RESEARCH

USING THE ROTTERDAM CT SCORE TO PREDICT OUTCOMES OF HEAD INJURIES IN THE GERIATRIC POPULATION

Turkish Journal of Geriatrics
DOI: 10.31086/tjgeri.2021.239
2021; 24(3): 416-423

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Received: Apr 21, 2021
Accepted: Sep 01, 2021

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Abstract

Introduction: Managing head traumas are quite different in the geriatric population than in other age groups due to patient comorbidities, decreased cerebral compliance, and antithrombotic use. The aim of this study was to examine head injuries in geriatric patients and investigate the effectiveness of the Rotterdam CT score in diagnosing and treating patients at the time of admission to facilitate head trauma management.

Methods: Demographic, clinical, and radiological data from head trauma cases in geriatric patients, along with each patient's latest status, if our clinic followed up with them, were studied retrospectively.

Results: The mean admission Glasgow Coma Scale score was 12.89±3.134. Patients who had experienced a fall had a higher mean age (p=.004), while patients who had fallen from a height had a lower Glasgow Coma Scale score at the time of admission (p=.000) but higher mortality (p=.018). Patients had a mean Rotterdam CT score of 1.514 ± 1.153 at the time of admission. Mean Rotterdam CT scores were higher in patients who were hospitalized in the intensive care unit (p=.000), had a history of falling from a height (p=.000), and required surgery in the acute period (p=.005). Patients with comorbidity had longer hospitalization times (p=.042), while patients with high Rotterdam CT scores had low modified Glasgow outcome scores (p=.000).

Conclusion: We determined that the need for rehabilitation and long-term care and the possibility of mortality increase after head traumas in the geriatric population and Rotterdam CT score were a good indicator of the clinical situation and final status.

Keywords: Craniocerebral Trauma; Glasgow Outcome Scale; Brain Injuries, Traumatic.

INTRODUCTION

Advanced age increases the risk of complications and mortality from trauma due to increased comorbidity and immobility (1). However, the risk of developing intracranial events also increases even in minor traumas due to physiological changes in the brain, especially in the elderly (2–5).

The Glasgow coma scale (GCS) is a quick way to obtain information about a patient's clinical condition. However, such clinical scales may not provide sufficient information in the presence of diseases such as dementia and delirium, which are common in the elderly (6). This requires new methods for patient management and outcome estimation.

Managing developing intracranial pathology is quite different in geriatric populations due to patient comorbidities, decreased cerebral compliance, and antithrombotic use. Neurological diseases can also affect the patient's examination at the time of admission and can make it difficult to effectively manage treatment, follow-up, and imaging findings. The aim of this study was to examine cases of head trauma in geriatric patients to facilitate trauma management. We also aimed to investigate the effectiveness of the Rotterdam CT score in diagnosing and treating patients at the time of admission.

METHOD

This study was approved by the non-interventional clinical research ethics committee of the University of Health Sciences, Gazi Yasargil Education and Research Hospital, under number 514 on July 24, 2020. Informed written consent was obtained from all patients, and the principles of the Declaration of Helsinki were followed.

The study included 142 patients over age 65 admitted to the emergency department of our hospital between January 2017 and July 2020 after a head trauma and who had undergone a computed tomography (CT) scan of the brain. We evaluated the relationship in geriatric patients between the Rotterdam CT score at the time of admission and the modified Glasgow outcome scores (mGOS) of the patient's final status and attempted to determine the factors affecting final status.

We recorded the patients' age, sex, GCS at the time of admission, hospitalization services (clinic/intensive care), type of trauma, pathology detected in the CT, Rotterdam CT score at the time of admission, surgeries, accompanying traumas, chronic subdural hematoma (cSDH), Markwalder score in patients with cSDH, comorbidities, antiaggregant/anticoagulant use, length of hospital stay, mGOS, and final status.

Statistical analysis

The data were evaluated in terms of averages, numbers and percentages, and minima-maxima. We used bivariate correlations (Pearson's R, Spearman's correlation, one-way ANOVA) to evaluate the correlation between data. Groups were analyzed primarily in terms of their suitability of normal distribution. Analyses were performed using the Kolmogorov-Smirnov normal distribution test, and we made graphs of conformity to normal distribution. Student's t-test was used to compare normally distributed variables, and the Mann-Whitney U test was used to analyze independent data that did not conform to a normal distribution. The chi-squared test was used for categorical data. SPSS for Windows (version 20.0) was used for analysis. A p-value of less than .05 was considered significant.

RESULTS

Demographics

Of the patients in the study, 61.3% (87) were male and 38.7% (55) were female. The youngest patient

was 65 years old, the oldest was 98, and the mean age was 74.25 ± 7.014. When patients were compared by sex, it was found that females had a higher average age, but this was not statistically significant (p = .079) (Table 1).

