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Characteristics and clinical aspects of patients with spinal cord injury undergoing surgery☆

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ABSTRACT

Objective: To identify the characteristics of patients with spinal cord injury (SCI) undergoing surgery.
Methods: Previously, 321 patients with SCI were selected. Clinical and socio-demographic variables were collected.
Results: A total of 211 patients were submitted to surgery. Fall and injuries in the upper cervical and lumbosacral regions were associated with conservative treatment. Patients with lesions in the lower cervical spine, worse neurological status, and unstable injuries were associated with surgery. Individuals undergoing surgery were associated with complications after treatment. The authors assessed whether age influenced the characteristics of patients submitted to surgery. Subjects with <60 years of age were associated with motorcycle accidents and the morphologies of injury were fracture-dislocation. Elderly individuals were associated to fall, SCI in the lower cervical spine and the morphology of injury was listhesis. Subsequently, the authors analyzed the gender characteristics in these patients. Women who suffered car accidents were associated to surgery. Women were associated with paraparesis and the morphologic diagnosis was fracture-explosion, especially in the thoracolumbar transition and lumbosacral regions. Men who presented traumatic brain injury and thoracic trauma were related to surgery. These individuals had a worse neurological status and were associated to complications. Men and the cervical region were most affected, thereby, these subjects were analyzed separately ($n = 92$). The presence of complications increased the length of hospital stay. The simultaneous presence of morphological diagnosis, worst neurological status, tetraplegia, sensory, and motor alterations were associated with complications. Pneumonia and chest trauma were associated with mortality.
Conclusion: These factors enable investments in prevention, rehabilitation, and treatment.

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Caracterização e aspectos clínicos de pacientes com traumatismo raquimedular submetidos à cirurgia

Palavras-chave:
Epidemiologia
Traumatismos da medula espinal
Fusão vertebral
Fraturas da coluna vertebral
Mortalidade
Traumatologia

RESUMO

Objetivo: Identificar as características de pacientes com traumatismo raquimedular (TRM) submetidos à cirurgia.

Métodos: Previamente, 321 pacientes com TRM foram selecionados. As variáveis clínicas e sócio-demográficas foram coletadas.

Resultados: Um total de 211 pacientes foram submetidos a cirurgia. A queda e lesões nas regiões cervical superior e lombosacral foram associadas com tratamento conservador. Pacientes com lesões nas regiões cervical inferior, pior status neurológico e lesões instáveis foram associados com cirurgia. Indivíduos operados foram associados com complicações após tratamento. Posteriormente, os autores avaliaram se idade influenciava as características dos pacientes submetidos à cirurgia. Sujeitos com < 60 anos foram associados com acidente motociclístico e o diagnóstico de fratura-luxação. Subsequentemente, analisaram-se as características dos sexos nestes pacientes. Mulheres que sofreram acidente automobilístico foram associadas com cirurgia. Mulheres foram associadas com paraparesia e diagnóstico morfológico de fratura explosão, principalmente nas regiões de transição tóraco-lombar e lombo-sacral. Homens que apresentaram traumatismo crânio-encefálico e torácico foram relacionados a cirurgia. Estes indivíduos tiveram um pior status neurológico e foram associados à complicação. Homens e região cervical foram mais afetadas; portanto, estes pacientes foram analisados isoladamente (n = 92). A presença de complicações aumentou a permanência hospitalar. A presença de diagnósticos morfológicos simultaneamente, pior status neurológico, tetraplegia, alteração sensório-motora foram associados com complicações. Pneumonia e traumatismo torácico foram associados com mortalidade.

Conclusão: Estes fatores possibilitam investimentos em prevenção, reabilitação e tratamento.

Introduction

The spinal cord injury (SCI) refers to vertebral column lesions that may result in transient or irreversible consequences, depending on the affected tissues during trauma.[1–3] The clinical complications after SCI are being evaluated[3–5] to improve interventions and achieve better prognosis for these patients, reducing socioeconomic costs and mortality. However, there are few studies addressing the characteristics and clinical aspects of patients undergoing surgery. Only one descriptive study[6] was found in Brazil, demonstrating the need to better understand this population and determine where investments should be made for prevention and treatment. Moreover, cultural factors and regional differences must not be neglected.[7]

There are numerous technical instrumentation and fixation methods used in patients with traumatic cord spinal injury. However, the technique used depends on the patient, characteristics of the lesion and on the surgeon's experience. In general, posterior instability should be treated by posterior fusion and anterior instability by anterior fusion. However, when there is complete discoligamentous injury, circular or combined fixation is recommended to give adequate stabilization.[8]

Surgical intervention promotes dissection and retraction of the several structures to exposure of spine to correct the injury installed,[9] possibly resulting in other tissue lesions, and, as a consequence, increasing the clinical complications and mortality.

Therefore, the objective of this study is to identify the characteristics and clinical aspects of patients with spinal cord injury submitted to surgery.

Methodology

Prospective study conducted at Hospital de Base, a tertiary referral center. Study approved by the Research Ethics Committee, protocol 806.452.

Three hundred and twenty-one patients with SCI were selected from 2008 to 2012. An initial evaluation was made to confirm the diagnosis of SCI. Patients were submitted to radiological analysis using computed tomography and/or magnetic resonance imaging.[2]

The following variables were analyzed: gender; age; etiology, morphology and topography of the SCI; neurological status; syndromic status; associated injuries; complications; length of hospitalization and deaths.

Patients with injury in the upper cervical region (C1–C2), lower cervical (C3–C7), thoracic (T1–T10), thoracolumbar transition (T11–L2) and lumbosacral (L3–S1) were included in the study.[3] Morphological classification of lesions was performed as suggested by Denis.[10] The neurological status of patients was obtained by the ASIA scale (American Spinal Injury Association).[11] Clinical complications presented within 30 days of hospitalization were collected.[3]

Initially, the variables frequently presented by patients undergoing surgery were reported. We then evaluated the factors most associated with surgery when compared to conservative treatment, age, gender and morbidity/mortality in men submitted to surgical treatment in the cervical spine.

Data analysis was performed using descriptive and inferential statistics. Descriptive results were expressed as mean ± standard deviation (parametric distribution), median with minimum, maximum (non-parametric distribution), and absolute and relative frequencies. The analysis of the normality of the data was performed using the Kolmogorov–Smirnov test. Data with parametric distribution were analyzed by unpaired t test, and the nonparametric for Mann–Whitney test. The association between variables was assessed for Odds Ratio (OR) with a confidence interval (CI), being confirmed by the Fisher exact test. A $p \leq 0.05$ value was considered statistically significant. Statistical analysis was performed using Instat software (version 3.0, GraphPad, Inc., San Diego, CA, USA).

