A cost analysis of radiologic imaging in pediatric trauma patients

Pediatrik travmalı hastalarda radyolojik maliyet analizi

Ahmet GÜZEL,[1] Osman TEMİZÖZ,[2] Burhan AKSU,[3] Necdet SÜT,[4] Serap KARASALİHOĞLU[1]

BACKGROUND

The aim of this study was to examine the cost of radiologic imaging in pediatric trauma patients admitted to the pediatric emergency department.

METHODS

All patients were retrospectively evaluated according to age, gender, details of injury, radiological investigations ordered and their results, cost of radiologic imaging, length of stay, outcome of the injury, and hospitalization rates.

RESULTS

The cost of radiologic imaging was retrospectively analyzed in 1231 trauma patients aged between one month and 15 years (mean 5.91±3.82 years). For the 996 patients who had radiological imaging, 3382 images were taken in total. Of these, only 300 (8.8%) were abnormal. The mean (and SD) total cost of radiologic imaging was US$ 40.42 ($34.38) (range $4.67 to $139.26). Total cost correlated inversely with Glasgow Coma Scale (GCS) (r= -0.37, p<0.001), directly with Injury Severity Score (ISS) (r= 0.27, p<0.001) and was not correlated with the Pediatric Trauma Score (PTS) (r= -0.16, p>0.05). The mean (and SD) duration of hospital stays was 8.54 (10.91) hours.

CONCLUSION

Advanced radiological images may help in early diagnosis of trauma cases. However, periodic education programs to prevent unnecessary radiological imaging in emergency departments are also necessary to decrease the cost of these imaging modalities.

Key Words: Cost; trauma; pediatric; radiology; imaging.

AMAÇ

Çocuk acil servisimize travma nedeniyle başvuran hastalarda radyolojik maliyet analizi yapmaktır.

GEREÇ VE YÖNTEM

Tüm olguların yaş, cinsiyet, travma tipi, istenilen radyolojik görüntüleme sonuçları ve bunların maliyetleri, hastaların gözlem süreleri ve tedavi sonuçları ile hastaneye yatış oranları geriye dönük olarak incelendi.

BULGULAR

Bu çalışmada yaşları 1-15 yaş arasında değişen ve yaş ortalaması 5,91±3,82 yıl olan 1231 travma olgusu incelendi. Radyolojik inceleme yapılan 996 olguya toplam 3382 radyolojik görüntüleme yapılmıştı ve bunlardan sadece 300'ünde (8,8%) patolojik bulgu mevcuttu. Ortalama radyolojik görüntülemelerin maliyeti 40,42±34,38 US$ (4,67-139,26 US$) idi. Total radyolojik inceleme maliyeti Glaskow Koma Skalası ile ters (r= -0,37, p<0,001) ve Travma Şiddet Skoru ile doğru (r= 0,27, p<0,001) orantılı olarak artış gösterirken Pediatrik Travma Skoru ile arasında anlamlı bir ilişki yoktu (r= -0,16, p>0,05). Çalışmaya alınan olguların hastanede kalış süresi ise ortalama 8,54±10,91 saat idi.

SONUÇ

Travmalı hastalarda ileri görüntüleme yöntemleri erken tanıda yardımcı bir unsurdur. Bununla birlikte acil servislerde gereksiz radyolojik incelemelerin ve bu incelemelere ait maliyetlerin azaltılması için periyodik eğitim programlarının uygulanması gerekmektedir.

Anahtar Sözcükler: Maliyet; travma; pediatrik; radyoloji; görüntüleme.

Departments of [1]Pediatrics, [2]Radiology, [3]Pediatric Surgery, [4]Bioistatistics, Trakya University, Faculty of Medicine, Edirne, Turkey.

Trakya Üniversitesi Tıp Fakültesi, [1]Çocuk Sağlığı ve Hastalıkları Anabilim Dalı, [2]Radyoloji Anabilim Dalı, [3]Çocuk Cerrahisi Anabilim Dalı, [4]Biyoistatistik Anabilim Dalı, Edirne.

