

The role of headache management in minor head injury before performing brain CT scan - can intravenous morphine sulfate predict intracranial injury?

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ABSTRACT

BACKGROUND: The aim of this study was to examine the association between the responses of headache to IV morphine and the findings of brain CT scan in minor head injury (MHI), and to propose a new risk indicator to identify patients requiring CT scanning.

METHODS: A total of 1857 MHI patients ≥ 15 years of age, presenting with headache and a GCS score of 14 or 15 were included in the study. Intravenous morphine sulfate was administered, and thereafter, patients were assessed for the relief or persistence of headache. Subsequently, a brain CT scan was obtained from all patients.

RESULTS: Patients were divided into two age groups: 15-60 and >60 years. There was a significant association between the response of headache to morphine and the result of brain CT in both age groups ($p < 0.001$). In patients aged between 15 and 60, none whose headache had responded to morphine showed any abnormal findings in CT scan (sensitivity=100%). In the >60 group, sensitivity was 58.3% for abnormal CT and 71.4% for neurosurgical intervention.

CONCLUSION: This study suggests that a headache not relieved by morphine is a risk indicator for intracranial injury. This protocol can be used in rural areas with limited access to CT scan as an adjunct to the existing criteria for selecting patients with MHI for CT scanning.

Key words: Brain injuries; computed tomography; craniocerebral trauma; headache; morphine; pain management.

INTRODUCTION

More than 1.5 million people sustain traumatic brain injury in the United States annually.^[1] Minor head injuries (MHI) account for a majority of cases in head trauma.^[2] The term "minor head injury" is used with variable definitions. It is

typically defined as history of blunt head trauma in a patient presenting with Glasgow Coma Scale (GCS) score of 13-15. Some authors include post-traumatic disorientation, loss of consciousness and/or amnesia for the traumatic event in the definition, classifying patients without mentioned alteration in mental status into another category: minimal head injury.^[3] Some others exclude patients with the GCS score of 13 from the mild category due to higher incidence of intracranial lesions requiring surgical operations.^[4]

The decision of which patients with MHI should undergo computed tomography (CT) evaluation has long been a subject of controversy.^[5] On the one hand, incidence of intracranial lesions, especially those clinically significant and more specifically those requiring operative intervention is relatively low in MHI (less than 10% and less than 1%, respectively).^[6] Thus, failure to detect clinically insignificant intracranial

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lesions seems to be an acceptable risk of selecting patients for CT scanning.^[3] For instance, it has been shown that the presence of isolated contusion in CT images of patients with MHI without any other space occupying lesions does not worsen the short term prognosis and does not increase the need for neurosurgical operations.^[7] Moreover, precluding unnecessary CT scanning can significantly reduce health care expenditure^[6] and resource use, as well as minimizing radiation exposure,^[8] saving time, and preventing unnecessary transfer from centers that CT scan is not available.^[9] On the other hand, there is an opposing opinion promoting a more liberal use of CT scan considering the unfavorable outcomes of missing an abnormality. The former is more dominant in a context that health policies emphasize on cost-effective use of resources or where resources are scarce and CT is not extensively available, whereas the latter is favored in a context that the fear of litigation is high.^[5] Several studies have assessed different indicators predicting abnormal CT scan,^[10-18] and different criteria and guidelines have been developed for judicious utilization of CT scan aiming to reduce the number of unnecessary scans and at the same time not to jeopardize optimal patient care.^[3,4,6,9,19-21] The Canadian CT Head Rule (CCHR)^[3] and the New Orleans Criteria (NOC)^[6] are among the most widely studied decision rules.^[8,22-27]