Results

Individuals with SCI who were submitted to surgery ($n = 211$) were from the private healthcare service (18%) and from the public healthcare system (82%). Patients from 65 different cities examined. With regard to ethnicity: 85% were Caucasian, 8% mulatto, 4% Black, 3% unidentified. The level of education was classified as illiterate (4%), primary education (59%), secondary education (26%) and higher education (11%). The most frequent marital status was single (47%), followed by married (38%), widowed (8%) and divorced (4%), and seven individuals not reported. The occupation of patients was distributed to employees (83%), home worker (7%), unemployed (5%), students (4%) and retired (1%). Religion was distributed as Roman Catholic (76%), Evangelical Protestant (10%), Orthodox Catholic (5%), agnostic (5%) and others (4%).

In addition, we observed that these patients are mainly: male (77%); admitted after suffering a car accident (41%); associated lesion: traumatic brain injury (12%); the lower cervical spine is the most affected region (49%); cervicalgia with paresthesia (22%); morphological diagnosis of fracture dislocation (34%); and neurological status ASIA-E (39%). Surgical interventions were distributed as anterior (51%) and posterior (46%) arthrodesis, decompressive laminectomy (4%) and corpectomy (9%). Of these patients, 10% required more than one surgical procedure simultaneously.

The factors most associated with surgery when compared to conservative treatment such as age, gender and morbidity/mortality in men undergoing surgical treatment in the cervical area are shown in Fig. 1.

Surgical or conservative treatment

Patients were initially analyzed to verify what were the criteria most associated to treatment options, surgical ($n = 211$) or conservative ($n = 110$). The characterization and predictive factors are shown in Table 1. Mean age of patients undergoing surgery [44.5 (11–93) years] was significantly higher ($p = 0.0004$, Mann–Whitney test) than those without surgery [36 (5–89) years]. Of all SCI etiologies, falling was associated with conservative treatment.

Thirty-five individuals had lesions in two regions concomitantly. Individuals who had SCI in the upper cervical and lumbosacral regions were referred mainly to conservative treatment, whereas patients with lesions in the lower cervical region were more associated with surgery. In this context, the syndromic status more associated with conservative treatment was neck and dorsal pain with paresthesia, whereas paraparesis, paraplegia and quadriplegia were more related to surgery. Patients with better neurological status were more associated with conservative treatment, whereas those with worse neurological status were more related with surgery. Patients with sensorimotor alterations were seven times more in operated patients.

Regarding the associated injuries, there were 180 events, and 31 patients had two lesions, and 15 had three lesions simultaneously. Patients admitted with associated lesions in the lower limbs and traumatic brain injury were significantly more referred to conservative treatment.

Morphological diagnosis of lesions obtained by imaging exame showed that patients with linear fracture of the vertebral body and compression fracture were referred to conservative treatment. However, patients with burst fracture, dislocation fracture and listhesis were referred to surgery. Thirty-two individuals had two morphologic diagnoses, whereas three of them had three simultaneous lesions.

Operated individuals were significantly more associated with complications after SCI. There were 86 complication events in 54 patients undergoing surgery, of which 13 had two complications, and seven had three complications. The complications most incidents in individuals submitted to surgery were pneumonia (11%) and urinary tract infection (8%), however, there was no difference among the non-surgical patients.

After admission, hospital stay was significantly longer in individuals undergoing surgery [7 (1–127) days] when compared to those with conservative treatment [3 (1–112) days]. Other variables were not significantly different.

Surgical treatment according to age

We then evaluated if the variable age, <60 years (5–59 years, $n = 182$) or ≥60 years (60–89 years, $n = 29$), played a role in the characteristics of patients undergoing surgery, according to Table 2. Subjects <60 years of age were more associated with motorcycle accidents ($p = 0.023$, Fisher test), whereas elderly individuals were twice as much associated with fall (OR: 1.622, CI: 1.622–8.248, $p = 0.002$, Fisher test).

Elderly patients were three times more associated with SCI in the lower cervical region than younger individuals (OR: 2.593, IC: 1.120–6.000; $p = 0.018$, Fisher test). In relation to

Table 1 – Distribution of individuals (conservative treatment and surgery) according to etiology, topography, morphology of the lesion, neurological status at admission (ASIA), syndromic status, injuries associated with SCI, complications, mortality and other variables.