Clinical characteristics

The mean GCS score of patients at the time of admission was 12.89 points (3–15 points, ± 3.134). Males had a lower GCS score at the time of admission (p = .024) (Table 1). In terms of hospitalization, 53.5% (76) were hospitalized in the clinic and 46.5% (66) in the intensive care unit.

Trauma type

There were multiple causes of traumas: falls (68.3%), traffic accidents (26.1%), falls from a height (4.2%), and assault (1.4%). Although it was thought that effective randomization could not be achieved due to the low number of patients who had been assaulted and who had been followed up with, it was found that patients involved in traffic accidents and who had fallen from a height could develop multitrauma that required intensive care more often (p = .000 and p = .000, respectively). Patients who had fallen had a higher mean age (p = 0.004), and patients who had fallen from a height had lower GCS scores at the time of admission and higher mortality (p = .000 and p = .018, respectively). Although patients who had experienced falls have a greater need for surgery due to cSDH at the time of admission (p = .674) and afterwards (p = .055), it was not statistically significant. Patients developed cSDH more often after a fall than after a traffic accident or falling from a height, but it was not statistically significant (p = .055). It appears that the development of cSDH in both patients who had been assaulted affected the statistical data (Table 2).

Radiological evaluation

No pathology was found in CT scans in 42.3% (60) of patients imaged at the time of first admission. No pathology was found in CT scans taken at the time of admission in 52.7% of females and 35.6% of males. Subarachnoid hemorrhages were found in 29.5% (42) of patients, subdural hematoma in 20.4% (29), intracerebral hematoma in 6.4% (9), epidural hematoma in 5.6% (8), intraventricular hemorrhage in 2.8% (4), and pneumocephalus in 1.4% (2). More than one pathology was found in 8.4% (12) of patients. Subdural hematomas were most common in males (23.0%), whereas subarachnoid hemorrhage was the most common (23.6%) in females. No statistical significance was found between sex and diagnosis at presentation (p = .061). The mean Rotterdam CT score at the time of admission was 1.514 ± 1.153. Mean Rotterdam CT scores were higher in patients hospitalized in the intensive care unit (p = .000), who had fallen from a height (p = .000), and who required surgery in the acute period (p = .005). Although Rotterdam CT scores were higher in males (p = .433) and in patients using antiaggregants (p = .547), it was not statistically significant. Mean Rotter-

Table 1. Comparison of patient characteristics according to gender

Gender	Age	GCS	Surgery	Multitrauma	cSDH	cSDH-S	Mortality
M (61.3%)	73.43±6.40	12.4±3.6	8.0%	20.7%	37.9%	57.6%	16.1%
F (38.7%)	75.55±7.76	13.6±2.1	5.5%	36.4%	14.5%	37.5%	10.9%
***p* value**	.079	.024	.410	.040	.002	.006	.272

Table 2. Comparison of trauma type and patient characteristics

Trauma Type	Assault (n=2)	Falls (n=97)	Traffic accidents (n=37)	Falls from height (n=6)	p value
Age	65.0±0.0	75.4±2.1	71.3±5.8	75.0±5.8	.004
Gender (M/F)	50%/50%	59.8%/40.2%	64.9%/35.1%	66.7%/33.3%	.925
GCS	13.0±0.0	13.7±6.7	11.05±4.1	10.8±4.7	.000
ICU	100 %	34.0 %	73.0 %	66.7 %	.000
Surgery	0.0 %	8.2 %	5.4 %	0.0 %	.674
cSDH	100 %	32.0 %	18.9 %	16.7 %	.055
cSDH-Surgery	100 %	18.6 %	5.4 %	0.0 %	.000
Multitrauma	100 %	16.5 %	48.6 %	33.3 %	.000
Mortality	0.0 %	8.2 %	27.0 %	33.3 %	.018

dam CT scores were lower at the time of admission in patients who developed cSDH (p = .075) and in those who required surgery (p = .004) (Table 3).

Comorbidity and multitrauma

One to four comorbidities were detected in 77.5% of patients. The average number of comorbidities across all patients was 1.317 ± 0.970. The most common one was hypertension (59.2%, or 84 patients), followed by diabetes mellitus (20.4%, or 29 patients), respiratory tract diseases (asthma, COPD, etc.) (12.6%, or 18 patients), neurological diseases (cerebrovascular diseases, dementia, Parkinson's, etc.) (11.2%, or 16 patients), cardiac diseases other than hypertension (atrial fibrillation, heart failure, valvular heart diseases) (11.2%, or 16 patients), and other diseases (psychiatric, hematological, urinary, endocrine, and malignancy) (13.3%, or 19 patients). The most common comorbidity in both sexes was hypertension. Comorbidities were found in 89.1% of females and 70.1% of males, which was statistically significant (p = .006). Diabetes mellitus occurred more often in females, and neurological, cardiovascular, and urogenital system diseases occurred more often in males and were statistically significant (p = .043). Patients with comorbidities had longer hospitalization times (p = .042). No relationship was found between comorbidity and age, final patient status, GCS score, Rotterdam CT score, needing surgery, mGOS score, or cSDH development ($p > .05$). A total of 31.7% (45) of patients used antithrombolytics.

