Outcome in patients undergoing surgery for spinal injury in an Ethiopian hospital

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OBJECT The objective of this study was to investigate epidemiology and outcome after surgical treatment for spinal injuries in Ethiopia.

METHODS Medical records of patients who underwent surgery for spine injuries at Myungsung Christian Medical Center in Addis Ababa, Ethiopia, between January 2008 and September 2012 were reviewed retrospectively. Assessment of outcome and complications was determined from patient consultations and phone interviews.

RESULTS A total of 146 patients were included (129 males, 17 females). Their mean age was 31.7 years (range 15–81 years). The leading cause of injury was motor vehicle accidents (54.1%), and this was followed by falls (26.7%). The most common injury sites were lumbar (41.1%) and cervical (34.2%) regions of the spine. In 21.2% of patients, no neurological deficit was present before surgery, 46.6% had incomplete spinal cord injury (American Spinal Injury Association [ASIA] Impairment Scale [AIS] Grade B–D), and 32.2% had complete spinal cord injury (AIS Grade A). Follow-up was hampered by suboptimal infrastructure, but information regarding outcome was successfully obtained for 110 patients (75.3%). At follow-up (mean 22.9 months; range 2–57 months), 25 patients (17.1%) were confirmed dead and 85 patients (58.2%) were alive; 49 patients (33.6%) underwent physical examination. At least 8 of the 47 patients (17.0%) with a complete injury and 29 of the 68 patients (42.6%) with an incomplete injury showed neurological improvement. The reported incidences of pressure wounds, recurrent urinary tract infections, pneumonia, and thromboembolic events were 22.5%, 13.5%, 5.6%, and 1.1%, respectively.

CONCLUSIONS Patients showed surprisingly good recovery considering the limited resources. Surgical treatment for spine injuries in Ethiopia is considered beneficial.

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KEY WORDS developing countries; Eastern Africa; neurotrauma; traumatic spinal cord injury; spinal instrumentation; surgery

SPINAL injury is a detrimental condition that often is associated with permanent disability or even death. Injuries inflict a major physical, emotional, and economic burden on affected individuals, relatives, and the society. Surgical decompression and stabilization can limit damages and promote early rehabilitation and is common practice in developed countries. Outcome after traumatic spinal injury has been shown to be far better in developed countries than in low-income countries because of the availability of high-quality prehospital management, treatment, rehabilitation, and long-term support facilities

for disabled patients.⁵ In general, such resources are limited in developing countries; thus, establishing medical priorities can be difficult. Information about epidemiology and outcome after spine injuries is necessary to establish appropriate prevention and treatment strategies in a given country. Such information is scarce, however, in low-income countries.^{6,7,11} A recent review article based on 64 articles from 28 developing countries found no published data about the epidemiology of traumatic spinal cord injuries (TSCIs) in Ethiopia.¹⁶ The availability of neurosurgical treatment is limited in Ethiopia, but a few centers exist

ABBREVIATIONS AAU = Addis Ababa University; AIS = American Spinal Injury Association (ASIA) Impairment Scale; MCM = Myungsung Christian Medical Center; SF-8 = Short Form-8 Health Survey; TSCIs = traumatic spinal cord injuries; UTI = urinary tract infection

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and all of these are in Addis Ababa. In 2006, a neurosurgery training program was initiated at the Addis Ababa University (AAU). Neurosurgical treatment availability has since then gradually improved, including surgery for spine injuries.¹ Myungsung Christian Medical Center (MCM) has been one of the training sites in this program from the beginning and has performed a substantial portion of the spinal fixations in the country.

As surgical treatment for spinal injuries demands vast resources in a developing country, we wanted to find out whether such procedures are beneficial to patients having suffered a TSCI. One may ask whether it is ethical and appropriate to perform spinal surgery in this particular resource-limited setting with a near-complete lack of facilities for postoperative care and rehabilitation. Crucial questions in this respect are whether the patients do survive such procedures on a long-term basis and, lacking many resources, to what extent they will regain an adequate level of functioning after spine surgery.

First and foremost, we wanted to assess the outcomes and the mortality rates after surgical treatment for spinal injury in Ethiopia, including the prevalence and severity of common complications. We also wanted to evaluate the accessibility of rehabilitation services such as physiotherapy and a wheelchair. Finally, we wanted to map epidemiological data, as they may be of help for developing prevention strategies.

Methods

Patient Data

In this retrospective study, patients with spinal injuries were included who underwent placement of spinal instrumentation or skull traction for a spinal injury at MCM between January 2008 and September 2012. For an initial identification of such patients, we went through the neurosurgery operating room protocols looking for procedure descriptions that included rods, screws, wire, instrumentation, or plates. Only some of the surgeons noted skull traction as a separate procedure; therefore, we registered skull traction as a procedure only for patients who had no other procedures performed.

