Brief Communication

Mild Paediatric Head Injury: The Diagnostic Value of Physical Examinations Compared with Computed Tomographic Scans

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Abstract

The study objective was to determine the diagnostic value of physical examinations for positive computer tomography (CT) scans in children with mild head injuries. Retrospective data of patients evaluated for mild head injuries with loss of consciousness (LOC) or amnesia were reviewed. Estimations of prevalence, sensitivity, specificity, and predictive values were calculated. Agreement between the physical examinations and CT brain scans was calculated using the Kappa test. 225 patients were included in the study. Of this group, 19.56% of patients had positive CT scans, and 7.56% had normal physical examinations. 15 underwent neurosurgical intervention. For positive CT scans, sensitivity and specificity were 61.36% and 60.22%, respectively. Agreement between physical examinations and CT scans was Kappa = 0.147 ($P < 0.05$), 95% CI (0.035, 0.259). The present study demonstrated that physical examinations were significantly associated with positive CT scans ($P = 0.01$). However, the calculated Kappa value showed only slight agreement between these 2 variables, and the low sensitivity and specificity of the physical examinations suggest that intracranial pathology in children with mild head injuries and LOC or amnesia cannot be excluded based on physical examinations alone.

Keywords: *CT scan, diagnostic value, mild head injury, physical examination, sensitivity, specificity*

Introduction

Few studies have been conducted on patients with mild head injuries compared with moderate and severe head injuries. A large number of hospital admissions and radiological investigations involve mild head injuries in children despite the fact that most do not involve long-term neurological deficits.

Several studies have attempted to determine clinical criteria that can reduce the cost of evaluating and treating these patients (1–10). Although conducting a computer tomography (CT) scan is acceptable in pediatric trauma patients with a Glasgow Coma Scale (GCS) lower than 13, deteriorating consciousness or focal deficits, the guidelines for scanning children with milder head injuries have remained controversial and poorly defined (11). The incidence of delayed surgery for children with extradural or acute subdural hematoma has resulted in increasing morbidity and mortality, further emphasising the importance of this controversy (12–14). A previous study concluded that the following clinical variables could not be consistently associated with intracranial injury (ICI), loss of consciousness (LOC), vomiting, headache, and amnesia (22). They found that ICI occurred in 4% of children, in which 1% of it needed surgical intervention, despite having normal clinical examinations. Similarly, Keskil et al. (21) were not able to find any dependable identifying clinical features for ICI and determined that CT scanning was the only reliable means of reducing avoidable mortality and morbidity.

The objective of this study was to determine the diagnostic value of physical examinations compared with positive CT scans in children with mild head injuries (GCS scores of 13–15) and LOC or amnesia in the emergency department. There were 2 specific objectives of this study: to (1) determine the sensitivity,

specificity, and (2) predictive values of a normal physical examination after mild head injury with LOC and to determine the correlation between physical examinations and CT brain scans in children with mild head injuries.

Subjects and Methods

This was a cross-sectional study using secondary data. This study was a retrospective case review of pediatric patients who presented to the Accident and Emergency Department of Hospital Kuala Lumpur (HKL) with mild closed-head injuries between January 2007–June 2009.

Subjects were children aged between 1–12 years with mild closed-head injuries (GCS 13–15) and a history of LOC or amnesia who had received head CT scans as part of their evaluation. All patients diagnosed with a head concussion and mild head injury were identified for the study population. Data concerning age, gender, mechanism of the injury, GCS at arrival, symptoms presented, physical findings, head CT results, and further management of the subjects were collected.

Results

In this study, 27 patients (27.3%) with positive physical examinations (PE) showed positive CT scans and 72 patients (72.7%) had negative CT scans. 17 (13.5%) of 126 patients with negative PEs had positive CT scans and 109 (86.5%) had negative CT scans. A Chi-square test was applied to analyse the association between these 2 variables. The results showed a significant association between physical examinations and CT scans (P = 0.01), as shown in Table 1.

The likelihood ratio (LR) indicates the test-value for increasing certainty of a positive diagnosis. In this study, the calculated LR was 1.5. The prevalence of positive CT scans was 19.56%. Sensitivity was 61.36% and specificity was 60.22% (Table 2).

Agreement between the physical examination and CT scan was Kappa = 0.14 (P = 0.01) (Table 3). This measure of agreement, while statistically significant, is only slightly convincing. Although not displayed in the output, we can calculate a 95% confidence interval using the generic formula for 95% confidence intervals: estimate ± 1.96 SE.

Using this formula and the results in the table, the approximate 95% confidence interval for Kappa was 0.035, 0.259. Agreement between physical examinations and CT scan was Kappa = 0.14 (P < 0.05), 95% CI (0.035, 0.259).

Discussion

Amongst children with minor head injuries, it is uncommon to observe LOC, but it is related to increased risk for intracranial injury. Since

Table 1: Association between physical examinations and CT scans in 225 patients

Physical examination	CT scan finding, *n* (%)		*P*-value[a]
	Positive	Negative	
Positive	27 (27.3)	72 (72.7)	0.01
Negative	17 (13.5)	109 (86.5)	0.01

[a] Pearson's Chi-square test. Abbreviation : CT = computer tomography.