Correspondence *(İletişim):* Ahmet Güzel, M.D. Trakya University Faculty of Medicine, Department of Pediatrics, 22030 Edirne, Turkey.
Tel: +90 - 284 - 235 76 41 / 3020 Fax *(Faks)*: +90 - 284 - 235 23 38 e-mail *(e-posta):* ahmetgzl@yahoo.com

Trauma is the most common cause of childhood morbidity and mortality despite regulatory intervention and medical advances.[1] Several trauma scoring systems have been developed to measure the severity of the injury and to analyze its impact on morbidity and mortality for trauma research. The most common scoring systems used include the Injury Severity Score (ISS),[2] Revised Trauma Score (RTS),[3] Pediatric Trauma Score (PTS),[4] APACHE II score,[5] A Severity Characterization of Trauma (ASCOT),[6] and the Trauma and Injury Severity Score (TRISS).[7]

Emergency units are important departments for admitted trauma cases and the largest clinical cost centers in hospitals. Cost studies have been conducted in some countries in pediatric trauma including pediatric trauma scores[8-10] but they are rare in Turkey.[11] These studies have estimated the overall costs of trauma cases in pediatric emergency departments[8-10] but no detailed study has estimated the cost of radiologic imaging in pediatric trauma cases. However, advanced imaging such as computed tomography (CT) is widely available and inexpensive both in Turkey and elsewhere. The decision to perform radiologic imaging of a patient who presents with trauma may be influenced by social conditions, such as medico-legal factors or family demand. Unnecessary radiation exposure and cost should be avoided if possible. The aim of our study was to call attention to purely the costs of radiological imaging and thus we did not estimate radiation exposure.

Our hospital is the only university hospital in Edirne, and our emergency department treats approximately 7,000 patients each year in its Pediatric Emergency Unit (PEU). This study was designed to determine the cost of radiologic imaging in pediatric trauma cases who presented to the PEU of Trakya University Faculty of Medicine. In our study, we aimed to review our pediatric emergency department's experience in using radiologic imaging for trauma cases and the cost of these imagings.

MATERIALS AND METHODS

This study utilized a retrospective sample of 1231 pediatric patients with trauma who presented to the PEU of Trakya University Faculty of Medicine between April 2003 and June 2008. Clinical data, including age, gender, presentation times and seasons, mechanism of injury, presenting symptoms, physical examination findings, radiological investigation results, cost of radiologic imaging, diagnosis, length of stay, outcome of the injury, and hospitalization rates after leaving the PEU, were evaluated. Patients with trauma were found to score between 5 and 15 on the Glasgow Coma Scale (GCS). The ISS (sum of the squares of the highest Abbreviated Injury Scale (AIS) score in each of the three most severely injured body regions) had been prospectively recorded in the trauma database. Components of the PTS (blood pressure, weight, presence of open wounds or fractures, airway and neurologic status) were collected from charts retrospectively. Patients with incomplete charts were excluded from the study.

Cost Assessment

The cost of radiologic imaging used in this study was that determined by the Ministry of Health and used in all government and university hospitals in Turkey rather than real costs. Costs for medications were not included. The cost of trauma was determined in Turkish liras and converted into United States (US) dollars according to daily exchange rates to enable comparison and to better understand the results of our study.

Statistical Analysis

Results are expressed as mean±standard deviation (range minimum-maximum) or by a number (percentage). Normality distribution of the variables was tested using the one-sample Kolmogorov-Smirnov test. Differences between groups were assessed using Student's t test for normally and the Mann-Whitney U test for non-normally distributed data. The chi-square test was used to compare the differences of categorical variables between the groups. Spearman correlation analysis was used to determine the relationship between the variables. The Kruskal-Wallis test was used to compare differences among groups and then the Bonferroni post-hoc test was used when a significant difference was found. Statistica 7.0 statistical software was used for statistical analysis. A p-value <0.05 was considered statistically significant.

RESULTS

In the sample, 781 (63.4%) cases were male and 450 (36.6%) were female. The mean age was 5.91±3.82 years. The majority of the patients (1186, 96.3%) had a GCS score of 15, with 19 patients (1.5%) scoring 14, 11 patients (0.9%) scoring 13, and only 15 patients (1.3%) scoring ≤12. The data were split for comparison into three age groups of 0-2 years, 2-5 years, and 5-14 years. The mean radiologic costs were \$38.6 (\$29.7) (range \$4.67-\$111.89) for the 0-2-year group, \$39.73 (\$35.82) (range \$4.67-\$139.26) for the 2-5-year group, and \$41.82 (\$35.81) (range \$4.67-\$134.07) for the 5-14-year group ($p>0.05$). The distributions of demographic findings for all age groups are shown in Table 1. The overall male to female ratio was 1.73:1 (male/female ratio was 1.3:1 in the 0-2 group, 1.72:1 in the 2-5 group, and 2.01:1 in the 5-14 group). The average admission during the period of our study was 19.85 patients per month. The sites of injury were as follows: head injury, 64.6%; extremity injury,