All procedures that possibly could have been related to a spinal trauma were registered and the corresponding medical records were retrieved from the hospital files. Only patients meeting the inclusion criteria were included. Patients with missing medical records and patients who underwent surgery more than 2 months after their injury were excluded. The medical records were not digitized and some of them were missing. After the archive staff had thoroughly searched through the files, we retrieved the written medical records for all but 9 patients. Since the presence or absence of medical records probably was unrelated to the outcome, these patients were excluded.

Inclusion and Exclusion Criteria

A total of 164 patients (142 males, 22 females) were identified who underwent spinal fixation or skull traction after a trauma between January 2008 and September 2012. Nine of these were excluded because of missing medical files, as were 9 other patients who underwent spinal sur-

gery more than 2 months after their injury. Thus, the study included 146 patients (129 males, 17 females).

The following information was retrieved from the medical records: demographic information (sex and age), date and cause of injury, diagnosis, level of spinal injury, presence or absence of neurological deficits, complete or incomplete neurological injury, associated injuries, and information about the surgical treatment (date and type of operation). Contact information for patients and relatives was also retrieved from medical records.

Surgical Procedures

Neither the training program nor the hospital was in the position to purchase instruments for spinal instrumentation, so the choice of surgical procedures and techniques depended on surplus equipment or gifts brought in by visiting surgeons. Thus, a variety of systems were used for instrumentation.

Patient Retrieval and Follow-Up

Ethiopian infrastructure is deficient. Street or postal addresses are not available; the only way to get in contact with patients, therefore, is via their cellular telephones. Most cellular telephones in the country are prepaid and may be discontinued if they are not refilled; however, they may still receive calls. Nevertheless, cellular telephone numbers can be regarded as temporary. Even though most patients were registered with 2 or 3 telephone numbers, we were unable to reach many of them.

Ethiopian nurses and doctors tried to establish telephone contact with patients or relatives. The patients we were able to get in contact with were offered a free medical consultation at MCM and reimbursement of travel and accommodation expenses. From those who were unable or unwilling to come for a follow-up, as much information as possible was gathered by a telephone interview. Two Amharic-speaking Ethiopian physicians, one an experienced neurosurgery resident, were in charge of the follow-up consultations. The consultations included a physical examination, collection of blood samples, and an interview. Clinical assessment was performed to document any neurological improvement or deterioration. Sensation, motor function, and sphincter control were evaluated and compared with the immediate postoperative information from the medical record. Blood samples were drawn and analyzed for lipid profile and liver and kidney function.

During the telephone interview, the patient's mortality status was recorded, as was their mobility status, if living. All complications, including pressure wounds, pneumonia, thrombosis, low-energy fractures, and recurrent urinary tract infections (UTIs), were recorded. We also obtained information about access to a wheelchair, use of physiotherapy, use of intermittent or indwelling urinary catheter, and whether the patient had returned to work after the injury.

Quality of Life

To get standardized and comparable results on health-related quality of life, we used the Short Form-8 Health Survey (SF-8),¹⁸ which measures 8 domains of health-re-

lated quality of life: physical functioning, role limitation due to physical health, bodily pain, general health, vitality, social functioning, emotional problems, and mental health. Information from these 8 health domains can be further aggregated into 2 variables: the physical component summary score and the mental component summary score. The responses are transformed into a 0–100 scale, using a standardized procedure. A higher score indicates a more favorable health state and quality of life. The score of an average population has a median of 50 and a standard deviation of 10. The advantages of SF-8 are the brief administration time (only 1–2 minutes), ease of translation, and the suitability for interviews of people with a low literacy level. SF-8 has been used in many nations, including low-income countries.^{17,18}

Neurological Status Before Surgery

Most of the surgeons used the American Spinal Injury Association Impairment (ASIA) Scale (AIS) to differentiate between complete and incomplete injury. AIS Grade A indicates complete neurological injury, AIS Grades B–D indicate incomplete neurological injury, and AIS Grade E indicates no neurological deficit. Injuries not classified by the AIS at admission were classified retrospectively by reviewing the medical records thoroughly.

Neurological Status at Follow-Up

To define postoperative neurological improvement, we compared the muscle strength in each extremity, sphincter tone, and sensation recorded in the medical records with the follow-up results. Increased muscle strength was given 1 point per extremity (e.g., going from Grade 1/5 to 2/5 in one leg would equal 1 point). Increased sensation equaled 1 point and regaining sphincter tone equaled 1 point. We defined an increase of 1–3 points as some improvement, and more than 3 points as substantial improvement. If no improvement was seen in strength, sensation, or sphincter tone, the patient was registered as showing no improvement.