	Conservator, n = 110 (%)	Surgery, n = 211 (%)	Total, n = 321(%)	OR	CI	p (Fisher test)
Etiology of injury						
Automobile Accident	39 (35)	86 (41)	125 (29)	1.253	0.777–2.019	0.2109
Diving in shallow water	04 (04)	09 (04)	13 (04)	1.181	0.355–3.925	0.5225
Fall the ground	37 (34)	51 (24)	88 (27)	1.590	0.959–2.637	0.0481[b]
Gunshot	03 (03)	06 (03)	09 (03)	1.044	0.256–4.258	0.6282
Motorcycle Accident	13 (12)	36 (17)	49 (15)	1.535	0.777–3.033	0.1404
Sports	08 (07)	13 (06)	21 (07)	0.837	0.336–2.085	0.4342
Trampling	03 (03)	05 (02)	08 (02)	0.866	0.203–3.693	0.5561
Other's[a]	03 (03)	05 (02)	08 (02)			
Morphology						
Burst fracture	08 (07)	68 (32)	76 (24)	6.063	2.792–13.168[b]	<0.0001[b]
Compression fracture	51 (46)	05 (02)	56 (17)	35.614	13.592–93.314[b]	<0.0001[b]
Dislocation fracture	01 (01)	71 (34)	72 (22)	55.279	7.556–404.40[b]	<0.0001[b]
Fracture in the posterior elements	07 (06)	21 (10)	28 (09)	1.626	0.669–3.955	0.1927
Gunshot	03 (03)	06 (03)	09 (03)	1.044	0.256–4.258	0.6282
Linear fracture in the vertebral body	10 (09)	02 (01)	12 (04)	10.450	2.247–48.606[b]	0.0006[b]
Listhesis	08 (07)	43 (20)	51 (16)	3.263	1.475–7.219[b]	0.0013[b]
Odontoid fracture	07 (06)	07 (03)	14 (04)	1.981	0.676–5.799	0.1630
Posterior ligamentar complex injury	02 (02)	06 (03)	08 (02)	1.580	0.314–7.967	0.4439
Spinal cord contusion	08 (07)	08 (04)	16 (05)	1.990	0.726–5.457	0.1385
Other's	05 (05)	07 (03)	12 (04)			
Number of events	111	244	355			
Topography						
Lower cervical (C3–C7)	30 (27)	104 (49)	134 (42)	2.592	1.574–4.269[b]	<0.0001[b]
Lumbosacral (L3–S1)	14 (13)	12 (06)	36 (11)	2.418	1.077–5.430[b]	0.0261[b]
Thoracic (T1–T10)	20 (18)	40 (19)	60 (19)	1.053	0.581–1.908	0.4967
Thoracolumbar transition (T11–L2)	36 (33)	62 (29)	98 (31)	1.169	0.712–1.921	0.3109
Upper cervical (C1–C2)	25 (23)	13 (06)	38 (12)	4.480	2.187–9.175[b]	<0.0001[b]
Number of events	125	231	351			
Neurological status						
ASIA-A	05 (05)	63 (30)	68 (21)	8.939	3.476–22.989[b]	<0.0001[b]
ASIA-B	02 (02)	10 (05)	12 (04)	2.687	0.578–12.488	0.1589
ASIA-C	05 (05)	35 (17)	40 (12)	4.176	1.586–10.994[b]	0.0010[b]
ASIA-D	05 (05)	18 (09)	23 (07)	1.959	0.707–5.427	0.1377
ASIA-E	89 (81)	83 (39)	172 (54)	6.536	3.771–11.329[b]	<0.0001[b]
Coma	04 (04)	02 (01)	06 (02)	3.943	0.711–21.886	0.1075
Syndromic status						
Cervicalgia with paresthesia	35 (32)	47 (22)	82 (26)	1.628	0.972–2.728	0.0432[b]
Coma	04 (04)	02 (01)	06 (02)	3.943	0.711–21.886	0.1075
Dorsal pain with paresthesia	49 (45)	32 (15)	81 (25)	4.493	2.640–7.649[b]	<0.0001[b]
Low back pain	07 (06)	10 (05)	17 (05)	1.366	0.505–3.694	0.3539
Paraparesis	02 (02)	31 (15)	33 (10)	41.006	9.585–175.43[b]	<0.0001[b]
Paraplegia	01 (01)	27 (13)	28 (09)	15.170	2.032–113.24[b]	0.0001[b]
Tetraparesis	06 (05)	23 (11)	29 (09)	2.013	0.795–5.101	0.0948
Tetraplegia	06 (05)	37 (18)	43 (13)	3.686	1.504–9.033[b]	0.0014[b]
Other's[a]	02 (02)	–	02 (01)			
Associated injury						
Abdome Trauma	05 (05)	05 (02)	10 (03)	0.510	0.144–1.801	0.2296
Apendicular lower limb	13 (12)	08 (04)	21 (07)	3.401	1.364–8.479[b]	0.0070[b]
Apendicular upper limb	10 (09)	14 (07)	24 (07)	1.407	0.604–3.281	0.2800
Facial trauma	05 (05)	14 (07)	19 (06)	0.670	0.235–1.912	0.3142
Injuries scalp	01 (01)	05 (02)	06 (02)	0.378	0.044–3.278	0.3308
Traumatic brain injury	26 (24)	26 (12)	52 (16)	2.202	1.207–4.020[b]	0.0079[b]
Thoracic trauma	10 (09)	24 (11)	34 (11)	1.283	0.590–2.791	0.3350
Other's[a]	05 (05)	05 (02)	10 (03)			
Individuals who had associated injury	46 (42)	73 (35)	119 (37)			
Complications	18 (16)	54 (26)	72 (22)	1.758	0.972–3.179	0.0391[b]
Alteration sensorimotor	19 (17)	124 (59)	143 (45)	6.826	3.878–12.016[b]	<0.0001[b]
Mortality	10 (09)	15 (07)	25 (08)	0.765	0.332–1.765	0.3355

OR, Odds Ratio; CI, confidence interval.

[a] Less than three individuals in each category.

[b] Statistically significant.

Table 2 – Distribution of individuals (<60 and ≥60 years) with surgical treatment, according to the etiology, topography, morphology of lesion, admission neurological status (ASIA), syndromic status, associated injuries with SCI, complications and mortality.

	<60 years (*n* = 182)	≥60 years (*n* = 29)	Total (*n* = 211)
Etiology of injury			
Automobile Accident	76 (42)	10 (34)	86 (41)
Diving in shallow water	09 (05)	–	09 (04)
Fall the ground	37 (20)	14 (48)	51 (24)
Gunshot	06 (03)	–	06 (03)
Motorcycle Accident	35 (19)	01 (03)	36 (17)
Sports	12 (07)	01 (03)	13 (06)
Other's[a]	07 (04)	03 (10)	10 (05)
Morphology			
Burst fracture	58 (32)	10 (34)	68 (32)
Compression fracture	05 (03)	01 (03)	06 (03)
Dislocation fracture	67 (37)	04 (14)	71 (34)
Gunshot	06 (03)	–	06 (03)
Listhesis	32 (18)	11 (38)	43 (20)
Odontoid fracture	07 (04)	–	07 (03)
Posterior ligamentar complex injury	05 (03)	01 (03)	06 (03)
Spinal cord contusion	06 (03)	02 (07)	08 (04)
Other's	14 (08)	01 (03)	15 (07)
Number of events	200	30	230
Topography			
Lower cervical (C3-C7)	84 (46)	20 (69)	104 (49)
Lumbosacral (L3-S1)	12 (07)	–	12 (06)
Thoracic (T1-T10)	35 (19)	04 (14)	39 (18)
Thoracolumbar transition (T11-L2)	56 (31)	06 (21)	62 (29)
Upper cervical (C1-C2)	13 (07)	–	13 (06)
Number of events	200	30	230
Neurological status			
ASIA-A	56 (31)	07 (24)	63 (30)
ASIA-B	08 (04)	02 (07)	10 (05)
ASIA-C	27 (15)	08 (28)	35 (17)
ASIA-D	17 (09)	01 (03)	18 (09)
ASIA-E	72 (40)	11 (38)	83 (39)
Coma	02 (01)	–	02 (01)
Syndromic status			
Cervicalgia with paresthesia	38 (21)	09 (31)	47 (22)
Dorsal pain with paresthesia	30 (16)	02 (07)	32 (15)
Low back pain	09 (05)	01 (03)	10 (05)
Paraparesis	26 (14)	05 (17)	31 (15)
Paraplegia	25 (14)	02 (07)	27 (13)
Tetraparesis	19 (10)	04 (14)	23 (11)
Tetraplegia	32 (18)	05 (17)	37 (18)
Other's[a]	03 (02)	01 (03)	04 (02)
Associated injury			
Abdome Trauma	05 (03)	–	05 (02)
Apendicular lower limb	07 (04)	01 (03)	08 (04)
Apendicular upper limb	15 (08)	02 (07)	17 (08)
Facial trauma	14 (08)	–	14 (07)
Injuries scalp	05 (03)	–	05 (02)
Thoracic trauma	19 (10)	03 (10)	22 (10)
Traumatic brain injury	23 (13)	02 (07)	25 (12)
Other's[a]	04 (02)	01 (03)	05 (02)
Individuals who had associated injury	68	05	73
Complications			
Athelectasis	05 (03)	–	05 (02)
Hypovolemic shock	03 (02)	–	03 (01)
Late hemodynamic instability	02 (01)	02 (07)	04 (02)
Urinary tract infection	12 (07)	04 (14)	16 (08)
Pneumonia	19 (10)	04 (14)	23 (11)
Surgical wound infections	02 (01)	01 (03)	03 (01)
Sepsis	02 (01)	01 (03)	03 (01)
Other's[a]	29 (16)	02 (07)	31 (15)
Individuals who had complications	44 (24)	10 (34)	54 (26)
Mortality	09 (05)	06 (21)	15 (07)

OR, Odds Ratio; CI, confidence interval.