Headache is a very prevalent symptom in the victims of MHI.^[28,29] There is no consensus if headache is a reliable indicator of intracranial injury in these patients.^[10] It is considered a risk indicator in the criteria developed by Miller et al.^[19] and Haydel et al. (NOC),^[6] however, not in the CCHR.^[3] A clinical policy established by a multidisciplinary panel recommends considering brain CT scan in MHI patients with a GCS score of 15 and no history of loss of consciousness/ amnesia if they have severe headache.^[4] However, according to a systematic review and meta-analysis carried out by Pandor et al., headache is not a reliable predictor of intracranial injury in adults.^[11] Headache is a major contributor to post concussive syndrome and long term disability after mild traumatic brain injury, and early utilization of analgesics might affect the long term outcome. However, the pain is usually undertreated in emergency departments. Paracetamol and non-steroidal anti-inflammatory drugs (NSAIDs) are among the most widely used analgesics in mild traumatic brain injury, followed by opiates.^[30] The effect of morphine in the management of pain in trauma patients, particularly limb trauma is well-established.^[31] The association between the response of headache to IV morphine and the results of brain CT scan in MHI was aimed to be examined, speculating that a headache not relieved by morphine is more likely to be associated with a structural damage that can be observed in the CT scan. The ultimate goal of this study was to propose a new protocol in the selection of patients for CT scanning, particularly to reduce the costly and time-consuming process of patient transfer in rural areas of developing countries, where CT scan and neurosurgery experts are not easily accessible.

MATERIALS AND METHODS

This prospective study was conducted between April 2010 and July 2013 in three major teaching hospitals, each with more than 70.000 annual visits to the emergency department (ED). Patients aged 15 years or older who had sustained blunt head trauma and presented to the ED with headache and a GCS score of 14 or 15 were considered eligible. Patients with any of the following criteria were excluded: focal neurological deficit, suspected open or depressed skull fracture, signs of basilar skull fracture, post-traumatic seizure, coagulopathy or anticoagulant therapy, vomiting, drug or alcohol intoxication, opium addiction, hypersensitivity to opiate analgesics, any concomitant injury, and refusal to participation in the study. The study was approved by the Medical Ethics Committee of the corresponding universities. Informed consent was obtained from all participants.

Patients were assessed by the attending physicians or supervised residents of emergency medicine. Headache was defined as any head pain, no matter diffuse or local. An initial dose of 0.05 mg/kg morphine sulfate was administered intravenously to all patients. After 15 minutes, the patients were assessed for presence or absence of headache (respectively equivalent to score ≥ 1 and 0 on 10-point visual analogue scale [VAS]). Had the headache persisted, another dose of intravenous morphine sulfate (0.05 mg/kg) was administered. Those patients still having headache 15 minutes after receiving the second dose of morphine were regarded as response-negative, and all others whose pain was relieved (score 0 on VAS) either by one or two dose(s) of morphine were considered response-positive. Since the evaluation process was completed before obtaining brain CT, the patients and the examiners were blind to the results of scanning.

Non-enhanced brain CT imaging was performed and the results were interpreted by staff radiologists blind to the results of clinical assessments. A brain CT scan was considered positive (abnormal) if any of the following lesions were present: Skull fracture, brain contusion, epidural hematoma (EDH), subdural hematoma (SDH), intra-cerebral hemorrhage (ICH),

Table 1. The frequency of pathologic findings in brain CT of patients in different age groups

Lesion	15-60 years	>60 years
Contusion	44	30
Epidural hematoma	39	16
Subdural hematoma	27	19
Skull fracture	19	12
Intra-cerebral hemorrhage	18	6
Subarachnoid hemorrhage	9	2
Intra-ventricular hemorrhage	1	2

Table 2. Primary and secondary outcomes according to the response of headache to IV morphine in patients aged 15-60 and >60 years

	15-60 (n=1667)			>60 (n=190)		
	Response +	Response -	Total	Response +	Response -	Total
CT +	0 (0)	144 (4)	144 (4)	20 (2)	28 (5)	48 (7)
CT -	1363	160	1523	104	38	142
Total	1363	304	1667 (4)	124	66	190 (7)

*: Numbers in the parentheses indicate the number of patients requiring neurosurgical intervention.

subarachnoid hemorrhage (SAH), or intra-ventricular hemorrhage (IVH). Primary outcome was positive brain CT scan and secondary outcome was neurosurgical intervention.