Results

Retrospective Review

Patient Characteristics

The mean age for the 146 patients included in the study was 31.7 years (median 28 years; range 15–81 years), and there was a marked male dominance: 129 patients (88.4%) were men and 17 (11.6%) were women.

Etiology

Motor vehicle accident was the most common cause of injury, accounting for more than half of the accidents, followed by falls and then objects falling on the patient (Table 1).

Level of Injury

The most common levels of injury were lumbar (n = 60; 41.1%) and cervical (n = 50; 34.2%), followed by thoracic (n = 32; 21.9%). A minority of the patients (n = 4; 2.7%) had a combined thoracic and lumbar injury.

TABLE 1. Cause of injury

Event	No. (%)
MVA	79 (54.1)
Fall	39 (26.7)
Falling object	21 (14.4)
Assault	3 (2.1)
Other*	3 (2.1)
Unknown	1 (0.7)
Total	146 (100)

MVA = motor vehicle accident.

* One patient was buried by a landslide, 1 sustained a gunshot wound, and 1 was dragged into an industrial machine.

Severity of Injury

Associated injuries occurred in 44 patients (Table 2). Of these, about 25% had a head injury and multitrauma, 25% had only a head injury, 25% had a multitrauma without head injury, and 25% had other fractures than the spinal fracture.

Neurological Status Before Surgery

One-fifth of the patients (21.2%) had no neurological deficit (AIS Grade E) before the operation, 46.6% were classified as AIS Grade B, C, or D, and 32.2% had a complete spinal cord injury (AIS Grade A) (Table 3). The highest proportion (53.1%) of AIS Grade A injuries was found among patients with thoracic injuries.

Surgical Procedures

Table 4 gives a detailed account of the performed procedures.

Cervical Injuries. A total of 43 patients (29.5%) underwent surgery for cervical injuries. An anterior approach with fusion and plate stabilization was used in 34 of these (79.0%) and an anterior approach without a plate was used in 2 (4.7%). Seven of the cervical operations (16.3%) involved a posterior approach with fusion and stabilization using lateral mass screws. Seven patients (16.3%) were treated with skull traction only.

Thoracic and Lumbar Injuries. A total of 96 patients were treated with posterior fusion and stabilization using pedicle screws and rods.

Local or Visiting Surgeons

As an increasing number of neurosurgeons graduated

TABLE 2. Patients' associated injuries

Injury	No. (%)
None	100 (68.5)
Head	12 (8.2)
Other fracture	12 (8.2)
Multitrauma w/ head trauma	10 (6.8)
Multitrauma w/o head trauma	10 (6.8)
Unknown	2 (1.4)
Total	146 (100)

TABLE 3. Neurological injury on admission stratified by level of injury

Level of Injury	No. of Patients (%)			Total
	No Injury	AIS Grade A	AIS Grade B–D	
Cervical	13 (26.0)	17 (34.0)	20 (40.0)	50
Thoracic	5 (15.6)	17 (53.1)	10 (31.3)	32
Combined T&L	0 (0)	0 (0)	4 (100.0)	4
Lumbar	13 (21.7)	13 (21.7)	34 (56.7)	60
Total	31 (21.2)	47 (32.2)	68 (46.6)	146

T&L = thoracic and lumbar.

from the training program, there was a shift from visiting teachers to locally trained neurosurgeons as primary surgeons. In 2008, nearly all of the procedures (93.3%) were performed by a primary surgeon trained outside Ethiopia who acted as a teacher. Local surgeons performed the rest of the operations. This ratio was reversed in 2012, when visiting teachers performed only 9.8% of the procedures. We did not compare surgical outcome between the 2 groups of surgeons, as it possibly may reflect a bias of which patients the surgeons preferred to operate on.

Follow-Up

We were able to establish contact by telephone with either the patient or the patient's relatives for 110 study subjects (75.3%). Forty-nine patients (33.6%) were willing and able to come to the hospital for a physical examination. In addition, we got information by telephone from 36 patients (24.7%) who were still alive and for 25 patients (17.1%) who had died. We were unable to obtain any follow-up data from 36 patients (24.7%) simply because it was impossible to establish contact. The mean follow-up time was 22.9 months (range 2–57 months). The response rate was higher for female patients than for male patients (94.1% and 72.9%, respectively).

Neurological Status at Follow-Up

Of the 49 patients who underwent a clinical examination, 21 (42.9%) had no neurological improvement, 11 (22.4%) had some improvement, and 17 (34.7%) showed substantial improvement (Tables 5 and 6). None of these patients showed impairment at follow-up.