[a] Less than three individuals in each category.

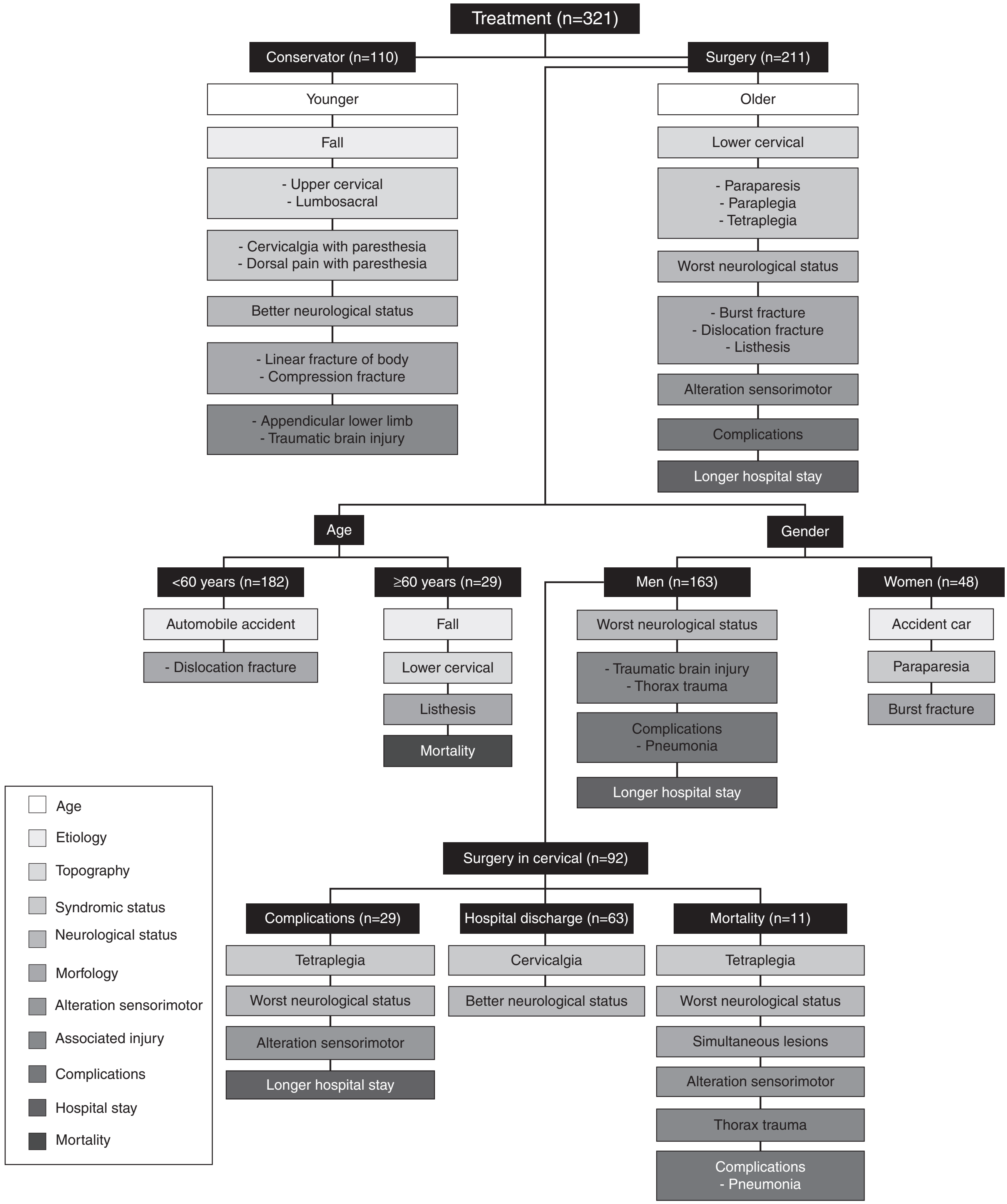

Fig. 1 – Factors most associated with surgery when compared to conservative treatment, age, gender and morbidity/mortality in men undergoing surgical treatment in the cervical spine.

topography and the morphologic diagnosis, 19 patients had two simultaneous lesions. The morphologies of injury, dislocation fracture (OR: 3.641, CI: 1.215–10.916; $p = 0.010$, Fisher test) and listhesis (OR: 2.865, CI: 1.234–6.647, $p = 0.015$, Fisher test) were significantly more associated with age <60 years and ≥60 years, respectively.

Twenty-four patients had two, and four had three concomitant lesions. Twenty-seven patients had two, and seven had three complications at the same time. However, associated injuries and complications did not differ between the different age groups ($p > 0.05$).

Hospital stay was similar between the different age groups ($p = 0.071$, Mann–Whitney test). However, the number of deaths was five times more associated with elderly patients (OR: 5.014, CI: 1.634–15.386; $p = 0.008$, Fisher test). Other variables were not significantly different.

Surgical treatment according to gender

Subsequently, we analyzed the characteristics of both genders (♂$n = 163$; ♀$n = 48$) in patients undergoing surgery. The characterization and predictive factors are shown in Table 3. Mean age in operated women [37 (6–84) years] was not significantly different ($p = 0.160$, Mann–Whitney test) than in men [36 (5–89) years]. We observed that women who suffered car accidents were three times more subjected to surgical intervention.

Nineteen individuals had two morphological simultaneous diagnoses. Nineteen patients had two, and five had three lesions associated with SCI. Men with traumatic brain injury and thoracic trauma were more related to surgery than women.

Twenty individuals presented lesions in two regions concomitantly. The topography of lesion was divided into upper (6%) and lower cervical (49%) spine, thorax (19%), thoracolumbar (29%) and lumbosacral (6%) transition. The affected regions did not differ between genders.

When analyzing the symptoms, it was observed that women are three times more associated with paraparesis. Still, women were more associated with the morphologic diagnosis burst fracture, especially in the thoracolumbar transition and lower back (OR: 18.4, IC: 4.266–79.371; $p < 0.0001$, Fisher test).

Men have a worse neurological status and had three times more complications than women, especially the presence of pneumonia after surgery. Twenty patients had two complications, whereas seven patients had three simultaneous complications. The length of hospital stay in men [8 (1–127 days] was significantly higher than in women [5 (1–34) days]. Other variables were not significantly different.

