Brief Communications

Paediatric Mild Head Injury: Diagnostic Value of Physical Examination in Comparison With Computed Tomographic Scan

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Abstract

The study objective was to determine diagnostic value of physical examination for positive CT scan findings in children with mild head injury. Retrospective data of patients who were evaluated for mild head injury with loss of consciousness (LOC) or amnesia was reviewed. The estimations of prevalence, sensitivity, specificity and predictive values were calculated. The agreement between physical examination and CT brain was calculated using Kappa test. Two hundred and twenty five patients were included into the study. Out of this, 19.56% patient had positive scan finding and 7.56% of this showed normal physical examination. Fifteen underwent neurosurgical intervention. For positive CT findings, sensitivity and specificity were 61.36% and 60.22%, respectively. The agreement between physical examination and CT scan was found to be Kappa = 0.147 (p <0.05), 95% CI (0.035, 0.259). Present study showed physical examination was significantly associated with positive CT scan finding (p=0.01). However, kappa value calculated only showed a slight agreement between these two variables and the findings of low sensitivity and specificity made that intracranial pathology in mild head injury children and having LOC or amnesia cannot be excluded on the basis of physical examination alone.

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

Introduction

Not many studies were done in mild head injury compared with moderate and severe head injury patients. Large number of hospital admissions and radiological investigations are done on mild head injury in children despite that most of them do not have long term neurological deficits.

There were number of studies to determine clinical criteria that can reduce the cost of evaluations and treatment of these patients (1-10). Although paediatric trauma patient with a GCS lower than 13, deteriorating consciousness or focal deficits to receive head CT scan is acceptable, the guidelines for scanning of a child with milder head injury remained controversial and poorly defined (11). The observation that children with delayed surgery for extradural haematoma or acute subdural resulted in increasing number of morbidity and mortality further emphasized the importance of this controversy (12-14). A study concluded not any of the following clinical variable which includes loss of consciousness (LOC), vomiting, headache and amnesia can be consistently associated with intracranial injury (ICI) (21). They found that ICI still happened in 4% of children despite normal clinical examination, which surgical intervention was needed in 1% of the time. Likewise, Keskil et al. could not find any dependable identifying clinical features for ICI and established that CT scanning was the only means that is reliable in reducing avoidable mortality and morbidity (22).
The objective of this study was to determine the diagnostic value of physical examination in comparison with positive CT scan findings in children with mild head injury (GCS score 13-15) and with loss of consciousness or amnesia in the emergency department. There were 2 specific objectives aimed to achieve in this study, they were to determine the sensitivity, specificity and predictive values of a normal physical examination after mild head injury with LOC and to determine the correlation between physical examination and CT brain in children with mild head injury.

**Subjects and Methods**

This was a cross-sectional study using secondary data. It was a retrospective case review on paediatric patients who presented to the Accident and Emergency Department of HKL with mild closed head injury over a period of two and a half years from January 2007 to June 2009.

The subject were children ages between 1 and 12 years old with a closed mild head injury (GCS 13-15), history of loss of consciousness or amnesia and received a head computer tomography (CT) as part of their evaluation. All the patients with the diagnosis of head concussion and mild head injury were identified for the study population. Data collected included age, gender, mechanism of injury, GCS on arrival, presenting symptoms, physical sign findings, head computed tomography (CT) results and further management of the subjects.

**Results**

In this study, twenty seven patients (27.3%) who had positive physical examination (PE) had showed positive CT scan finding and seventy-two patients (72.7%) had negative CT scan finding. Seventeen (13.5%) out of 126 patients who had negative PE had showed positive CT scan finding and one hundred and nine (86.5%) showed negative CT scan finding. Chi-square test was applied to analyse the association between these two variables. The result showed there was a significant association between physical examination and CT scan finding (p=0.01), Table 1.

The likelihood (LR) ratio indicates the value of the test for increasing certainty about a positive diagnosis. In this study the LR calculated is 1.5. The prevalence of positive CT scan finding was 19.56%. The sensitivity was 61.36% and the specificity was 60.22% (Table 2).

The results of the agreement between the physical examination and CT scan analysis are Kappa = 0.14 with 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 ± 1.96SE
SE = Standard Error

Using this formula and the results in the table an approximate 95% confidence interval on Kappa is (0.035, 0.259). The agreement between physical examination and CT scan was found to be Kappa = 0.14 (p < 0.05), 95% CI (0.035, 0.259).

**Discussion**

Amongst children with minor head injury, it is uncommon that they have LOC but it is related with an increased risk for intracranial injury. Since the beginning of CT scanning, studies performed suggest that children who had LOC, or who demonstrate amnesia, at the time of evaluation, have incidence of intracranial injury that can be detected on CT which ranges from 0% to 28% (3, 12, 20). Though most of these intracranial lesions remain
clinically irrelevant, a large proportion of children, between 2% and 8% of those with mild head injury and LOC, might need neurosurgical intervention (12).

