ARTÍCULO ORIGINAL

Associated factors for Tracheostomy in adults with severe traumatic brain injury. Score proposal

Traqueostomía en pacientes adultos con trauma craneoencefálico grave: factores asociados. Escala propuesta

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Abstract

Background: *In patients with severe traumatic brain injury (TBI), there is a lack of consensus about the need and time to perform a tracheostomy. Nowadays, the decision is individualized to each case. It is considered that patients that will need a tracheostomy profit by performing it earlier.* **Patients and methods:** *An observational and prospective study was performed. One hundred and twenty patients in a period of 18 months between 2016 and 2018, older than 18 years, with severe TBI at the first 24 h of trauma were analyzed. Clinical, biochemical, and radiological findings at admission were measured; patients were followed up until discharge. The statistical analysis was made with Student's t-test, χ^2, and prevalence risk ratio.* **Results:** *Ten associated factors were grouped according to the prevalence risk ratio. The principal factors were CRASH score, IMPACT score, SAPS II score, APACHE II score, age, revised trauma score, Glasgow Coma Scale, subdural hematoma, uni or bilateral abnormal pupil reactivity, and collapse of basal cisterns.* **Conclusions:** *We conclude that there are multiple factors associated with the need for tracheostomy in adult patients with severe TBI and it is possible to predict according to our findings from admission which patients will profit by this procedure.*

Key Words: *Traumatic brain injury. Tracheostomy. Mechanical ventilation. Prognostic factors. Glasgow coma scale.*

Resumen

Antecedentes: *No existe aún consenso respecto de la necesidad y el tiempo de realización de traqueostomía en el paciente con trauma craneoencefálico (TCE) grave. En la actualidad, la decisión se individualiza en cada caso. Se considera que los pacientes que requieren traqueostomía tendrán mayor beneficio si se realiza de forma temprana.* **Método:** *Se llevó a cabo un estudio observacional y prospectivo, en un periodo de 18 meses entre 2016 y 2018, con 120 pacientes mayores de 18 años con diagnóstico de TCE grave, en las primeras 24 horas del trauma. Se evaluaron datos clínicos, bioquímicos y radiológicos al ingreso, y se siguió hasta el alta hospitalaria. Se analizan las variables con las prueba t de Student y ji al cuadrado, y también la tasa de riesgo de prevalencia.* **Resultados:** *Los factores de riesgo asociados con la necesidad de traqueostomía en el paciente con TCE grave fueron los resultados en las escalas CRASH, IMPACT, SAPS II y APACHE II, la edad, la puntuación de la Revised Trauma Score y de la Escala de Glasgow al ingreso, la presencia y el volumen de hematoma subdural, la respuesta pupilar anormal unilateral o bilateral, y el colapso parcial o total de las cisternas basales.* **Conclusiones:** *Existen*

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numerosos factores de riesgo asociados con la necesidad de traqueostomía en los pacientes adultos con TCE grave, y es posible predecir desde el momento del ingreso qué pacientes se beneficiarán de la realización de una traqueostomía.

Palabras Clave: *Trauma craneoencefálico grave. Traqueostomía. Ventilación mecánica. Factores pronósticos. Escala de coma de Glasgow.*

Introduction

In patients with severe traumatic brain injury (TBI), a tracheostomy is frequently performed to protect the airway and to allow withdrawal of assisted mechanical ventilation (AMV)[1]. The actual incidence of tracheostomy in patients with severe TBI is around 50-70%[2].

The decision to perform a tracheostomy should be individualized, considering the risk of mortality, days of AMV, and neurological prognosis in the setting of severe TBI[3].

Some authors have shown advantages by performing an early tracheostomy such as to reduce the rate of pneumonia[4], days of AMV[5,6], length of stay, and mortality[5,7,8]. It has been considered that patients that will require tracheostomy will profit by performing it earlier[8-11].

There is still lack of consensus about if and when the tracheostomy should be performed and it is also unclear in which clinical and biological factors are associated with the need of tracheostomy in patients with severe TBI.