Morbidity/mortality in men undergoing surgical treatment after SCI in the cervical spine

As observed previously, men and cervical region were most affected and are more susceptible to complications, thereby, these subjects were analyzed separately. The characterization and predictive factors are shown in Tables 4 and 5.

Ninety-two men were analyzed. They were divided into a group without complications ($n = 63$) and another group of patients who presented complications ($n = 29$). Mean age (without complications = 41 ± 17 years; with complications = 46 ± 20 years) was similar ($p = 0.162$, unpaired t-test). Individuals with complications had longer hospital stay ($p < 0.0001$, Mann–Whitney test). The main cause of SCI in both groups was motor vehicle accident, corresponding to 43% of the individuals (Table 4).

The main morphologies of trauma were: fracture dislocation (37%) and listhesis (34%). Six individuals had two morphological lesions associated to SCI (Table 4). The presence of two simultaneous morphological diagnoses of injury increased the association with postoperative complications. The most prevalent topography of injury was C6 ($n = 58$), followed by C5 ($n = 45$), C7 ($n = 27$), C4 ($n = 24$), C3 ($n = 12$), C2 ($n = 10$) and C1 ($n = 1$). Four patients had four injured vertebrae, 11 had injuries in three vertebrae, 61 in two, and 16 had only an injured vertebra. Furthermore, ten patients had a vertebral injury in the thoracic spine simultaneously.

The most common neurologic status according to the ASIA scale were "E" (35%), followed by "A" (33%). However, individuals without complications had predominantly ASIA-E (41%), whereas ASIA-A (69%) was more associated to complications (Table 4).

The most prevalent syndromic state was tetraplegia (33%), followed by cervicalgia (29%). The tetraplegia was more associated with the development of complications after surgery. There were sensorimotor alterations in the groups (no-complication = 34; complication = 23). Individuals with complications were three times more associated with sensorimotor alterations subsequent to SCI. Thirty-eight men suffered injuries associated with the SCI (without complications = 27, with complications = 11). Traumatic Brain Injury was the most common in this population (without complications = 15, with complication = 6), as shown in Table 4. Thoracic trauma was the second most frequent associated injury in patients with complications (14%). However, only thoracic trauma demonstrated an association with mortality (Table 5). Two subjects suffered three injuries, 14 suffered two, and the others ($n = 32$) only one injury associated with the SCI.

The most common complications presented were pneumonia (66%), urinary tract infection (31%), atelectasis (14%), hypovolemic shock (7%), late hemodynamic instability (7%), sepsis (7%) and others complications in only one individual per category (45%). Five subjects had three complications, 12 had two, and the others ($n = 12$) had only one complication after the SCI. There were 11 cases of death, 82% in the individuals with complications. Complications were 14 times more associated with mortality. Pneumonia was associated with increased mortality (OR: 31.95, CI = 6.02–169.64; $p < 0.0001$). Neurological status ASIA-A was 30 times more associated with mortality and ASIA-E was more associated with hospital discharge (Table 5). Tetraplegia, sensorimotor alterations and the presence of two morphological injury diagnoses were more associated with mortality. Cervicalgia was more associated with hospital discharge (Table 5).

Discussion

Aiming at identifying the characteristics and clinical aspects of patients with spinal cord injury undergoing surgery, we analyzed the variables most associated with surgery when compared to conservative treatment, age, gender and morbidity/mortality in men submitted to surgical treatment in the cervical.

The most frequent cause of SCI was car accident, but it was not a determining variable in the choice of treatment. Falling was more associated with conservative treatment and with elderly when submitted to surgery. The increased risk of

Table 3 – Distribution of individuals (men and women) with surgical treatment, according to the etiology, morphology of lesion, admission neurological status (ASIA), syndromic status, associated injuries with SCI, complications and mortality.

	Women (n = 48)	Men (n = 163)	Total (n = 211)	OR	CI	p (Fisher test)
Etiology						
Automobile Accident	28 (58)	58 (36)	86 (41)	2.534	1.313–4.891[b]	0.0042[b]
Diving in shallow water	–	09 (06)	09 (04)	5.964	0.341–104.44	0.0930
Fall the ground	11 (23)	40 (25)	51 (24)	1.094	0.511–2.344	0.4917
Gunshot	01 (02)	05 (03)	06 (03)	1.487	0.170–13.054	0.5873
Motorcycle Accident	06 (13)	30 (18)	36 (17)	1.579	0.615–4.054	0.2344
Sports	02 (04)	11 (07)	13 (06)	1.664	0.356–7.785	0.3985
Other's[a]	–	10 (06)	10 (05)			
Morphology						
Burst fracture	21 (44)	47 (29)	68 (32)	1.936	0.997–3.759	0.0380[b]
Compression fracture	01(02)	05 (03)	06 (03)	0.672	0.077–5.901	0.5873
Dislocation fracture	16 (33)	55 (34)	71 (34)	0.982	0.496–1.943	0.5522
Fracture in the posterior elements	07 (15)	–	07 (03)	4.649	0.261–82.934	0.1593
Gunshot	01 (02)	05 (03)	06 (03)	0.672	0.077–5.901	0.5873
Listhesis	07 (15)	35 (21)	42 (20)	1.602	0.661–3.879	0.2011
Odontoid fracture	–	07 (04)	07 (03)	4.649	0.261–82.934	0.1593
Posterior ligamentar complex injury	01 (02)	05 (03)	06 (03)	1.487	0.170–13.054	0.5873
Spinal cord contusion	02 (04)	06 (04)	08 (04)	1.138	0.222–5.830	0.5782
Other's	02 (04)	07 (04)	09 (04)			
Number of events	58	172	230			
Neurological status						
ASIA-A	09 (19)	54 (33)	63 (30)	2.147	0.970–4.754	0.0385[b]
ASIA-B	03 (06)	07 (04)	10 (05)	0.673	0.167–2.710	0.4064
ASIA-C	10 (21)	25 (15)	35 (17)	0.688	0.304–1.558	0.2441
ASIA-D	06 (13)	12 (07)	18 (09)	0.556	0.197–1.571	0.2002
ASIA-E	20 (42)	63 (39)	83 (39)	1.134	0.589–2.182	0.4153
Coma	–	02 (01)	02 (01)	1.502	0.071–31.834	0.5959
Syndromic status						
Cervicalgia with paresthesia	12 (25)	35 (21)	47 (22)	0.820	0.386–1.742	0.3683
Dorsal pain with paresthesia	08 (17)	24 (15)	32 (15)	0.863	0.360–2.069	0.4483
Low back pain	02 (04)	08 (05)	10 (05)	1.187	0.243–5.789	0.5936
Paraparesis	13 (27)	18 (11)	31 (15)	2.992	1.340–6.682b	0.0078[b]
Paraplegia	03 (06)	24 (15)	27 (13)	2.590	0.745–9.010	0.0918
Tetraparesis	04 (08)	19 (12)	23 (11)	1.451	0.469–4.494	0.3628
Tetraplegia	06 (13)	31 (19)	37 (18)	1.644	0.642–4.212	0.2064
Other's[a]	04 (08)	02 (01)	06 (03)			
Associated injury						
Abdome Trauma	01 (02)	04 (02)	05 (03)	1.182	0.129–10.842	0.6807
Apendicular lower limb	03 (06)	05 (03)	08 (04)	0.475	0.109–2.064	0.2640
Apendicular upper limb	01 (02)	15 (09)	16 (08)	4.764	0.613–37.046	0.0834
Facial trauma	01 (02)	13 (08)	14 (07)	4.073	0.519–31.981	0.1293
Injuries scalp	01 (02)	04 (02)	05 (03)	1.182	0.129–10.842	0.6807
Thoracic trauma	01 (02)	20 (12)	21 (10)	6.573	0.858–50.338	0.0259[b]
Traumatic brain injury	02 (04)	24 (15)	26 (12)	3.971	0.903–17.461	0.0356[b]
Other's[a]	02 (04)	05 (03)	07 (07)			
Individuals who had associated injury	13	60	73			
Complications						
Hypovolemic shock	–	03 (02)	03 (01)	2.115	0.107–41.698	0.4591
Urinary tract infection	02 (04)	14 (09)	16 (08)	2.161	0.473–9.865	0.2487
Pneumonia	–	23 (14)	23 (11)	16.224	0.966–272.41	0.0018[b]
Surgical wound infections	01 (02)	02 (01)	03 (01)	1.713	0.152–19.318	0.5409
Sepsis	–	03 (02)	03 (01)	2.115	0.107–41.698	0.4591
Other's[a]	03 (06)	32 (20)	35 (17)			
Individuals who had complications	05 (10)	49 (30)	54 (26)	3.696	1.380–9.898b	0.0035[b]
Mortality	02 (04)	13 (08)	15 (07)	1.993	0.434–9.162	0.2931