Patients were divided into two age groups: 15-60 and >60 years. For each age group, outcomes were compared in response-positive and response-negative patients using cross-tabulation and Chi-square analysis. P-values ≤ 0.05 were considered statistically significant. Statistical analysis was performed using the SPSS software version 20 (SPSS, Inc., Chicago, IL).

RESULTS

A total of one thousand eight hundred and fifty-seven patients were included in the study. Three hundred and eighty-seven (21.4%) were female. Mean age of the participants was 35.5 years; 1667 (89.8%) aged 15-60 years and 190 (10.2%) were older than 60. The majority of patients (78.1%) had a GCS score of 15 (78.7% in the 15-60 and 73.2% in the over 60 years). Three hundred and twenty patients (17.2%) had a history of loss of consciousness or amnesia for the traumatic event (16.6% of 15-60 and 23.2% of >60). Of all patients, one hundred and ninety-two (10.3%; 8.64% of 15-60 and 25.3% of >60) had at least one lesion in CT. Brain contusion was the most prevalent pathologic finding in both age groups (Table 1). Eleven patients required neurosurgical intervention (0.6% overall; 0.240% of 15-60 and 3.68% of >60).

Table 3. CT findings of patients aged >60 years with a headache that was ameliorated by morphine

Pathology*	Frequency
Intra-cerebral hemorrhage	-
Contusion	9
Skull fracture	3
Subarachnoid hemorrhage	-
Subdural hematoma	8
Epidural hematoma	3
Intra-ventricular hemorrhage	-

*: Three patients had more than one lesion in the CT scan; one had skull fracture + epidural hematoma and two had skull fractures + brain contusions.

Of the one thousand six hundred sixty-seven patients aged between 15 and 60, the headache was relieved in 81.8% of the patients after administering intravenous morphine sulfate. Interestingly, none of these 1363 patients had any pathologic findings in the CT scan (Table 2). On the contrary, of the remaining three hundred and four patients in this age group whose headache was not responsive to morphine, 47.4% had abnormality in the CT scan and 4 required neurosurgical procedures. In >60 years age group, one hundred and twenty-four patients (65.3%) reported their headache to be ameliorated by morphine. However, twenty of them had pathologies in the CT scan (Table 3). Two patients in this category had subdural hematomas necessitating neurosurgical interventions.

Statistical analysis revealed a significant association between the response of headache to IV morphine and the results of brain CT in both age groups (Pearson Chi-Square=706.676 for 15-60 and 15.774 for >60; p-values <0.001). In other words, the rate of abnormal brain CT scan was significantly lower in patients whose headache was ameliorated by morphine. This protocol showed a sensitivity of 100%, specificity of 89.5% and accuracy of 90.4% for detecting abnormal CT scan in the age group of 15-60 years. In the age group of >60, though, sensitivity was 58.3% for the primary outcome and 71.4% for the secondary outcome.

DISCUSSION

The purpose of this study was to propose a new protocol in identification of cases that should undergo CT scanning in minor head injury of the adult population. Patients with minor head injuries, presenting with a GCS score of 14 or 15, and with a complaint of headache were assessed for the relief of the headache by morphine, and patients whose headache was relieved by morphine were compared to those who did not respond to morphine with respect to abnormal CT rate and rate of operative interventions. To the best of our knowledge, no previous study has assessed the association of pain relief by analgesics and pathologic findings in imaging studies. The results of this study put forward that in patients aged 15-60 years, the response of headache to morphine has a sensitivity of 100% for any abnormal findings in the brain CT scan. Therefore, we propose for this age group that a headache not relieved by morphine is an indicator for the need to

perform brain CT scan. This protocol can help physicians in rural areas with limited access to CT scan and neurosurgical services to decide on selecting patients to be transferred to an equipped center.