Patients and methods

This was a prospective, observational, and analytical study. To estimate the sample size, we used as reference a prevalence study of pneumonia associated with severe TBI because it is one of the most associated factors to perform tracheostomy, this study reported a prevalence of 45%[6]. The proportion of patients was calculated considering a population of 140 patients in average per year admitted to our hospital, yielding a result of 103 patients for the statistical calculation.

One hundred and twenty patients were included over a period of 18 months, between 2016 and 2018, older than 18 years old, and with diagnose in the first 24 h of admission of severe TBI. Twelve patients died before the decision of tracheostomy/not tracheostomy was made, so the final sample number was 108 patients.

The decision to perform a tracheostomy was made by the attending physician according to the patient clinical characteristics after the withdrawal of sedation.

For the diagnosis of pneumonia, we used the ventilator-associated pneumonia criteria that include new or progressive lung infiltrates, consolidation, cavitation, or pleural effusion on the chest radiograph and at least one of the following: new onset of purulent sputum or change in the macroscopical characteristics of sputum, fever, increase or decrease in the leukocyte count, positive blood cultures, or identification of a microorganism in bronchoalveolar washout or biopsy.

Results

Of our final sample, 94 men (87.04%) and 14 women (12.96%) comprise our universe of study. The most frequent mechanism of trauma was road traffic accidents (57%), followed by falls (26.6%), aggression (8.3%), gunshot wounds (4.2%), and others (3.7%). The average of Glasgow Coma Scale (GCS) at evaluation was 6.33 ± 1.4. The computed tomography (CT) scan at admission was classified according to Marshall scale and results were the following: Grade 5, 40 patients (48%); Grade 4, 13 patients (11%); Grade 3, 19 patients (16%); Grade 2, 39 patients (33%); and Grade 1, 1 patient (1%). In 74% of the cases, there was a skull fracture, 55% in the convexity and 19% in the cranial base. About 25% of the patients did not required surgical treatment. Table 1 summarizes the characteristics and significant variables.

After the analysis, the global mortality was 23.3%, none associated with the performance of tracheostomy. Twelve patients died before we could decide to do a tracheostomy. Comparing the frequency of pneumonia in the tracheostomy group was 84.2% (Table 2).

According to our bivariate analysis (Table 3), the main associated factors were CRASH score, GCS, and alteration of the pupil response. The pupil response was grouped for the analysis in two groups: those with both pupils reactive and those with the inadequate response of one or both pupils.

Out of this bivariate analysis, we took into account those variables with p-values that showed statistical

Table 1. Comparison of the groups with tracheostomy and non-tracheostomy with significant statistical findings

	Non-tracheostomy, n = 38	Tracheostomy, n = 70	p
Age	29 ± 10	36 ± 15	0.003*
Glasgow	7 ± 1	6 ± 1	> 0.001*
Glasgow motor	5 ± 1	4 ± 1	> 0.001*
Revised trauma score	5.8 ± 0.3	5.5 ±.7	0.003*
CRASH score	23 ± 12	48 ± 22	> 0.001*
Impact score	7.8 ± 3.2	12.7 ± 4.5	> 0.001*
APACHE II score	14.3 ± 2.5	17.5 ± 3.8	> 0.001*
SAPS II score	36.6 ± 6.4	43.7 ± 10.2	> 0.001*
Days of mechanical ventilation	4.6 ± 2.6	7.2 ± 2.8	> 0.001*
Subdural hematoma	3 ± 6	21 ± 30	> 0.001*
Midline shift	2.5 ± 3.9	4.6 ± 5.5	0.023*
Pupil reactivity			
Both	31 (81.6%)	33 (47.1%)	0.0026¬
One	6 (15.8%)	27 (38.6%)	
None	1 (2.6%)	10 (14%)	
Pneumonia			> 0.001¬
No	23 (60.5%)	11 (15.7%)	
Yes	15 (39.5%)	59 (84.3%)	
Cisterns			
Abnormal	9 (23.7%)	40 (57.1%)	0.001¬
Normal	29 (76.43%)	30 (42.9%)	
Surgical indication			
No surgery	11 (28.9%)	17 (24.3%)	0.016¬
Epidural hematoma	11 (28.9%)	10 (14.3%)	
Subdural hematoma	4 (10.5%)	29 (41.4%)	
Contusion of edema	6 (15.8%)	8 (11.4%)	
Fracture	6 (15.8%)	6 (8.6%)	