OR, Odds Ratio; CI, confidence interval.

[a] Less than three individuals in each category.

[b] Statistically significant.

Table 4 – Distribution of individuals (no-complications and complications) with surgical treatment in the cervical region, according to the etiology, morphology of lesion, admission neurological status (ASIA), syndromic status, associated injuries with SCI, complications and mortality.

	No-complications, n = 63 (%)	Complications, n = 29 (%)	Total, n = 92 (%)	OR	CI	p (Fisher test)
Etiology of injury						
Automobile Accident	29 (46)	11 (38)	40 (43)	0.716	0.292–1.761	0.505
Diving in shallow water	05 (08)	04 (14)	09 (10)	1.856	0.459–7.498	0.456
Fall the ground	12 (19)	07 (24)	19 (21)	1.352	0.469–3.895	0.588
Motorcycle Accident	07 (11)	03 (10)	10 (11)	0.923	0.221–3.860	1.000
Sports	06 (10)	04 (14)	10 (11)	1.520	0.394–5.863	0.720
Other's	04 (06)	–	04 (04)	–	–	–
Morphology						
Burst fracture	10 (16)	01(03)	11 (12)	0.189	0.023–1.556	0.163
Dislocation fracture	21 (33)	13 (45)	34 (37)	1.625	0.661–3.998	0.354
Linear fracture in the vertebral body	02 (03)	03 (10)	05 (05)	3.519	0.555–22.328	0.321
Listhesis	23 (37)	08 (28)	31 (34)	0.662	0.523–1.735	0.481
Odontoid fracture	05 (08)	01 (03)	06 (07)	0.661	0.046–3.718	0.661
Spinal cord contusion	02 (03)	04 (14)	06 (07)	4.880	0.839–28.378	0.076
Other's	–	05 (17)	05 (05)	–	–	–
Number of events	63	35				
Admission neurological status						
ASIA-A	10 (16)	20 (69)	30 (33)	11.778	4.174–33.233[b]	<0.0001[b]
ASIA-B	03 (05)	01 (03)	04 (04)	0.714	0.071–7.180	1.000
ASIA-C	13 (21)	02 (07)	15 (16)	0.285	0.060–1.357	0.132
ASIA-D	09 (14)	-	09 (10)	0.097	0.005–1.731	0.053
ASIA-E	26 (41)	06 (21)	32 (35)	0.371	0.133–1.039	0.063
Coma	02 (03)	–	02 (02)	0.417	0.019–8.970	1.000
Syndromic status						
Cervicalgia with paresthesia	29 (46)	06 (21)	35 (38)	3.270	1.172–9.124[b]	0.016[b]
Paraparesis	02 (03)	01 (04)	03 (03)	1.089	0.095–12.527	1.000
Tetraparesis	16 (25)	03 (10)	19 (21)	0.339	0.090–1.273	0.164
Tetraplegia	11 (18)	19 (65)	30 (31)	8.982	3.288–24.536[b]	<0.0001[b]
Other's[a]	05 (08)	–	05 (07)	–	–	–
Associated injury						
Apendicular lower limb	01 (02)	02 (07)	03 (03)	4.593	0.399–52.861	0.233
Apendicular upper limb	06 (10)	02 (07)	08 (09)	0.704	0.133–3.719	1.000
Facial trauma	08 (13)	01 (03)	09 (10)	0.245	0.029–2.063	0.264
Injuries scalp	02 (03)	02 (07)	04 (04)	2.259	0.302–16.898	0.588
Thoracic trauma	04 (06)	03 (10)	07 (08)	1.702	0.355–8.155	0.674
Traumatic brain injury	15 (24)	05 (18)	20 (22)	0.667	0.216–2.053	0.592
Other's[a]	02 (03)	01 (03)	03 (03)	–	–	–
Individuals who had associated injury	27	11	38			
Two morphological diagnoses of injury simultaneously		06 (10)	06 (07)	35.128	1.902–648.600[b]	0.0007[b]
Alteration sensorimotor	34 (54)	23 (80)	57 (62)	3.270	1.172–9.124[b]	0.023[b]
Mortality	02 (03)	09 (31)	11 (12)	13.725	2.733–68.915[b]	0.0004[b]

OR, Odds Ratio; CI, confidence interval.

a Just one individual in each category.

b Statistically significant.

falling in the elderly may be due to musculoskeletal weakness, decreased proprioception and balance, cognitive impairment and visual, polypharmacy and associated diseases.[12] Moreover, cultural factors and regional differences must not be neglected.[7]

Regarding the affected segment, the upper cervical and lumbosacral regions were more associated with conservative treatment. Possibly due to the size of the vertebral canal in the upper cervical spine and high stabilization provided to ligaments of atlanto-occipital articulation, lesions in this region are stable and rare. In relation the lumbar (L3–L5) region, a better prognosis may be explained by the fact that the vertebral body is wider; by the amount of muscles; orientation of articular facets; pelvic stability and ilio-lumbar ligaments.[13] The lower cervical region was the most affected in individuals who required surgery, and age was a determining factor. In this region, the bony and ligamentous elements are totally responsible for the stabilization of segmental vertebrae and the canal is narrower, thereby, the SCI can be more severe.[13] Thus, the affected segment determines the most appropriate treatment.

