Diagnostic accuracy of clinical characteristics following minor head injury: a systematic review and meta-analysis

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INTRODUCTION

Computed tomography (CT) of the head is the diagnostic standard for identifying intracranial injury. Routine CT of all minor head injury patients would result in a large number of normal CT scans being performed with associated risks of radiation exposure and waste of health care resources. Clinical decision rules for minor head injury patients incorporate a number of individual characteristics grouped together to provide a tool for identifying those at risk of intracranial injury and in need of CT. We performed a systematic review of the individual characteristics that contribute to clinical decision making and calculated likelihood ratios of significance for each.

METHODS

Potentially relevant studies were identified by an electronic search of key databases from inception to March 2010. Papers in English were included with a cohort of more than 20 patients and over 50% being adults having suffered a minor head injury (GCS 13-15). Studies described any characteristic to identify patients at risk of intracranial injury or neurosurgery and had to include a proportion of the cohort undergoing imaging. Titles, abstracts and full-text articles were independently screened for relevance by two sets of paired authors (one clinician and one reviewer in each pair) with any discrepancies being resolved through discussion. A checklist based on the QUality Assessment of Diagnostic Accuracy Studies (QUADAS) checklist was compiled and each article scored appropriately. Studies which included only children and studies which included only infants (any age definitions accepted) were meta-analysed separately from studies which included all age groups, did not specify an age limit or included adults only. Data that had been defined in a reasonably homogeneous and clinically meaningful way were selected and analysed as follows. If data from only one study was available, the analysis produced estimates of sensitivity, specificity, negative likelihood ratio (NLR) and positive likelihood ratio (PLR), and corresponding 95% confidence intervals (CI). The latter were calculated assuming the statistics were normally distributed on the logit scale (sensitivity, specificity) and on the logarithm scale (NLR, PLR). If two studies were available, meta-analysis was conducted using the DerSimonian and Laird method.[1] For data from three or more studies, a full Bayesian meta-analysis was conducted. The bivariate random effects method of Reitsma et al. (2005)[2] was used.

RESULTS

Data were extracted from 71 studies, with cohort sizes ranging from 39 to 31694 patients. The most useful clinical characteristics for identifying those with intracranial injury were depressed or basal skull fracture in both adults and children (positive likelihood ratio [PLR] >10). Other useful characteristics in adults or children included focal neurological deficit, post traumatic seizure (PLR >5), persistent vomiting, and coagulopathy (PLR 2 to 5). Characteristics that had limited diagnostic value included loss of consciousness and headache in adults, and scalp haematoma and scalp laceration in children. Few studies were undertaken in children and even fewer in infants. The complete set of analyses for all clinical characteristics, in all three age groups and for outcomes of both intracranial injury and need for neurosurgery are presented in Pandor et al. (2011).[3]

CONCLUSIONS

Amongst other characteristics, depressed or basal skull fracture indicated increased risk of intracranial injury and the need for CT scanning in adults and children. Other characteristics, such as headache in adults and scalp laceration or haematoma in children, do not reliably indicate increased risk.

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Table 1. Pooled sensitivity, specificity, PLR and NLR for diagnosing intracranial injury in adults with minor head injury

Clinical characteristic	No. of studies	No. of patients	Pooled estimates (where applicable) [a]							
			Sensitivity	95% CI [b]	Specificity	95% CI [b]	NLR	95% CI [b]	PLR	95% CI [b]
Age > 60	7	20514	23.9 [c]	14.5, 36.5	88.0 [c]	78.1, 93.8	0.868	0.785, 0.925	1.97	1.48, 2.81
Anterograde or post-trauma amnesia	6	16965	16.2 [c]	6.8, 30.9	91.9 [c]	83.2, 96.4	0.912	0.825, 0.972	1.95	1.48, 2.62
Any headache	13	15757	36.8 [c]	25.5, 50.5	70.3 [c]	57.3, 79.8	0.901	0.792, 1.005	1.23	0.99, 1.55
Any LOC	17	43640	59.9 [c]	43.0, 75.8	58.0 [c]	39.5, 74.1	0.698	0.532, 0.871	1.41	1.14, 1.84
Any seizure	10	28660	2.8	1.1, 5.1	99.0 [c]	96.2, 99.7	0.984	0.970, 0.996	2.59	1.20, 6.40
Assault	8	6273	14.1 [c]	3.9, 36.0	86.2 [c]	67.4, 95.4	0.997	0.924, 1.038	1.02	0.68, 1.33
Basal skull fracture	8	27717	21.1 [c]	8.4, 33.9	98.4 [c]	90.5, 100.0	0.80	0.72, 0.92	54.070	3.594, 353.700
Chronic alcohol	4	16929	5.9 [c]	0.7, 40.8	97.6 [c]	49.5, 99.8	0.973	0.933, 1.186	2.00	0.79, 9.03
Coagulopathy	8	35567	4.9 [c]	0.6, 16.0	98.2 [c]	93.3, 99.8	0.968	0.897, 0.999	3.27	1.21, 7.52
Depressed skull fracture	2	2680	9.1 [c]	5.5, 14.5	99.9	99.6, 100.0	0.967	0.819, 1.141	102.15	13.13, 794.41
Dizziness	3	1341	18.7	11.9, 27.3	73.8	70.2, 78.1	1.101	0.970, 1.217	0.72	0.44, 1.09
Fall – any	10	8719	31.3 [c]	20.3, 44.3	72.0 [c]	62.2, 80.2	0.953	0.871, 1.024	1.12	0.93, 1.29
Fall from a height	1	1064	28.0	17.3, 41.9	87.8	85.6, 89.6	0.820	0.689, 0.977	2.29	1.43, 3.68
Focal neurological deficit	8	21729	6.6 [c]	1.2, 16.9	98.6 [c]	95.2, 99.8	0.95	0.84, 1.01	9.671	0.663, 38.950
GCS < 14	5	25026	40.4 [c]	12.8, 77.5	89.1 [c]	18.9, 99.6	0.718	0.429, 1.674	3.58	0.80, 46.84
GCS < 15	12	59924	46.3 [c]	29.6, 64.2	89.6 [c]	81.1, 94.7	0.602	0.418, 0.765	4.42	2.63, 7.66
Intoxication	4	25613	3.8	1.8, 6.4	98.6 [c]	90.2, 99.8	0.976	0.946, 1.072	2.72	0.29, 26.06