Table 2: Cross tabulation of physical examinations versus CT scans

Physical examination	CT scan finding, *n*		Total, *n*
	Positive	Negative	
Positive	27	72	99
Negative	17	109	0.01

Abbreviation : CT = computer tomography.

1. Sensitivity = 27 / (27 + 17) x 100 = 61.36%
2. Specificity = 109 / (109 + 72) x 100 = 60.22%
3. Positive predictive value (ppv) = 27 / 99 x 100 = 27.22%
4. Negative predictive value (npv) = 109 / 126 x 100 = 86.50%
5. Prevalence = 44 / 225 x 100 = 19.56%

Table 3: Symmetric measures of agreement using the Kappa test

Paramater	Value	Asymptotic standard error[a]	Approximate T[b]	Approximate Sig.
Measure of agreement, Kappa value	0.147	0.057	2.587	0.010
No. of valid cases	225			

[a] Not assuming the null hypothesis.
[b] Using the asymptotic standard error assuming the null hypothesis.

CT scanning began, studies have suggested that up to 28% of children with LOC or those who demonstrate amnesia at the time of evaluation present with intracranial injury that can be detected on a CT scan (3,12,20). Although most of these intracranial lesions remain clinically irrelevant, between 2% and 8% of those with mild head injuries and LOC might require neurosurgical intervention (12).

The present study showed that physical examinations were significantly associated with positive CT scans (P = 0.01). However, a further assessment of the predictive ability of normal physical examinations and their unacceptably low sensitivity and specificity (61.4% and 60.2%, respectively) suggests that intracranial pathology in children with minor head injuries cannot be excluded based on physical examinations alone. Sensitivity and specificity are important measures of the diagnostic accuracy of a test but cannot be used to estimate the probability of disease in an individual patient. The effectiveness of a test depends on its ability to identify people with disease; the sensitivity of a test is determined by observing only those with disease. Thus, a test with high sensitivity is valuable for excluding a disease if subject's test was negative. To define specificity, the proportion of people without the disease whose test was negative is of interest. Thus, a test with high specificity is valuable for excluding a disease if subject's test was positive.

In this study, the positive and negative values were 0.27 and 0.87, respectively. This indicates that in this study population, in which a 19.56% prevalence of positive CT scans was observed, a child who has a positive physical examination has 27% chance of having a positive CT scan. Likewise, a child who has a negative physical examination has 87% chance of not having a positive CT scan. We can presume from the above data that the negative predictive value (NPV) might also be termed as the probability of not having a disease given a negative test. Therefore, it is vital to note that 'the post-test probability of disease given a negative test' is the converse of NPV (1-NPV), and is not equal to NPV.

This study also showed that the post-test probability of disease given a negative physical examination was 13%, indicating that a child who has a normal physical examination has a 13% chance of having a positive CT scan. This is a high percentage and cannot be ignored given the detrimental effects of overlooking intracranial injuries in developing and growing children. The calculated likelihood ratio was 1.5. This suggests that a child with a positive physical examination is 1.5 times more likely to have a positive CT scan. A high probability ratio implies that the test is useful but does not necessarily confirm that a positive test is a positive indicator of disease existence. Because probability ratios are derived from sensitivity and specificity, they are stable operating test characteristics that are unaffected by disease frequency.

Although there was an association between physical examinations and CT scans, only slight agreement was observed between these 2 observations (Kappa = 0.15), as values less than zero indicate less than chance agreement (Table 4) (23). Most statisticians select Kappa values of at least 0.6 and many, higher than 0.7, before declaring an acceptable level of agreement. This agreement test has further strengthened the conclusion that intracranial pathology in children with minor head injuries cannot be excluded based on physical examinations alone. Kappa values does not differentiate amongst the different types and sources of disagreement because it is affected by frequency. It may not be appropriate to compare Kappa values between different studies or populations; however, Kappa values can provide more information than simple deductions of the raw proportions of agreement.

Conclusions

This study showed that positive physical examinations were significantly associated with positive CT scans (P = 0.01). However, the calculated Kappa value showed only slight

Table 4: Qualitative terms for Kappa values.

Kappa value	Qualitative value
< 0	Less than chance agreement
0.0–0.2	Slight agreement
0.2–0.4	Fair agreement
0.4–0.6	Moderate agreement
0.6–0.8	Substantial agreement
0.6–1.0	Near-perfect agreement

agreement between these 2 variables, and the low sensitivity and specificity of physical examinations suggest that intracranial pathology in children with mild head injuries and LOC or amnesia cannot be excluded based on physical examinations alone.

Authors' Contribution

Conception and design, analysis and interpretation of the data, drafting of the article, critical revision of the article for important intellectual content, obtaining of funding, administrative, technical, or logistic support, and collection and assembly of data: FF

Drafting of the article, critical revision of the article for important intellectual content, final approval of the article, provision of study materials or patients, and administrative, technical, or logistic support: MSMH

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