Of the 36 patients who were alive but unable to come to the hospital for a physical examination, 8 (22.2%) reported that they had no neurological improvement after

TABLE 4. Type of surgical procedure

Procedure	No. (%)
ACF w/ plate	34 (23.3)
ACF w/o plate	2 (1.4)
Posterior cervical fusion w/ lateral mass screws	7 (4.8)
Posterior thoracolumbar fusion w/ pedicle screw fixation	96 (65.8)
Skull traction only	7 (4.8)
Total no. of surgeries	146 (100.1)

ACF = anterior cervical fusion.

TABLE 5. Neurological improvement by type of evaluation and level of injury*

Evaluation/ Level of Injury	Neurological Improvement After Discharge			
	None	Some	Substantial	Unknown
Only by telephone, alive				
Cervical	1 (12.5)	2 (25.0)	0 (0.0)	5 (62.5)
Thoracic	1 (12.5)	3 (37.5)	0 (0.0)	4 (50.0)
Combined T&L	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)
Lumbar	6 (31.6)	1 (5.3)	2 (10.5)	10 (52.6)
Only by telephone, dead				
Cervical	6 (31.6)	1 (5.3)	0 (0.0)	12 (63.2)
Thoracic	2 (40.0)	0 (0.0)	0 (0.0)	3 (60.0)
Combined T&L	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)
Lumbar	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Physical exam				
Cervical	7 (50.0)	1 (7.1)	6 (42.9)	0 (0.0)
Thoracic	4 (57.1)	1 (14.3)	2 (28.6)	0 (0.0)
Combined T&L	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)
Lumbar	10 (37.0)	8 (29.6)	9 (33.3)	0 (0.0)

* Values are presented as the number (%) of patients.

discharge, 6 (16.7%) reported some improvement, and 2 (5.6%) reported substantial improvement. For 20 of the 36 patients (55.6%), we could not obtain reliable information about neurological status. In sum, of the 65 surviving patients for whom we obtained information about postoperative neurological status, 17 experienced some neurological improvement and 19 experienced substantial neurological improvement.

None of the patients who died were reported to have had substantial neurological improvement before death. For the 25 patients who were confirmed dead, 9 (36.0%) had no neurological improvement before death and 1 (4.0%) showed some improvement. The informants were uncertain if there had been any neurological improvement in 15 of the deceased patients (60.0%).

Of the 47 patients with a complete neurological injury on admission, 14 (29.8%) had no neurological improvement at follow-up, 4 (8.5%) had some improvement, and 4 (8.5%) had a substantial neurological improvement. We obtained no data on neurological improvement for 25 of these patients (53.2%).

TABLE 6. Neurological improvement at physical exam at follow-up in patients with neurological deficits on admission measured by AIS

AIS Grade on Admission	AIS Grade at Follow-Up*				
	A	C	D	E	Total
A	9	3	1	0	13
B	0	0	6	2	8
C	0	3	5	1	9
D	0	0	1	6	7
Total	9	6	13	9	37

* No patient was classified as AIS Grade B at follow-up.

Of the 68 patients with an incomplete injury on admission, 6 (8.8%) had no neurological improvement at follow-up, 14 (20.6%) had some improvement, and 15 (22.2%) had a substantial neurological improvement. We had no data on neurological improvement for 33 of these patients (48.5%).

Complications

We were mainly able to collect data about complications for those who answered their telephone personally and those who appeared for follow-up. Of the 89 patients (61.0%) for whom we were able to retrieve data on postoperative complications, 20 (22.5%) reported that they had suffered pressure wounds, 12 (13.5%) reported recurrent UTIs, 5 (5.6%) reported pneumonia, and 1 patient (1.1%) reported a thromboembolic event defined as deep vein thrombosis or pulmonary embolism. There was no reported low-energy fracture.

Blood Sample Results at Follow-Up

The albumin level was low (< 3.1 g/dl) for 20 of 44 patients (45.5%) in whom albumin was measured, compared with a reference range from an American population (<http://labmed.ucsf.edu/labmanual/mftlng-mtzn/test/refrange.html>). Hemoglobin levels were, in general, low (< 12.0 and < 14.0 g/dl in women and men, respectively) in 11 of 45 patients (24.4%) in whom hemoglobin was measured. In the 49 patients in whom high-density lipoprotein was measured, levels were low (< 35.0 mg/dl) in 10 (20.4%) and high (> 60.0 mg/dl) in 2 (4.1%). Results from blood analysis of random blood sugar levels and levels of total cholesterol, triglycerides, low-density lipoproteins, total bilirubin, total protein, glutamic oxaloacetic transaminase, serum glutamic pyruvic transaminase, blood urea nitrogen, and creatinine were mostly within normal ranges.