When subjected to imaging tests, there was an association of linear fracture of the vertebral body and compression

Table 5 – Distribution of individuals (mortality and hospital discharge) with surgery treatment in the cervical region, according to the associated injuries with SCI, neurological status (ASIA), syndromic status and other variables.

	Mortality (*n* = 11)	Hospital discharge (*n* = 81)	OR	CI	*p* (Fisher test)
Associated injury					
Apendicular upper limb	02 (18)	06 (07)	2.778	0.486–15.885	0.244
Facial trauma	–	08 (10)	0.376	0.020–6.970	0.589
Thoracic trauma	03 (27)	02 (02)	14.813	2.146–102.24[b]	0.011[b]
Traumatic brain injury	02 (18)	14 (17)	1.278	0.245–6.658	0.672
Other's[a]	02 (18)	05 (06)	–	–	–
Individuals who had associated injury	06	32			
Admission neurological status					
ASIA-A	10 (91)	20 (25)	30.500	3.671–253.41[b]	<0.0001[b]
ASIA-B	–	04 (05)	0.749	0.038–14.852	1.000
ASIA-C	01 (09)	14 (17)	0.479	0.057–4.049	0.685
ASIA-D	–	09 (11)	0.332	0.018–6.102	0.593
ASIA-E	–	32 (40)	15.101	0.859–265.41	0.007[b]
Coma	–	02 (02)	1.383	0.062–30.674	1.000
Syndromic status					
Cervicalgia with paresthesia	–	35 (43)	17.559	1.000–308.34	0.003[b]
Paraparesis	–	03 (04)	1.025	0.050–21.179	1.000
Tetraparesis	02 (18)	17 (21)	1.108	0.218–5.638	1.000
Tetraplegia	08 (73)	22 (27)	7.152	1.738–29.430[b]	0.005[b]
Other'sa	–	07 (09)	–	–	–
Two morphological diagnoses of injury simultaneously	03 (27)	03 (04)	10.125	1.746–58.726[b]	0.019[b]
Alteration sensorimotor	11 (14)	34 (42)	31.667	1.803–556.210[b]	0.0002

OR, Odds Ratio; CI, confidence interval.

[a] Just one or two individual in each category.

[b] Statistically significant.

fracture to conservative treatment, whereas listhesis, burst fracture and dislocation fracture were more associated with surgery. Surgical intervention may be related the need to stabilize the spine to prevent neurological damage or deformities in the injured region. In this context, the immediate immobilization after any type of trauma is extremely relevant.[13]

Listhesis and dislocation fracture were more frequently observed in the elderly, and individuals with <60 years, respectively. These morphologies promote failures in three columns of Denis[10] being the most unstable injuries[8,14] and can result in poor prognosis for the patient.

Listhesis refers to the anterior or posterior sliding relative to the lower vertebra.[15] In this study it was observed that the fall was the cause more closely associated with the elderly. Thus, this etiology associated with progressive degeneration of articular facets and intervertebral discs during aging,[15] may justify the morphology more associated with elderly.

In younger patients (<60 years), motorcycle accident demonstrated to be a determining factor for the need for surgery. According to Oliveira et al.,[16] these patients do not use appropriate safety equipment or are associated with some type of traffic infraction, and are more susceptible to polytrauma. Therefore, the etiology of injury can justify the morphology (fracture dislocation) associated to this population, with the presence of bone lesions and adjacent soft tissues. These results indicate the need of investments in traffic education as a means of prevention.

In addition, older patients were significantly more submitted to surgery, and the elderly had increased mortality. This can be explained by the higher prevalence of comorbidities in these patients.[17]

Women with SCI were more associated with the necessity of surgery and with burst fracture. However, the non-surgical treatment has been recommended due to a satisfactory functional prognosis after this morphologic diagnosis of lesion.[18] Burst fracture involves the axial constriction of vertebral body, more frequent in a high degree of flexion, with comminuted characteristic, involving the upper plateau and the posterior margin of vertebral body with retropulsion of fragment for the vertebral canal.[19] The high rate of surgery in women observed in this study is probably due to the need for decompression of neural elements to preserve or improve neurological function.[13] Therefore, a radiological evaluation could help in the choice of an appropriate therapy.

In men the presence of two morphologic diagnosis of simultaneous injury was associated with higher mortality, regardless of the morphology. This type of injury requires multilevel spinal fusion, is more traumatic to the patient, has longer surgery time and loss of intraoperative blood.[20] Thus, these factors render patients more vulnerable to evolve with death.

During clinical evaluation, women have a greater association with paraparesis. This is a result of the higher incidence of burst fracture in the thoracolumbar transition and lumbar region.[13] This morphology is frequently displayed when the sample is associated with automobile accidents. These results were demonstrated in this research. Neurological status, clinical status (paresis and plegia) and sensory and motor function were variables associated with the choice of treatment when negative. However, when individuals are analyzed according to gender, a worse status and sensorimotor alterations were significantly more frequent among men, being a determining factor for the presence of complications and mortality when submitted to surgery in the cervical spine. Chen and Chen[21] indicate that these prognostic factors should be analyzed together with imaging tests. The presence of unstable fractures in the spine is determinant in the choice of treatment.

In individuals submitted to conservative treatment the associated lesions in the lower appendicular limb and traumatic brain injury are more frequent. Among patients undergoing surgery, men were more related to the presence of polytrauma, being the traumatic brain injury and thoracic trauma the most common ones. The highest incidence of polytrauma in men is related to greater frequency in driving motor vehicles and vulnerability to urban violence.[22] Therefore, the characterization of these patients contributes to social and educational projects and should be implemented to reduce their incidence.

Tetraplegia and thoracic trauma were more associated with complications and mortality in men submitted to surgery in the cervical region. These individuals have more complications after SCI, especially pneumonia, are associated with mortality when submitted to surgery in the cervical region. These variables are related because the thoracic trauma alters the pulmonary mechanics. Furthermore, pneumonia may be due to paralysis of the diaphragm muscle (innervation: phrenic nerve; medullar level: C3–C5) and functional deficiency of the accessory muscles in breathing. Still, an imbalance of autonomic function may result in hypertrophy of mucous glands in the lower airways, leading to pulmonary hypersecretion.[3,23] Immobility may influence other clinical complications,[24] highlighting the importance of early physiotherapy in these patients.