Table 1. Distribution of demographic findings in all age groups

	Total (n=1231)	0-2 years (n=281)	>2-5 years (n=360)	>5-14 years (n=590)
Sex				
Male	781 (63.4)	159 (56.6)	228 (63.3)	394 (66.8)
Female	450 (36.6)	122 (43.4)	132 (36.7)	196 (33.2)
Cause of injury				
Falls	605 (49.1)	193 (68.7)	169 (46.9)	243 (41.2)
Impact from objects	381 (31.0)	69 (24.6)	129 (35.8)	183 (31.0)
Motor vehicle crashes				
Collision-passenger	114 (9.3)	8 (2.8)	34 (9.4)	72 (12.2)
Collision-pedestrian	58 (4.7)	9 (3.2)	11 (3.1)	38 (6.4)
Bicycle accident	73 (5.9)	2 (0.7)	17 (4.7)	54 (9.2)
Type of injury				
Head	795 (69.6)	189 (67.3)	215 (59.7)	391 (66.3)
Cutaneous	913 (74.2)	172 (61.2)	284 (78.9)	457 (77.5)
Extremity	472 (38.3)	55 (19.6)	125 (34.7)	292 (49.5)
Pelvic	5 (0.4)	0	0	5 (0.8)
Spinal	4 (0.3)	0	2 (0.6)	2 (0.3)
Abdominal	24 (1.9)	0	7 (1.9)	17 (2.9)
Trunk	20 (1.6)	2 (0.7)	10 (2.8)	8 (1.4)
Multiple	121 (9.8)	13 (4.6)	38 (10.6)	70 (11.9)
Patient outcome				
Outpatient treatment	880 (71.5)	205 (73.0)	257 (71.4)	418 (70.8)
Hospitalization rate	220 (17.9)	31 (11.0)	66 (18.3)	123 (20.8)
Left on own accord	131 (10.6)	45 (16.0)	37 (10.3)	49 (8.3)

38.3%; cutaneous injury, 25.8%; abdominal injury, 1.9%; trunk injury, 1.6%; and other site injury, 0.7%. Of all patients, 121 (9.8%) were admitted with multiple traumas. There were no trauma-related deaths.

Of all patients who received radiological imaging, 87 (8.7%) had a positive result, but 909 had a negative result. The mean radiologic costs were US$12.40 ($4.57) (range $4.90-$51.33) for positive result imagings and $43.10 ($34.80) (range $4.67-$139.26) for negative result imagings (p<0.001). Falls (519 patients, 52.1%) accounted for the highest incidence of the patients who underwent radiological imaging; others were impacts from objects (242 patients, 24.3%), motor vehicle crashes (MVC) collision-passenger (113 patients, 11.3%), MVC collision-pedestrian (57 patients, 5.7%), and bicycle accidents (65 patients, 6.5%). The cost analysis and radiological imaging results are shown in Table 2 and Table 3. Statis-

Table 2. Radiological data and cost analysis of all radiologic imaging

	Rate of imaging (n, %)	Total cost of imaging (US$)	Abnormal finding (n, %)	Total cost of abnormal imaging (US$)
Cranial radiography	726 (21.5)	4996	40 (5.5)	277
Cervical spine radiography	482 (14.3)	3315	3 (0.6)	19
Cranial computed tomography	343 (10.1)	23488	71 (20.7)	4874
Spinal radiography	320 (9.5)	4407	2 (0.6)	28
Chest radiography	339 (10.0)	2684	14 (4.1)	112
Pelvic radiography	302 (8.9)	2634	2 (0.6)	18
Abdominal ultrasonography	261 (7.7)	7237	12 (4.5)	336
Town radiography	153 (4.5)	1057	12 (7.8)	83
Extremity radiography	381 (11.2)	6467	139 (36.4)	2363
Waters' radiography	21 (0.6)	146	1 (4.7)	7
Nasal radiography	19 (0.5)	133	4 (21.0)	28
Mandibular radiography	15 (0.4)	105	0	0
Abdominal radiography	12 (0.3)	103	0	0
Abdominal computed tomography	8 (0.2)	547	0	0
Total	3382	57319	300 (8.8)	8145