Physiotherapy and Wheelchair Access

Data on postoperative physiotherapy were obtained for 84 patients (57.5%). A total of 39 of these (46.4%) had received physiotherapy. Three of these patients (3.6%) had received physiotherapy for more than 3 months. The MCM does have a physiotherapy service. Most of the patients who received physiotherapy, therefore, did so when hospitalized in the acute stage.

Data on access to wheelchair and crutches were obtained for 83 patients (56.9%). Of these, 12 (14.4%) had access to a wheelchair and 50 (60.2%) did not need one. Ten patients (12.0%) in need of a wheelchair did not have access to one and 12 patients (14.4%) used crutches.

Employment

Employment data at follow-up were obtained for only 49 patients. Only 1 patient with a complete injury was employed at follow-up (Table 7).

Death and Cause of Death

At least 25 patients were dead (17.1%), and at least 85 patients (58.2%) were still alive at follow-up. There were no significant differences in survival rates between the

TABLE 7. Neurological injury and employment at follow-up*

AIS Grade	Employment After Injury	
	No	Yes
No injury†	5 (41.7)	7 (58.3)
A	9 (100.0)	0 (0.0)
B–D	14 (73.7)	5 (26.3)
E	5 (55.6)	4 (44.4)
Total	33 (67.3)	16 (32.7)

* Patients with no employment data were excluded from this analysis. Values are presented as the number (%) of patients.

† Patients without a preoperative neurological deficit.

years in which the patients underwent surgery (i.e., between visiting neurosurgical teachers in the beginning and Ethiopians trained in the AAU program).

Eleven of the confirmed dead patients (44.0%) died of cardiorespiratory failure and 4 patients (16.0%) died of sepsis or infection. For 10 patients (40.0%), the cause of death remains unknown.

Quality of Life

The mean SF-8 physical component summary score was 42.1 (SD 9.9) and the mean mental component score was 43.7 (SD 11.7). This is below the normative mean of 50 but not significantly different at a 95% confidence level. Patients with a complete injury scored significantly lower than those with an incomplete injury or no injury (Table 8).

Predictors of Outcome

Women appeared to have a lower survival rate than men. At least 21 of the male patients (16.3%) and 4 of the female patients (23.5%) had died in the follow-up period. The risk of dying was highest for cervical injuries and

TABLE 8. SF-8 scores by neurological injury

AIS Grade	PCS Score	MCS Score
No injury*		
Mean	48.5	53.4
No.	12	12
SD	6.9	5.6
A		
Mean	31.9	32.8
No.	13	13
SD	6.5	6.8
B–D		
Mean	44.4	44.8
No.	24	24
SD	8.5	11.4
Total		
Mean	42.1	43.7
No.	49	49
SD	9.9	11.7

MCS = mental component summary; PCS = physical component summary.

* Patients without a preoperative neurological deficit.

TABLE 9. Survival predictors*

Parameter	Alive at Follow-Up (%)		
	No	Yes	Unknown
Level of injury			
Cervical	19 (38.0)	22 (44.0)	9 (18.0)
Thoracic	5 (15.6)	15 (46.9)	12 (37.5)
Combined T&L	1 (25.0)	2 (50.0)	1 (25.0)
Lumbar	0 (0.0)	46 (76.7)	14 (23.3)
AIS grade on admission			
No injury†	0 (0.0)	22 (71.0)	9 (29.0)
AIS Grade A	19 (40.4)	20 (42.6)	8 (17.0)
AIS Grade B–D	6 (8.8)	43 (63.2)	19 (27.9)
Sex			
M	21 (16.3)	73 (56.6)	35 (27.1)
F	4 (23.5)	12 (70.6)	1 (5.9)
Associated injury			
None	21 (21.0)	57 (57.0)	22 (22.0)
Head	1 (8.3)	8 (66.7)	3 (25.0)
Multitrauma w/ head trauma	1 (10.0)	7 (70.0)	2 (20.0)
Multitrauma w/o head trauma	1 (10.0)	3 (30.0)	6 (60.0)
Other fracture	0 (0.0)	9 (75.0)	3 (25.0)
Unknown	1 (50.0)	1 (50.0)	0 (0.0)

* Values are presented as the number (%) of patients.

† Patients without a preoperative neurological deficit.