The present study showed that physical examination was significantly associated with a positive CT scan finding (p = 0.01). However on further assessment of its predictive ability of a normal physical examination and the findings of unacceptably low sensitivity and specificity, 61.4% and 60.2% respectively, a conclusion was made that intracranial pathology in children with minor head injury cannot be excluded on the basis of physical examination 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. How effective the test is to identify people with disease when only looking at those with disease only, shows us the sensitivity of a test. A high sensitivity test is valuable to exclude a disease if a person tests negative. To define specificity, the proportion of people without the disease who tests negative are what we are interested in. A high specificity test is valuable to exclude a disease if a person tests positive.

In this study, the Positive and Negative Values were 0.27 and 0.87 respectively. This means that, in this study population with a prevalence of positive CT scan findings of 19.56%, a child who has a positive physical examination has a 27% chance of having positive CT scan. Likewise, a child who has a negative physical examination has a 87% chance of not having positive CT scan. We can presume from the above that NPV might also be termed as the probability of not having disease given a negative test. So, it is vital to note that ‘the post-test probability of disease given a negative test’ is the converse (1-NPV), and NOT the same as the NPV.

This study also showed the post-test probability of disease given a negative test was 13%. This means that in this study population, a child who tests negative for physical examination, in other word, normal physical examination has a 13% chance of having positive CT scan. This is a quite a high percentage and cannot be ignored given the detrimental effects of missing intracranial injury in developing and growing children. The calculated likelihood ratio was 1.5. This means that a child with a positive physical examination will have 1.5 times more likely positive CT scan findings. A high probability ratio implies that the test is useful but does not necessarily follow that a positive test is a good sign of the existence of disease. Since probable ratios are derived from sensitivity and specificity, probable ratios are stable operating test characteristics, not affected by frequency of disease.

Although there was an association between the physical examination and CT scan finding, a kappa value of 0.15 showed only a slight agreement between these two observations with value less than zero give less than chance agreement (Table 4). Most statisticians select Kappa values at least 0.6 and most of higher than 0.7 before declaring a good level of agreement. This agreement test of kappa statistic has strengthened further the conclusion stated earlier that intracranial pathology in children with minor head injury cannot be excluded on the basis of physical examination alone. Kappa does not differentiate amongst the different types and sources of disagreement. This is because it is affected by frequency. It may not be right to compare kappa between different studies or populations. However, kappa can give more information than simple deduction of the raw proportion of the agreement.

**Conclusion**

This study showed physical examination was significantly associated with positive CT scan finding (p=0.01). However, kappa value calculated only showed a slight agreement between these two variables and the findings of low sensitivity and specificity made that intracranial pathology in mild head injury children and having LOC or amnesia cannot be excluded on the basis of physical examination alone.
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References


Table 1: Association between physical examination and CT scan finding in 225 patients

<table>
<thead>
<tr>
<th>Physical examination N (%)</th>
<th>CT scan finding N (%)</th>
<th>P-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positive</td>
<td>Negative</td>
</tr>
<tr>
<td>Positive</td>
<td>27 (27.3)</td>
<td>72 (72.7)</td>
</tr>
<tr>
<td>Negative</td>
<td>17 (13.5)</td>
<td>109 (86.5)</td>
</tr>
</tbody>
</table>

*Pearson Chi-Square Test

Table 2: Physical examination versus CT scan finding cross tabulation table

<table>
<thead>
<tr>
<th>Physical examination</th>
<th>CT Scan Finding</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positive</td>
<td>Negative</td>
</tr>
<tr>
<td>Positive</td>
<td>27</td>
<td>72</td>
</tr>
<tr>
<td>Negative</td>
<td>17</td>
<td>109</td>
</tr>
<tr>
<td>Total</td>
<td>44</td>
<td>181</td>
</tr>
</tbody>
</table>

1. Sensitivity = \(\frac{27}{(27 + 17)} \times 100 = 61.36\%\)
2. Specificity = \(\frac{109}{(109 + 72)} \times 100 = 60.22\%\)
3. Positive predictive value (ppv) = \(\frac{27}{99} \times 100 = 27.22\%\)
4. Negative predictive value (npv) = \(\frac{109}{126} \times 100 = 86.50\%\)
5. Prevalance = \(\frac{44}{225} \times 100 = 19.56\%\)

Table 3: Symmetric Measures for the agreement using kappa statistic

<table>
<thead>
<tr>
<th>Measure of agreement, Kappa</th>
<th>Value</th>
<th>Asymp. Std. Errora</th>
<th>Approx. Tb</th>
<th>Approx. Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.147</td>
<td></td>
<td>0.057</td>
<td>2.587</td>
<td>0.010</td>
</tr>
</tbody>
</table>

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

Table 4: Qualitative terms for kappa (JR and GG, 1977)

<table>
<thead>
<tr>
<th>Kappa</th>
<th>Qualitative value</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;0</td>
<td>Less than chance agreement</td>
</tr>
<tr>
<td>0 – 0.2</td>
<td>Slight agreement</td>
</tr>
<tr>
<td>0.2 – 0.4</td>
<td>Fair agreement</td>
</tr>
<tr>
<td>0.4 – 0.6</td>
<td>Moderate agreement</td>
</tr>
<tr>
<td>0.6 – 0.8</td>
<td>Substantial agreement</td>
</tr>
<tr>
<td>0.6 – 1.0</td>
<td>Almost perfect agreement</td>
</tr>
</tbody>
</table>