Morphine is one of the most widely used analgesics for trauma patients in the emergency departments.^[31] However, patients with head trauma are less likely to receive opiate analgesics in the emergency departments due to the concern of masking the symptoms of traumatic brain injury and making the re-evaluation of patients difficult.^[32] In addition, morphine has other unfavorable side effects such as respiratory depression, increase in intracranial pressure, hypotension,^[33] and decrease in cerebral perfusion pressure.^[34] Nevertheless, none of these effects were observed in our study. It seems that the concern is more prominent in critically ill and/or severely injured patients and in higher doses of morphine. Furthermore, effects of opiates can be reversed by administering opioid antagonists (e.g. naloxone). Thus, we feel that its benefit in pain management and presumed reduction of unnecessary referrals for CT scanning outweighs the risk.

Our suggested protocol has relatively low sensitivity for detecting abnormal CT scan (58.3%) and need for surgical intervention (71.4%) in patients over 60 years of age. There is evidence that due to age-related changes, threshold of injury is lower in elderly people and the guidelines used in the general population cannot be applied to this group.^[18] As a result, brain CT scan is recommended for all elderly patients (>60^[6] or >65^[3] years of age) sustaining minor head injury.

Current study has some limitations. Most importantly, due to a deficit in the records of some patients, a multivariate analysis could not be performed. Therefore, the results cannot be attributed solely to the response of headache to morphine and the role of other variables such as history of amnesia or loss of consciousness and GCS score in predicting abnormal CT scan of the study population is unclear. Hence, the findings should be interpreted with caution. Another limitation is that although we had an optimal sensitivity of 100%, the protocol should be externally validated and tested on an extremely larger sample size before drawing this conclusion that those patients (under the age of 60) with a positive response of the headache to morphine can be safely excluded from referring for CT scanning if the clinical decision rules recommend otherwise. The idea opens a new horizon for future investigations.

Conclusion

This study suggests that the presence of a headache not relieved by morphine is a risk indicator which can be used as an adjunct to the existing criteria for selecting patients with minor head injury for the CT scanning. It can assist in making the decision of transferring patient in centers where CT scan is not accessible. This factor should be validated in future studies with larger sample sizes.

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KLİNİK ÇALIŞMA - ÖZET

Minör baş travmasında beyin BT taraması çekmeden önce baş ağrısı tedavisinin rolü: İntravenöz morfin sülfat kafa içi travmasını öngörebilir mi?

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AMAÇ: Bu çalışmanın amacı, beyin BT taramasında minör kafa travması (MHI) bulguları olan hastalarda baş ağrısının morfine yanıtını incelemek ve BT taraması gereken hastaları tanımlamak için yeni bir risk göstergesini önermektir.

GEREÇ VE YÖNTEM: Baş ağrısı ve GCS skoru 14 veya 15 ile gelen 15 yaş ve üstü toplam 1857 MHI hastası çalışmaya alındı. İntravenöz morfin sülfat yapıldı ve hastalar daha sonra baş ağrısının geçmesi veya süregelmesine göre değerlendirildi. Daha sonra tüm hastaların beyin BT taraması çekildi.

BULGULAR: Hastalar 15-60 ve 60 yaş üstü olmak üzere iki yaş grubuna ayrıldı. Her iki grupta BT sonucu ile morfine yanıt arasında önemli bir ilişki mevcuttu ($p < 0.001$). On beş ile 60 yaş arasında, baş ağrısı morfine yanıt vermiş olanların hiçbirinin BT taramasında herhangi bir anormal bulgu görülmedi (duyarlılık = %100). Altmış yaş üstü grupta anormal BT bulgusu ve nöroşirürji girişim endikasyonu açısından morfine yanıtın duyarlılık dereceleri sırasıyla %58.3 ve %71.4 idi.

TARTIŞMA: Bu çalışma morfinle geçmeyen baş ağrısının kafa içi travması için bir risk göstergesi olduğunu düşündürmektedir. BT'ye erişimin sınırlı olduğu kırsal alanlarda, BT taraması endike MHI hastalarının seçimine ilişkin mevcut kriterlere ek olarak bu protokol kullanılabilir.

Anahtar sözcükler: Ağrı yönetimi; baş ağrısı; beyin yaralanmaları; bilgisayarlı tomografi; kraniyoserebral travma; morfin.

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