TABLE 10. Survival stratified by level of injury and neurological injury*

Level of Injury	Alive on Follow-Up (%)		
	No	Yes	Unknown
Cervical			
No injury†	0 (0.0)	8 (61.5)	5 (38.5)
AIS Grade A	14 (82.4)	2 (11.8)	1 (5.9)
AIS Grade B, C, or D	5 (25.0)	12 (60.0)	3 (15.0)
Thoracic			
No injury	0 (0.0)	3 (60.0)	2 (40.0)
AIS Grade A	5 (29.4)	7 (41.2)	5 (29.4)
AIS Grade B, C, or D	0 (0.0)	5 (50.0)	5 (50.0)
Combined T&L			
No injury	0 (0.0)	0 (0.0)	0 (0.0)
AIS Grade A	0 (0.0)	0 (0.0)	0 (0.0)
AIS Grade B, C, or D	1 (25.0)	2 (50.0)	1 (25.0)
Lumbar			
No injury	0 (0.0)	11 (84.6)	2 (15.4)
AIS Grade A	0 (0.0)	11 (84.6)	2 (15.4)
AIS Grade B, C, or D	0 (0.0)	24 (70.6)	10 (29.4)

* Values are presented as the number (%) of patients.

† Patients without a preoperative neurological deficit.

lowest for lumbar injuries (Tables 9 and 10). The best predictor of low quality of life (low SF-8 score) at follow-up was a complete spinal cord injury (Table 8).

The patients with the highest mortality rate were those with an AIS Grade A cervical injury. Four of the patients who died, and who had a cervical injury, were treated with skull traction only. Patients with an AIS Grade A thoracic injury had the second highest mortality rate and the patients with an AIS Grade B cervical injury had the third highest mortality rate. These three groups accounted for 22 of the 25 confirmed deaths (88.0%) in the study (Table 10).

Discussion

We started this study by asking ourselves whether it is ethical and appropriate to perform spine surgery in this particular resource-limited setting with a near-complete lack of facilities for postoperative care and rehabilitation. Crucial questions in this respect are whether the patients do survive such procedures on a long-term basis and to what extent, lacking resources, they will regain an adequate level of functioning after spine surgery. With some limitations—mainly, high cervical transections—we believe the answer to these questions is yes.

There is a lack of data on the outcome of spinal injuries and the usefulness of spinal fixation in developing countries. We have found no studies on spinal fixation after TSCI and only a few studies looking at outcome after TSCI; most of these, however, have focused on hospital outcome without long-term follow-up.^{4,8,9}

Etiology

The distribution of sex, age, and injury mechanisms ap-

pears similar to what is found in other studies of TSCI in African low-income countries.¹⁶

Mortality and Outcome

One of our main goals was to determine the survival rate of these patients. Since we know that at least 25 patients died and that at least 85 patients were still alive, we can derive that in an unlikely worst-case scenario in which all unknown cases were dead, 61 patients (41.8%) would be dead. In an even more unlikely best-case scenario in which all unknown cases were alive, 121 patients (82.9%) would be alive. Therefore, we can be certain that the percentage of patients who survived until follow-up (late 2012) was between 58.2% and 82.9%.

A study of 24 patients who were treated conservatively in Sierra Leone reported a loss to follow-up of 16.7% after 6–24 months and a survival rate of between 20.8% and 37.5%.⁹ Most of the patients in that study, however, had experienced complete TSCI, so these numbers should be compared with a survival rate between 42.6% and 59.6% for the 47 complete injuries in the present study.

A study of 136 conservatively treated patients in Zimbabwe reported a loss to follow-up of 24%. In that study, the 1-year survival rate was between 51% and 75%.¹⁴ This can be compared with a survival rate between 58.2% and 82.9% in our study.

Survival in our patients appeared to be similar for patients who underwent spinal surgery at the beginning of the study period and those who underwent surgery at the end of the study period, indicating that most of the deaths occurred during the first postoperative year. For the 25 patients who were confirmed dead, the average time between surgery and death was 81 days. Only 2 patients died more than 1 year after the operation. The fact that only one-quarter of the patients in our study with a complete

cervical injury survived until follow-up may be an indication that these patients should not have undergone surgery before better rehabilitation facilities were established.

One may argue that none of the patients with complete injuries should undergo surgery before better rehabilitation facilities are available and chances of postoperative employment are improved. On the other hand, an improved survival rate from about 33% to about 50% for all patients with complete injuries is not insignificant. In this setting, we believe it is important to take into consideration what resources and kind of life quality a paraplegic or tetraplegic Ethiopian patient can expect.

We now have at least some data on the outcome of these operations in a country with limited resources. Even though our data are not complete, our general impression is that these procedures benefitted the patients. This remains true even though postoperative care and rehabilitation facilities are not available to the same extent as in industrialized countries. One suggestion is to operate on all patients except those with a complete cervical or thoracic injury. For the rest of the patients, the survival rate is somewhere between the worst-case scenario of 66.4% and best-case scenario of 92.2%. One would get an even higher survival rate by also not operating on those with an incomplete cervical injury, but this group has one of the best rates of neurological improvement, with 20.0% showing some improvement and another 20.0% showing substantial improvement at follow-up.