Variables such as surgical treatment, male gender and the presence of complications contributed to longer hospital stay. Intensive physiotherapy has demonstrated to be essential in reducing the length of hospital stay and costs,[25] operating focused on motor rehabilitation, respiratory intervention and use of electrotherapy resources to stimulate the muscles which are in disuse, secondary to denervation.[26] Therefore preventing clinical complications, promoting greater functional independence and resulting in improved quality of life.[26]

Conclusion

These characteristics contribute to better conduct in the diagnosis of patients, enabling more appropriate and rapid intervention treatment. Moreover, age and gender indicate particularities which should be taken into account during clinical management.

Therefore, the characterization of patients undergoing surgery contributes directly to a better care and therapy. Thus, being aware of these factors enables a better prognosis, providing better investments in prevention, rehabilitation and appropriate treatment of patients with SCI undergoing surgery.

Conflicts of interest

The authors declare no conflicts of interest.

REFERENCES

1. de Melo Neto JS, Tognola WA, Spotti AR, Morais DF. Analysis of patients with spinal cord trauma associated with traumatic brain injury. Coluna/Columna. 2014;13(4):302–5.
2. Morais DF, de Melo Neto JS, Meguins LC, Mussi SE, Filho JR, Tognola WA. Clinical applicability of magnetic resonance imaging in acute spinal cord trauma. Eur Spine J. 2014;23(7):1457–63.
3. Morais DF, de Melo Neto JS, Spotti AR, Tognola WA. Predictors of clinical complications in patients with spinomedullary injury. Coluna/Columna. 2014;13(2):139–42.
4. Grossman RG, Frankowski RF, Burau KD, Toups EG, Crommett JW, Johnson MM, et al. Incidence and severity of acute complications after spinal cord injury. J Neurosurg Spine. 2012;17 1 Suppl.:119–28.
5. Santos EA, Santos Filho WJ, Possatti LL, Bittencourt LR, Fontoura EA, Botelho RV. Clinical complications in patients with severe cervical spinal trauma: a ten-year prospective study. Arq Neuropsiquiatr. 2012;70(7):524–8.
6. Cunha MLV, Araújo Júnior FA, Grapiglia CC, Veríssimo DCA, Rehder R, Bark SA, et al. Complications of the anterior approach to the cervical spine. Coluna/Columna. 2014;13(3):177–9.
7. Koch A, Graells XSI, Zaninelli EM. Epidemiologia de fraturas da coluna de acordo com o mecanismo de trauma: análise de 502 casos. Coluna/Columna. 2007;6(1):18–23.
8. Herculano MA, Tella Júnior OI, Bonatelli APF. Tratamento cirúrgico das lesões traumáticas do segmento médio-inferior da coluna cervical. Arq Neuro-Psiquiatr. 2000;58(3A):656–63.
9. Bernardi DM. Epidemiologic profile of surgery for spinomedullary injury at a referral hospital in a country town of Brazil. Coluna/Columna. 2014;13(2):136–8.
10. Denis F. Spine instability as defined by the three-column spine concept in acute spinal trauma. Clin Orthop Relat Res. 1984;(189):65–76.
11. Ditunno JF, Young W, Donovan WH, Creasey G. The international standards booklet for neurological and functional classification of spinal cord injury. American Spinal Injury Association. Paraplegia. 1994;32(2):70–80.
12. Güzelküçük Ü, Demir Y, Kesikburun S, Yaşar E, Yılmaz B. Spinal cord injury in older population in Turkey. Spinal Cord. 2014;52(11):850–4.
13. Grant RA, Quon JL, Abbed KM. Management of acute traumatic spinal cord injury. Curr Treat Options Neurol. 2015;17(2):334.
14. Jindal R, Pruthi M, Garg S, Sharma RB. Traumatic L4-5 spondylolisthesis: case report and literature review. Eur J Orthop Surg Traumatol. 2012;22:61.
15. He LC, Wang YX, Gong JS, Griffith JF, Zeng XJ, Kwok AW, et al. Prevalence and risk factors of lumbar spondylolisthesis in elderly Chinese men and women. Eur Radiol. 2014;24(2):441–8.
16. Oliveira TAB, Andrade SMS, Prado GO, Fernandes RB, Gusmão MS, Gomes EGF, et al. Epidemiology of spine fractures in motorcycle accident victims. Coluna/Columna. 2016;15(1):65–7.
17. Legrand E, Chappard D, Pascaretti C, Duquenne M, Rondeau C, Simon Y, et al. Bone mineral density and vertebral fractures in men. Osteoporos Int. 1999;10(4):265–70.

18. Seybold EA, Sweeney CA, Fredrickson BE, Warhold LG, Bernini PM. Functional outcome of low lumbar burst fractures. A multicenter review of operative and nonoperative treatment of L3–L5. Spine (Phila Pa 1976). 1999;24(20):2154–61.
19. Morais DF, Spotti AR, Cohen MI, Mussi SE, Melo Neto JS, Tognola WA. Perfil epidemiológico de pacientes com traumatismo raquimedular atendidos em hospital terciário. Coluna/Columna. 2013;12(2):149–52.
20. Smorgick Y, Park DK, Baker KC, Lurie JD, Tosteson TD, Zhao W, et al. Single- versus multilevel fusion for single-level degenerative spondylolisthesis and multilevel lumbar stenosis: four-year results of the spine patient outcomes research trial. Spine (Phila Pa 1976). 2013;38(10): 797–805.
21. Chen QM, Chen QX. Multivariate analysis for prognostic factors on non-operative treatment of cervical spinal cord injury without fracture or dislocation. Zhongguo Gu Shang. 2016;29(3):242–7.
22. Castro RRM, Ribeiro NF, Andrade AM, Jaques BD. Profile of patients of orthopedic ward of a public hospital in Salvador-Bahia. Acta Ortop Bras. 2013;21(4):191–4.
23. Chen Y, Shao J, Zhu W, Jia LS, Chen XS. Identification of risk factors for respiratory complications in upper cervical spinal injured patients with neurological impairment. Acta Orthop Traumatol Turc. 2013;47(2):111–7.
24. Cazeiro APM, Peres PT. A Terapia Ocupacional na prevenção e no tratamento de complicações decorrentes da imobilização no leito. Cade Ter Ocup UFSCar. 2010;18:149–67.
25. Berney S, Stockton K, Berlowitz D, Denehy L. Can early extubation and intensive physiotherapy decrease length of stay of acute quadriplegic patients in intensive care? A retrospective case control study. Physiother Res Int. 2002;7(1):14–22.
26. Ferreira LL, Marino LHC, Cavenaghi S. Atuação fisioterapêutica no trauma raquimedular em ambiente hospitalar. Rev BrasCiênc Saúde. 2012;10(1):55–60.