Table 2. Comparison of groups tracheostomy versus non-tracheostomy

	Tracheostomy, n = 70	Non-tracheostomy, n = 38	p
Days of mechanical ventilation	7.2 ± 2.8	4.6 ± 2.6	> 0.001
Days of stay at hospital	14.3 ± 7.4	9.3 ± 4.1	> 0.001
Days of stay after mechanical ventilation removal	8.87 ± 6.2	4.7 ± 2.8	> 0.001
Pneumonia	59 (84.2%)	15 (39.4%)	> 0.001
Deaths	16 (22.9%)	0	0.001

Table 3. Bivariate analysis

	Odds ratio	Confidence interval 95%	p
CRASH score	1.06	1.02-1.1	0.002
Glasgow	0.448	0.287-0.698	> 0.001
Dilated pupil, one or both	4.965	1.93-12.77	0.001

Table 4. Prevalence risk ratio

	Odds ratio	Confidence interval 95%	p
CRASH ≥ 60	1.06	1.02-1.1	0.002
Impact ≥ 15	9.391	2.08-42.38	0.001
SAPS II ≥ 49	18.106	2.33-140.35	> 0.001
APACHE II ≥ 19	7.326	2.05-26.177	0.001
Subdural volume ≥ 20	21.86	2.83-168.91	> 0.001
Revised trauma score ≤ 5.89	2.781	1.07-7.19	0.031
Age ≥ 44	3.896	1.23-12.33	0.015
Glasgow ≤ 6	6.233	2.17-17.82	> 0.001
Dilated pupil, one or both	4.965	1.93-12.77	0.001
Collapse or absent of cisterns	4.296	1.77-10.41	0.001

significance (Table 4). Considering the 75 percentile as the cut point for the statistical analysis, we found that the cumulative risk after 4 items was 100% (Table 5). Each factor provides the same value, considering that the cut point was adjusted by percentile.

Discussion

Sociodemographic variables

In our study, patients younger than 44 years had less risk of tracheostomy; Shamim et al. and Goettler et al. found the same results as ours, as younger the patient, less frequent the tracheostomy was[12,13].

Clinical variables

The GCS at admission is directly related to the need of tracheostomy. In our study, we found that a CGS of 6 points or less at admission is strongly associated with the need of tracheostomy, and we also found that the motor response of this scale is the one that correlates strongly with the need of

Table 5. Predictive values according to the sum of each of the factors associated with tracheostomy

	Positive predictive value (%)	Negative predictive value (%)
4 points	100	52.78
3 points	92	60.71
2 points	82.35	68.42
1 point	73.56	78.95

tracheostomy. Major et al. found similar results as ours, GCS <7 at the 4th day correlated directly with the requirement of tracheostomy[4]. Gurkin et al. defined that on day 7, a GCS <9 is a tracheostomy predictor along with an injury severity score (ISS) >24[12]. Goettler et al. also found a significant p-value in terms of the GCS[13].

Other clinical scales such as revised trauma score <5.89, IMPACT >15, SAPS >49, and APACHE II >19 are also associated with the need of tracheostomy[4]. In our study, unlike other authors, we did not found an association between the ISS and the need for tracheostomy, different from Gurkin, Shamim, and Goetler[14].

Radiological variables

In our study, we founded two main radiological variables associated with the need of tracheostomy: partial or total collapse of basal cisterns and acute subdural hematoma >20 cc, in the initial CT scan.

Pneumonia, days of AMV, and total length of stay in hospitalization

About 42% of our patients were treated at neurosurgery hospitalization floor because we do not have 100% of availability at intensive care unit (ICU) all the time, we found significant differences between these two groups. The total length of stay and days of AMV were less in the neurosurgery floor group, as also the frequency of pneumonia (73.9% ICU) versus 45.1% neurosurgery floor. These results show the direct relationship between the number of days with AMV and frequency of pneumonia and also this with the total length of stay. Some other authors have found that the use of early tracheostomy decreases the number of days with AMV[5,7,11,12].