Complications

The incidence of pressure wounds in this study was 22.7%. This is lower than the 33% reported from Zimbabwe,¹⁴ and the 26.9% reported in an Italian study,¹⁵ but much higher than the 6.8% in a study from the UK.³ The same study from the UK reported an incidence of 4.6% for pneumonia, which is only a little lower than 5.9% reported in our study. A UTI incidence of 13.6% is very low in a global perspective.² This may be because only a small fraction of our patients (19.1%) used a urinary catheter. Our general impression is that the number of patients experiencing complications is surprisingly low. This could be due to the initial selection of patients or because people simply do not report minor complications. It may also be due to recall bias, as it probably is easier to remember a complication causing a doctor's visit than one that did not prompt such an event. One can assume that Ethiopians have a higher threshold for calling a doctor than patients in industrialized countries.

Quality of Life

The SF-8 scores for our patients (mean physical component summary score, 42.1; mean mental component summary score, 43.7) are below, but not significantly different from, the normative mean of 50. Studies of patients from Canada and Australia with spinal cord injury reported physical component scores of 31.4 and 33, and mental component scores of 49.7 and 56, respectively.^{12,13} The only significantly lowered SF-8 score was, not unexpectedly, for the group of patients with a complete injury. They had a mean physical component summary score of 32.0 and a mean mental component summary score of 32.8, indicat-

ing that this patient group, not surprisingly, had the lowest life quality. It is interesting that the physical component is not lower than what is reported in Western countries. Our experience has been that mental health seems to be a taboo even in the doctor-patient relationship in the Ethiopian culture. This complicated the use of Western scoring tools; therefore, we recommend the use of a simpler scoring tool for similar studies in the future.

During the follow-up consultations, we observed that the patients hesitated to ask their doctors questions about their condition. The patients seemed to have little knowledge about their injury and about how they should improve their chances of a good outcome (e.g., it appeared that many of the patients tried to avoid physical activity even years after the injury because they were afraid that their injury might be worsened). We believe it is important that the patients are well informed about the procedure and expected outcome before they undergo surgery, and also that they receive good information about how to improve their recovery postoperatively. One simple way to do this could be to create a brochure in the most common Ethiopian language: Amharic.

Employment

An employment rate of 4.2% for patients with complete injuries is very low compared with Western countries. In a study from Latvia, 22.3% of the patients with a complete neurological injury (AIS Grade A injury) were employed 2 years after the injury.¹⁰ In the same study, 38.3% of patients with an incomplete injury were employed. This is lower than the 44.2% recorded in our study. The main reason why only 1 patient with a complete injury was employed in our study is most likely that workplaces do not have the facilities available in Western countries.

Economic and Ethical Issues

When comparing spinal fixation with conservative treatment in a developing country, it is paramount to consider the cost of the procedures. Even if the cost of spinal fixation is much lower in Ethiopia than in industrialized countries, it is still relatively expensive, limiting the treatment to those who can afford it. It is likely, therefore, that those included in our study had more resources available than the average Ethiopian. This may have influenced the results in a positive manner, as it is likely that such patients and their families also have more resources, financial and human, to provide good long-term care for the patients.

One can argue that it is unfair to offer advanced treatment only to a fairly small group of patients based on their ability to pay for it. We believe, however, that it is crucial for future Ethiopian patients with spine injuries that the country possesses neurosurgical experts able to perform advanced procedures, including spinal instrumentation. Therefore, such skills must be learned and maintained.

Another pertinent ethical question is, as always when one is teaching neurosurgery but perhaps even more relevant in low-income countries: Why do we primarily want to perform the procedure? Is it to help the patient or because we want to use "important" cases for training purposes even when the prognosis is bad? This question must always be raised and discussed, especially with the

trainees, to set their minds on such matters. Our results, with high mortality and low quality of life, indicate that one possibly should be more restrictive in operating on complete, high cervical injuries.

Conclusions

This study has shown relatively good outcomes and a surprisingly high recovery rate in patients in Ethiopia who have undergone surgery for spine fractures, despite the almost complete lack of rehabilitation facilities in the country. It seems justified, therefore, to continue this activity, as it appears to benefit most of these patients as well as the training of neurosurgeons. As might be expected, patients with complete high cervical injuries had a high mortality rate and the survivors reported low quality of life, indicating the need for caution when deciding treatment for this category. The present study has many limitations; many of these were caused by a suboptimal infrastructure that hampered follow-up. We recommend colleagues who plan starting similar training programs to take such factors into account to obtain more scientifically sound results. A better follow-up can be facilitated by securing several back-up mobile telephones in the family and thorough pre- and postoperative information of the whole family.