a, Pooled estimates based on the following: data from one study only - observed data; data from two studies - a fixed effects meta-analysis conducted using the method of DerSimonian and Laird (1986); data from three or more studies - a full Bayesian meta-analysis conducted using the bivariate random effects method of Reitsma et al. (2005) ; b, Credible Interval if more than 3 studies meta-analysed ; c , Significant heterogeneity, p-value <0.05

Table 2 Pooled sensitivity, specificity, PLR and NLR for diagnosing intracranial injury in children with minor head injury

Clinical characteristic	No. of studies	No. of patients	Pooled estimates (where applicable) [a]							
			Sensitivity	95% CI [b]	Specificity	95% CI [b]	NLR	95% CI [b]	PLR	95% CI [b]
Anterograde or post-trauma amnesia	1	337	20.9	12.8, 32.3	93.0	89.2, 95.5	0.851	0.401, 1.804	2.97	1.40, 6.29
Any headache	14	57064	33.9 [c]	22.9, 47.6	73.3 [c]	62.1, 81.3	0.905	0.784, 1.010	1.26	0.97, 1.61
Any LOC	17	60565	45.9 [c]	36.4, 55.6	80.1 [c]	67.4, 87.3	0.679	0.566, 0.814	2.30	1.46, 3.47
Any seizure	9	25138	10.0	7.3, 13.3	96.3 [c]	91.9, 98.3	0.935	0.899, 0.987	2.69	1.17, 6.24
Assault	2	23033	3.4	1.9, 6.0	95.9 [c]	95.6, 96.1	1.010	0.565, 1.805	0.79	0.44, 1.42
Basal skull fracture	5	59013	17.8 [c]	7.8, 31.7	98.7 [c]	96.5, 99.6	0.833	0.703, 0.929	16.90	6.13, 32.44
Coagulopathy	2	24438	5.8 [c]	3.2, 10.5	99.7 [c]	99.6, 99.8	0.942	0.520, 1.706	6.56	3.08, 14.00
Depressed skull fracture	2	23033	16.0 [c]	12.4, 20.5	99.8 [c]	99.7, 99.9	0.855	0.756, 0.966	73.82	46.45, 117.32
Dizziness	3	1207	5.2	0.6, 13.3	93.5 [c]	85.7, 98.5	1.014	0.910, 1.109	0.79	0.11, 4.30
Fall – any	5	24779	34.7 [c]	17.0, 56.5	54.7 [c]	49.1, 60.6	1.206	0.726, 1.683	0.78	0.34, 1.41
Fall from a height	2	22811	20.0	15.8, 25.0	80.2	79.7, 80.7	0.991	0.787, 1.247	1.01	0.80, 1.28
Focal neurological deficit	10	30942	21.1 [c]	8.8, 41.1	99.0 [c]	95.4, 99.8	0.798	0.615, 0.915	20.46	7.40, 54.24
GCS < 14	5	25026	40.4 [c]	12.8, 77.5	89.1 [c]	18.9, 99.6	0.718	0.429, 1.674	3.58	0.80, 46.84
GCS < 15	12	59924	46.3 [c]	29.6, 64.2	89.6 [c]	81.1, 94.7	0.602	0.418, 0.765	4.42	2.63, 7.66
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