The use of antithrombolytics had no effect on mortality or mGOS score ($p > .05$). Furthermore, 26.8% (38) of patients had trauma to another system. Additional trauma was found in 36.4% of females and 20.7% of males and was statistically more common in females (p = .040). The most common additional trauma for both sexes was to the spine (13.4%, or 19 patients), followed by trauma to the extremities (6.3%, or 9 patients), thorax (5.6%, or 8 patients), and abdomen or maxillofacial area (1.4%, or 2 patients) (Table 1). The second most common trauma was to the extremities in females and to the thorax in males. Two additional traumas were found in 1.4% of patients.

The incidence of additional trauma was higher in patients presenting after a traffic accident (p = .000), and patients with additional trauma had longer hospitalization times (p = .006) and a higher chance of

Table 3. Rotterdam CT score evaluation according to patient characteristics

Rotterdam CT score (mean)					
Gender		***Unit***		***Trauma type***	
female	1.41 ± 0.95	*clinic*	1.06 ± 0.52	*assault*	1.21 ± 0.98
male	1.57 ± 1.26	*ICU*	2.03 ± 1.43	*fall*	2.24 ± 1.21
				traffic accident	2.17 ± 1.47
				falls from height	3.15 ± 1.69
p = .433		*p = .000*		*p = .000*	
Final situation		***Surgery***		***cSDH***	
discharge	1.24 ± 0.76	*yes*	2.50 ± 1.84	*yes*	1.24 ± 0.83
mortality	3.15 ± 1.69	*no*	1.43 ± 1.05	*no*	1.62 ± 1.24
p = .000		*p = .005*		p = .075	
cSDH-S		***Antiagg.***		***Comorbidity***	
yes	0.86 ± 0.46	*yes*	1.60 ± 1.43	*yes*	1.50 ± 1.20
no	1.63 ± 1.20	*no*	1.47 ± 1.00	*no*	1.53 ± 0.94
p = .004		p = .547		p = .924	

pathologies revealed in cranial imaging at the time of presentation (p = .026). However, the presence of additional trauma did not have an effect on mortality or mGOS score.

Surgery

At the time of admission, 7.0% (10) of patients had undergone surgery. Although males required surgery more often and had a higher mortality rate in the acute period after trauma, it was not statistically significant (Table 1). In 28.9% (41) of patients, cSDH developed in the first three months after trauma, and 53.7% of those needed surgery. The clinical conditions of patients who developed cSDH were evaluated using the Markwalder grading scale (MGS). The clinical conditions of patients who developed cSDH ranged from grade 0 (normal neurological picture) to grade 3 (stupor and hemiplegia); the mean was 0.854 ± 0.910. Males developed cSDH more frequently (p = .002) and needed surgery for cSDH hematomas more often (p = .006) (Table 1).

Hospitalization and mortality

Patients were hospitalized for 1 to 209 days; the average was 10.47 ± 21.621 days. Patients' final statuses, as assessed by mGOS, ranged from 1 to 8 points (± 2.495), with an average of 6.19. A total of 14.1% (20) of patients died during hospitalization. No statistically significant relationship was found between comorbidity and mortality (p = .365). Patients with a higher Rotterdam CT score had a significantly increased risk of mortality (p = .000) (Table 3), and also patients with high Rotterdam CT scores had low mGOS scores (p = .000).

Table 4. Comparison of Rotterdam CT Scale and mGOS

mGOS score	Number of patients	Rotterdam CT score (mean)
1	21	3.143 ± 1.65
2	3	2.333 ± 1.52
3	2	1.000 ± 1.41
4	1	3.000
5	6	1.500 ± 1.37
6	13	1.692 ± 0.85
7	34	1.324 ± 0.68
8	62	0.984 ± 0.46
p = .000		

DISCUSSION

Certain physiological changes that develop with age can cause hemorrhagic complications in head trauma, including cerebral atrophy (increased wall tension in the brain), hypertension (increased wall tension), reduced cerebral blood flow resulting in hypoxic brain injury, cerebrovascular atherosclerosis, reduced cerebrovascular autoregulation, and increased superoxide production (2). Major complications also increase with age, even in minor traumas (7–9). Although country-based studies of head trauma in the geriatric population in America (10) and Europe (11) have shown that head injuries are more common in females, our study was majority male. This is thought to be related to sociocultural restrictions on participation by females in social life as they age.

