, N. and Langeron, O. (2009) Traumatisme médullaire. In: Boles, J.M., Bollaert, P.E., Jaeger, J., Offenstadt, G., Saulnier, F., Wolff, M. and Zéni, F., Eds., *Réanimation médicale*, Issy-les-Moulineaux, Masson, 1304-1307.

[7] Mbaki, H.B.E., Boukassa, L., Ngackosso, O.B., *et al.* (2017) Prise en charge hospitalière des traumatismes du rachis cervical à Brazzaville. *Health Sciences and Disease*, **18**, 43-47.

[8] Kéita, S. (2001) Etude sur les mines artisanales et les exploitations minières à petite échelle au Mali. IIED, MMSD, 54 p. http://pubs.iied.org/pdfs/G00727.pdf

[9] Sanogo, D.K. (2009) Etude épidémio-clinique des fractures du rachis Cervical dans le service de chirurgie orthopédique et traumatologie du CHU Gabriel Touré. Thèse

de médecine. Université de Bamako, 88 p.

[10] Diarra, F. (2008) Etude épidémio-clinique et diagnostique des traumatismes du rachis Dorsolombaire dans le service de Traumato-neurochirurgie du CHU Gabriel Touré: A propos de 90 cas. Thèse de médecine, Université de Bamako, 66 p.

[11] Kyeremateng-Amoah, E. and Clarke, E.E. (2015) Injuries among Artisanal and Small-Scale Gold Miners in Ghana. *International Journal of Environmental Research and Public Health*, **12**, 10886-10896. https://doi.org/10.3390/ijerph120910886

[12] Camara, N. (2018) Aspects épidémiologiques Cliniques et thérapeutiques des Traumatismes vertébro-médullaire suite a un éboulement de mines traditionnelles au service de neurochirurgie du CHU Gabriel Toure. Université des Sciences, des Techniques et des Technologies de Bamako, Bamako, 82 p.

[13] Kinta, H. (2016) Aspects cliniques et thérapeutiques des traumatismes vertébro-médullaires au CHU Gabriel Toure. Thèse de médecine. Université de Bamako, 177 p.

[14] Mangané, M., Almeimoune, A., Diop, T.M., Dembélé, A.S., Diallo, B., Napo, A., Sogoba, Y., Bomou, Y., Doumbia, M., Koita, S., Tambassi, S.I. and Diango, M.D. (2018) Aspects épidémio-cliniques des traumatismes au cours de l'orpaillage traditionnel au service d'accueil des urgences du chu Gabriel Touré de Bamako. *Le Mali Médical*, **33**, 5-8.

[15] Touré, O.Y. (2015) Aspect epidemio-cliniques des traumatisme au cours de l'orpaillage traditionnelle dans le service d'accueil des urgences. Université des Sciences, des Techniques et des Technologies de Bamako, Bamako, 177 p.

[16] Dongmo Tchemeza, A.A. (2014) Epidémiologie des traumatismes vertébro-médullaires en milieu hospitalo-universitaire à Yaoundé. *Health Sciences and Diseases*, **4**, 445-455.

[17] Bracken, M.B., Shepard, M.J., Collins, W.F., Holford, T.R., Young, W., Baskin, D.S., Eisenberg, H.M., Flamm, E., Leo-Summers, L., Maroon, J., *et al.* (1990) A Randomized, Controlled Trial of Methylprednisolone or Naloxone in the Treatment of Acute Spinal-Cord Injury. Results of the Second National Acute Spinal Cord Injury Study. *The New England Journal of Medicine*, **322**, 1405-1411. https://doi.org/10.1056/NEJM199005173222001

[18] Evaniew, N., Noonan, V.K., Fallah, N., Kwon, B.K., Rivers, C.S., Ahn, H., Bailey, C.S., Christie, S.D., Fourney, D.R., Hurlbert, R.J., Linassi, A.G., Fehlings, M.G., Dvorak, M.F. and the RHSCIR Network (2015) Methylprednisolone for the Treatment of Patients with Acute Spinal Cord Injuries: A Propensity Score-Matched Cohort Study from a Canadian Multi-Center Spinal Cord Injury Registry. *Journal of Neurotrauma*, **32**, 1674-1683. https://doi.org/10.1089/neu.2015.3963