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References

1. Abebe M, Munie T, Lende G, Bekele A: Pattern of neurosurgical procedures in Ethiopia: experience from two major neurosurgical centres in Addis Ababa. **East Central Afr J Surg** 16:2073-9990, 2011
2. Ackery A, Tator C, Krassioukov A: A global perspective on spinal cord injury epidemiology. **J Neurotrauma** 21:1355-1370, 2004
3. Aung TS, el Masry WS: Audit of a British Centre for spinal injury. **Spinal Cord** 35:147-150, 1997
4. Brasil AV, Coelho DG: The neurological outcome of acute spinal cord injury in a neurosurgical hospital of a developing country. **Spinal Cord** 36:353-356, 1998
5. Burns AS, O'Connell C: The challenge of spinal cord injury care in the developing world. **J Spinal Cord Med** 35:3-8, 2012
6. Chiu WT, Lin HC, Lam C, Chu SF, Chiang YH, Tsai SH: Review paper: epidemiology of traumatic spinal cord injury: comparisons between developed and developing countries. **Asia Pac J Public Health** 22:9-18, 2010
7. Cripps RA, Lee BB, Wing P, Weerts E, Mackay J, Brown D: A global map for traumatic spinal cord injury epidemiology: towards a living data repository for injury prevention. **Spinal Cord** 49:493-501, 2011
8. Feng HY, Ning GZ, Feng SQ, Yu TQ, Zhou HX: Epidemiological profile of 239 traumatic spinal cord injury cases over a period of 12 years in Tianjin, China. **J Spinal Cord Med** 34:388-394, 2011
9. Gosselin RA, Coppotelli C: A follow-up study of patients with spinal cord injury in Sierra Leone. **Int Orthop** 29:330-332, 2005
10. Guserova J, Smite D, Vetra A: Characteristics of patients with spinal cord injuries and primary rehabilitation analysis for patients with incomplete tetraplegia after traumatic spinal cord injuries, in **Collection of Scientific Papers 2012: Research Articles in Medicine and Pharmacy**. Rīga, Latvia: Rīgas Stradiņa Universitāte, 2013
11. Hagen EM: Still a need for data from developing countries on traumatic spinal cord injury. **Neuroepidemiology** 41:86-87, 2013
12. Haran MJ, Lee BB, King MT, Marial O, Stockler MR: Health status rated with the Medical Outcomes Study 36-Item Short-Form Health Survey after spinal cord injury. **Arch Phys Med Rehabil** 86:2290-2295, 2005
13. Leduc BE, Lepage Y: Health-related quality of life after spinal cord injury. **Disabil Rehabil** 24:196-202, 2002
14. Levy LF, Makarawo S, Madzivire D, Bhebhe E, Verbeek N, Parry O: Problems, struggles and some success with spinal cord injury in Zimbabwe. **Spinal Cord** 36:213-218, 1998
15. Pagliacci MC, Celani MG, Zampolini M, Spizzichino L, Franceschini M, Baratta S, et al: An Italian survey of traumatic spinal cord injury. The Gruppo Italiano Studio Epidemiologico Mielolesioni study. **Arch Phys Med Rehabil** 84:1266-1275, 2003
16. Rahimi-Movaghar V, Sayyah MK, Akbari H, Khorramirouz R, Rasouli MR, Moradi-Lakeh M, et al: Epidemiology of traumatic spinal cord injury in developing countries: a systematic review. **Neuroepidemiology** 41:65-85, 2013
17. Roberts B, Browne J, Ocaña KF, Oyok T, Sondorp E: The reliability and validity of the SF-8 with a conflict-affected population in northern Uganda. **Health Qual Life Outcomes** 6:108, 2008
18. Ware JE, Kosinski M, Dewey JE, Gandek B: **How to Score and Interpret Single-item Health Status Measures: A Manual for Users of the SF-8 Health Survey (with a Supplement on the SF-6 Health Survey)**. Lincoln, RI: QualityMetric Incorporated, 2001

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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Conception and design: Wester, Park, Lundervik Bøthun. Acquisition of data: Lehre, Eriksen, Tirsit, Bekele, Petros, Lundervik Bøthun. Analysis and interpretation of data: Wester, Lehre, Eriksen, Tirsit, Park, Lundervik Bøthun. Drafting the article: Wester, Lehre, Eriksen, Tirsit, Petros, Park, Lundervik Bøthun. Critically revising the article: Wester, Lehre, Eriksen, Tirsit, Bekele, Petros, Lundervik Bøthun. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Wester. Statistical analysis: Lehre, Eriksen, Tirsit, Lundervik Bøthun. Administrative/technical/material support: Park. Study supervision: Wester, Park, Lundervik Bøthun.

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