Table 3. Radiologic imaging results (positive and negative) and cost in all age groups

	0-2 years	>2-5 years	>5-14 years	Total	p
Positive (n, %)	9 (10.3)	19 (21.8)	59 (67.9)	87 (100)	<0.001
Cost (US$)*	12.3±0.5	13.8±9.3	12.0±1.9	12.4±4.6	0.705
Negative (n, %)	240 (26.4)	264 (29.0)	405 (44.6)	909 (100)	<0.001
Cost (US$)*	39.6±28.8	41.6±36.3	46.2±36.3	43.1±34.8	0.062
Average total cost (US$)*	38.6±29.7	39.7±35.8	41.8±35.8	40.4±34.3	0.369

* Mean±SD.

tical analysis showed that the differences in all of these variables by cause of injury were statistically significant. The total cost of radiological imaging correlated inversely with GCS (r= -0.37, p<0.001), directly with ISS (r= 0.27, p<0.001) and was not correlated with the PTS (r= -0.16, p>0.05). The costs for MVCs were significantly higher than for other injury types (Table 4).

For the 996 patients who underwent radiological imaging, 3382 images were taken in total. Of these, only 300 (8.8%) were abnormal. The distribution and cost of radiologic imaging are shown in Table 2. Of these patients, 725 (72.8%) cases were treated as outpatients, 151 (15.2%) were admitted for hospitalization, and 120 (12.0%) left the PEU of their own accord. The mean radiologic costs for these patients were US$34.33 ($30.89) (range $4.67-$134.07), $72.50 ($38.27) (range $4.90-$134.07) and $36.83 ($26.25) (range $4.67-$116.78), respectively (p<0.001). The mean (and SD) total cost of radiologic imaging was US$40.42 ($34.38) (range $4.67-$139.26). The distribution and cost of radiologic imaging in all age groups are shown in Table 4.

During the period of our study, 880 cases (71.5%) were treated as outpatients, 220 (17.9 %) were admitted for hospitalization, and 131 (10.6%) left the PEU of their own accord. The mean (and SD) duration of hospital stays was 8.54 (10.91) hours. Of all patients, 32 (2.6%) required surgical intervention.

DISCUSSION

Trauma is a significant cause of morbidity and mortality in children.[12] The cost of trauma care is always of concern; maximizing care while minimizing the cost is the goal.

The demographic data of pediatric trauma in the literature show noticeable variation. Traumas happen most commonly in male children, and this is likely interrelated with their high level of curiosity, lack of motor skills and judgment and inadequate parental supervision. In our study, the overall male to female ratio was 1.73:1, consistent with other studies suggesting a preponderance of male trauma cases, ranging from 58.8% to 78.4%.[13-15] Most of the traumas in our study were due to falls (49.1%), a result that is commonly supported by the literature.[16,17] The next most common cause of trauma was impact from objects, although some studies assign MVCs as the most common cause of trauma.[17,18] The average age of patients in our study (5.91±3.82 years) was similar to those found in other pediatric studies in Turkey.[11]

In some developed and developing countries, there have been studies[8-10] to estimate overall trauma costs, but their results regarding radiologic imaging are limited. Early identification of factors predicting radiological imaging is important for quality assessment and could contribute to more effective management of traumas.

Several trauma scoring systems have been develo-

Table 4. Patient variables (age, ISS score, PTS score and total cost of radiologic imaging) by cause of injury

	Total (n=1231)	Age*	ISS score*	PTS score*	Total costs of radiologic imaging (US$)*
Cause of injury					
Falls	605 (49.1)	5.1±3.7	6.1±3.2	10.0±1.1	10.0±1.1
Impact from objects	381 (31.0)	6.1±3.8	5.6±1.5	10.2±1.1	10.2±1.1
Motor vehicle crashes					
Collision-passenger	114 (9.3)	7.2±3.4	8.6±6.2	9.6±1.9	9.6±1.9
Collision-pedestrian	58 (4.7)	7.4±4.3	8.9±8.2	10.4±1.7	10.4±1.7
Bicycle accident	73 (5.9)	7.7±3.0	6.3±2.8	10.4±1.1	10.4±1.1
p value (Kruskal-Wallis test)		<0.001	<0.001	<0.001	<0.001