Alali et al. reported in their series 30% reduction in AMV in patients with an early tracheostomy and 20% fewer days of hospitalization[15]. In our study, we found a reduction in the days of AMV in patients with early tracheostomy and making a new subgroup in patients who underwent tracheostomy before the day 4 of stay a radical reduction in the rate of pneumonia (63.6% ultra-early tracheostomy vs. 100% late tracheostomy). These results are similar as those reported by other authors[7,4,11,15]. Other authors differ in their results arguing that they found a decrease in the frequency of pneumonia[5,6,16,17].

In our study, the patients that needed a tracheostomy had 5 more days of total length stay and days of AMV were greater, this can be explained because patients that required tracheostomy were critically ill.

Table 6. Predictive tracheostomy scale in a patient with severe head trauma

	Points
If CRASH ≥ 60	1
If impact ≥ 15	1
If SAPS II ≥ 49	1
If APACHE II ≥ 19	1
If subdural volume ≥ 20 cc	1
If revised trauma score ≤ 5.89	1
If age ≥ 44 years	1
If Glasgow Coma Score ≤ 6	1
If dilated pupil one or both	1
If collapse or absent cisterns	1
	Maximum 10

Mortality

There was a global mortality of 23.3%, none associated with the performance nor the time of the tracheostomy, as reported in the "TracMan Randomized Trial"[18].

A total of 12 patients died before we were able to decide if they were going to need tracheostomy. Analyzing this situation and along with the findings reported by other authors that suggest that early tracheostomy has to be performed after day 3 and before the 1st week of stay[4,11-13,19,20], led us to suggest that this procedure should be done between day 3 and 4 of stay because before day 3 critically ill patients should not be exposed to unnecessary procedures as they will die during hospitalization as reported by Major et al. and Bouderka et al.[4,21]

We did not found a relationship between the time of performing the tracheostomy and mortality rate. The deaths in the tracheostomy group were 22.9% versus 0% in the non-tracheostomy group, as also days of AMV and total length of stay were higher in the tracheostomy group, this can be explained because this group of patients was critically ill. Some authors even associate the early tracheostomy with a decrease in mortality[5-7,19]. This was not the case in our results.

Complications of tracheostomy

No immediate complications of the tracheostomy were identified, so at our hospital, there seems to be no contraindication to perform an early tracheostomy as other authors refer[5].

Functional prognosis

The functional result was not modified by the time of performance of the tracheostomy, as in other published reports[9]. However, like the previous variables, the global clinical scenario of the patient reflects that those critically ill and with worse functional prognosis are the ones that will require and benefit from the tracheostomy at hospitalization.

Conclusions

According to our results, we can conclude that there are multiple factors associated with the need for tracheostomy in adult patients with severe TBI, most of them according to the clinical conditions and that it is possible to predict at admission which patients will need this procedure during their hospitalization, using scales such as CRASH, IMPACT, SAPS II, and APACHE II that have already been validated as prognostic in TBI. This scale (Table 6) can be used to calculate the need for tracheostomy; however, further studies are required to validate these results in a statistical way. At time, we are running a validation test of this scale in a new protocol.

We propose a new term for the performance of tracheostomy as ultra-early on the 4th day or earlier, early on day 7 or before, and late if it is performed after the 7th day of hospitalization. This proposal should be analyzed in subsequent studies to define its usefulness.

Until today has not been possible to standardize the ideal time to perform the tracheostomy in patients with severe TBI or to determine what patients are candidate for this procedure, being able to perform a prognostic scale could reflect benefit for institutions, as it will decrease the total length of stay and associated morbidities such as days of AMV and pneumonia frequency.

Conflicts of interest

There are no conflicts of interest.

Ethical disclosures

Protection of human and animal subjects. The authors declare that no experiments were performed on humans or animals for this study.

Confidentiality of data. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors have obtained the written informed consent of the patients or subjects mentioned in the article. The corresponding author is in possession of this document.

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