Nearly 80% of all traumas in the geriatric population are mild head traumas (GCS score 13–15), but the geriatric population has a higher morbidity and mortality than young people do for both cranial traumas and other types (12). In our study, the average GCS score was 12.89 points (3–15 points, ± 3.134) and 76.1% of cases were mild head traumas. Of the head traumas, 10.5% were moderate and 13.4% were severe. Studies have shown that even in mild head injuries, both neurobehavioral and functional outcomes are affected (12). Also, elderly patients have a greater need for rehabilitation and long-term care and a higher mortality rate from mild to moderate head trauma compared to younger patients (13). While up to 60% of young people have a good outcome with mild to moderate head traumas, the rate for the elderly is only 20% (14). In our study, patients had good outcomes (as defined by their mGOS) more frequently (43.6%) than in the literature.

As patients age, they are at greater risk of developing complications from minor traumas (15). Studies have shown that the most common cause of head trauma in the elderly is falls (falling down, tripping, etc.), followed by traffic accidents (16). Although our study supports the literature when it comes to trauma type, it also found a higher mean age for patients who had experienced a fall (p = .004), which supports the potential of low-energy traumas to cause damage as age increases. However, mortality was higher in high-energy traumas (most commonly falls from heights, followed by traffic accidents). An increased subdural distance in geriatric patients increases the risk of developing subdural hematoma by up to 45% (16). Although subdural hematomas were most commonly found in men in our study, the most common radiological finding was subarachnoid hemorrhage.

When evaluated radiologically, the mean Rotterdam CT score was 1.514 ± 1.153. Mean Rotterdam CT scores were higher in patients hospitalized in the intensive care unit (p = .000), who had fallen from a height (p = .000), and who required surgery in the acute period (p = .005), suggesting that the Rotterdam CT score might be more effective than GCS scores, as it is a radiological parameter that offers clinical clues and indications of final statuses in geriatric patients. It might also be used to support neurological findings in clinical evaluations of patients with conditions such as dementia who cannot be examined effectively. In a study evaluating the effectiveness of the Rotterdam CT score in all age groups, it was found that the score correlated with trauma severity and outcome in the elderly (17). In our study, the Rotterdam CT score was found to be highly correlated with outcome (as defined by their mGOS) in the geriatric population (p = .000).

Comorbid diseases and medications used by the aged may increase the risk of falls (7), make it difficult to manage treatment after trauma, and cause prolonged hospitalizations (18). In particular, the use of antithrombolytics are associated with an increased risk of hemorrhagic complications (16). Of our patients, 77.5% had at least one comorbidity, and 31.7% took an antithrombolytic. Our study also found that comorbidity was more common in female patients, and hospital stays were longer when

comorbidities were present.

One study of head and other traumas in the geriatric population found that the most common extremity fractures and subsequent head traumas were observed in the geriatric population. The study stated that fragility increased with age and that all traumas were more common in females (11). Our study found that the incidence of additional trauma was higher in females, with spinal trauma being the most common additional trauma in both sexes, suggesting that osteoporosis, the risk of which increases with age, may increase susceptibility to spinal trauma.

Although very few patients (7.0%) required surgery at the time of presentation, a relatively large number developed cSDH and required surgery (28.9%–53.7%). However, fewer patients needed surgery at the time of admission than suggested by the literature (16). Patients had a higher risk of developing cSDH if they had experienced a fall, which was thought to be related to the fact that patients involved in traffic accidents or falls present with a worse clinical picture in the acute period and a higher mortality rate in the following period.

One study found similarities in demographics, injury mechanism and severity, and comorbidity but showed that the risk of death was four times higher in the elderly than in young adults (11). In our study, in high-energy traumas, the presence of ICH/IVH in the CT scan at the time of admission, a low GCS score, and a high Rotterdam CT score were all found to be associated with mortality. The risk of mortality also increased in those whose pathologies required surgery. On the other hand, low-energy traumas, high GCS scores, low Rotterdam CT scores, normal CTs or SAH at the time of admission, and an absence of comorbidity were found to be associated with good outcomes.

CONCLUSION

The geriatric population has a greater need for rehabilitation and long-term care and higher mortality after head traumas. The Rotterdam CT score is a radiological parameter that offers indications of the clinical picture in elderly people with dementia and similar neurological problems and can help predict final outcomes. Concomitant diseases and medications used by the elderly may increase the risk of falls, make it difficult to manage treatment after trauma, and cause prolonged hospitalizations. All in all, we concluded that diagnoses and treatment of head trauma in the geriatric population should be evaluated and followed up more closely and for a longer time than in other age groups.

Acknowledgement

Statement of Ethics

The study was approved by the Ethics Committee of University of Health Sciences, Diyarbakır Gazi Yasargil Education and Research Hospital. The study complied with the Declaration of Helsinki.

Disclosure Statement

The authors have no conflicts of interest to declare.

Funding Sources

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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