ISS: Injury Severity Score; PTS: Pediatric Trauma Score; * Mean±SD.

ped to measure the severity of the injury and to analyze its impact on morbidity and mortality for trauma research. As expected, GCS and ISS scores showed significant correlations with total cost of radiological imagings in our study. A similar pattern of increasing costs with higher ISS scores has been reported.[9] In our study, the PTS appeared not to be a predictor of the cost of radiological imagings, despite previous reports showing PTS and ISS equivalence.[15] Our observation that increasing age correlated with increasing cost is also supported by the literature.[13] This may reflect the higher frequency of resource-intensive MVCs in the older age group. An analysis of our findings revealed the prominence of MVCs in terms of both severity of injury and cost of care. Children involved in MVCs tended to have more body regions injured and had significantly higher costs than other patients.

A previous cost-effectiveness analysis in Canada, based on a retrospective study at a regional trauma center, reported that the total costs were C$1,675,734. The mean cost per patient was C$7,583 ($12,370); however, the median cost was only C$2,666, and the costs for MVCs were significantly higher than for other injury types.[8] These findings did not include radiologic imaging costs. They reported a direct relationship between total cost and ISS, but stated that PTS is a poorer predictor of cost than the ISS.[8]

Compared with plain-film radiography, advanced radiologic imaging such as CT involves much higher doses of radiation and results in a marked increase in radiation exposure. The use of advanced imaging has been increasing just as our understanding of the carcinogenic potential of low doses of X-ray radiation has improved substantially, particularly for children.[19] By its nature, CT involves larger radiation doses than the more common conventional X-ray imaging procedures.[19]

Advanced diagnostic imaging studies such as ultrasound (US) and CT provide the advantage of an almost immediate diagnosis of injuries, thereby rendering the waiting time unnecessary. However, these methods may lead to significant cost increases with no significant benefit to the patient in some traumas.[20] Some studies prefer the use of advanced diagnostic imaging during the initial evaluation of stable trauma patients since it can uncover several pathologies that are not seen on plain films.[21] These studies found that routine chest, abdomen, and pelvis CT imaging was more sensitive than plain radiography. In addition, they recommended that the initial CT scans should be used to screen spine fractures in the blunt trauma patients in order to reduce the time in the radiology department for plain films.[21] A previous cost-effectiveness analysis study in the US, based on a retrospective trial in a regional trauma center, reviewed plain radiographs from 55 selected trauma patients who also underwent CT imaging of the chest, abdomen, and pelvis.[21] For the 47 patients who had thoracolumbar fractures who underwent radiological imaging, 13 patients were found to have 33 thoracolumbar spine fractures identified by CT imaging but not plain radiography. The radiologic cost for a standard test was US$1,487, but the radiologic cost for the recommended test was US$654 in that study. These findings were from thoracolumbosacral spine imaging series only and did not include other radiologic imaging costs.[21] In our study, for the 996 patients who underwent radiological imaging, 320 spinal radiographs were taken in total. Of these, only two (0.6%) were abnormal. The radiologic cost of these images was US$4407, but the radiologic cost for a recommended test was US$28 in our study.

In the study of Gurses et al.[11] reported from Turkey on the cost factors and outcome of 91 patients attending a pediatric emergency department with multiple traumas, they found that MVC accounted for 45% of the injuries, followed by falls (41%) and bicycle accidents (14%). The mean (and SD) costs for these were US$500 ($538) (range $20-$1995), $267 ($275) (range $30-$1045) and $291 ($281) (range $16-$980), respectively ($p<0.05$). Their results included costs of surgical procedures, laboratory tests, physicians' fees, nursing, anesthesia, bed fees, materials used in surgery, drugs, and other miscellaneous items. In our study, we reported only radiologic imaging costs; falls (52.1%) accounted for the largest group of patients needing radiological imaging, followed by impacts from objects (24.3%), MVC collision-passenger (11.3%), MVC collision-pedestrian (5.7%), and bicycle accidents (6.5%). The mean radiologic costs for these patients were US$36.61 ($32.06) (range $4.70-$123.70), $24.07 ($23.89), $75.66 ($33.78), $64.54 ($30.80), and $49.27 ($31.19), respectively ($p<0.001$).

In conclusion, early identification of factors predicting radiologic imaging is important for assessment, for preventing unnecessary radiation exposure, and for cost-effectiveness. Periodic education programs for emergency department staff may contribute to the appropriate determination of patients requiring advanced imaging procedures.

REFERENCES

1. 1-UNICEF. A league table of child deaths by injury in rich countries. Innocenti Report Card No. 2. UNICEF Innocenti Research Centre, Florence; 2001.
2. Baker SP, O'Neill B, Haddon W Jr, Long WB. The injury severity score: a method for describing patients with multiple injuries and evaluating emergency care. J Trauma 1974;14:187-96.
3. Champion HR, Sacco WJ, Copes WS, Gann DS, Gennarelli TA, Flanagan ME. A revision of the Trauma Score. J Trauma 1989;29:623-9.
4. Kaufmann CR, Maier RV, Rivara FP, Carrico CJ. Evaluation

of the Pediatric Trauma Score. JAMA 1990;263:69-72.

5. Rhee KJ, Baxt WG, Mackenzie JR, Willits NH, Burney RE, O'Malley RJ, et al. APACHE II scoring in the injured patient. Crit Care Med 1990;18:827-30.
6. Champion HR, Copes WS, Sacco WJ, Frey CF, Holcroft JW, Hoyt DB, et al. Improved predictions from a severity characterization of trauma (ASCOT) over Trauma and Injury Severity Score (TRISS): results of an independent evaluation. J Trauma 1996;40:42-9.
7. Boyd CR, Tolson MA, Copes WS. Evaluating trauma care: the TRISS method. Trauma Score and the Injury Severity Score. J Trauma 1987;27:370-8.
8. Dueck A, Poenaru D, Pichora DR. Cost factors in Canadian pediatric trauma. Can J Surg 2001;44:117-21.
9. Harris BH, Bass KD, O'Brien MD. Hospital reimbursement for pediatric trauma care. J Pediatr Surg 1996;31:78-81.
10. Levy EN, Griffith JA, Carvajal HF. Pediatric trauma care is cost effective: a comparison of pediatric and adult trauma care reimbursement. J Trauma 1994;36:504-7.
11. Gürses D, Sarioglu-Buke A, Baskan M, Kilic I. Cost factors in pediatric trauma. Can J Surg 2003;46:441-5.
12. Shanon A, Bashaw B, Lewis J, Feldman W. Nonfatal childhood injuries: a survey at the Children's Hospital of eastern Ontario. CMAJ 1992;146:361-5.
13. Hartzog TH, Timerding BL, Alson RL. Pediatric trauma: enabling factors, social situations, and outcome. Acad Emerg Med 1996;3:213-20.
14. Wesson DE, Scorpio RJ, Spence LJ, Kenney BD, Chipman ML, Netley CT, et al. The physical, psychological, and socioeconomic costs of pediatric trauma. J Trauma 1992;33:252-7.
15. Cosentino CM, Barthel MJ, Reynolds M. The impact of level 1 pediatric trauma center designation on demographics and financial reimbursement. J Pediatr Surg 1991;26:306-11.
16. Chan BS, Walker PJ, Cass DT. Urban trauma: an analysis of 1,116 paediatric cases. J Trauma 1989;29:1540-7.
17. Colombani PM, Buck JR, Dudgeon DL, Miller D, Haller JA Jr. One-year experience in a regional pediatric trauma center. J Pediatr Surg 1985;20:8-13.
18. Imami ER, Clevenger FW, Lampard SD, Kallenborn C, Tepas JJ 3rd. Throughput analysis of trauma resuscitations with financial impact. J Trauma 1997;42:294-8.
19. Brenner DJ, Hall EJ. Computed tomography-an increasing source of radiation exposure. N Engl J Med 2007;357:2277-84.
20. Campbell KA, Berger RP, Ettaro L, Roberts MS. Cost-effectiveness of head computed tomography in infants with possible inflicted traumatic brain injury. Pediatrics 2007;120:295-304.
21. Brandt MM, Wahl WL, Yeom K, Kazerooni E, Wang SC. Computed tomographic scanning reduces cost and time of complete spine evaluation. J Trauma 2004;56:1022-8.