

## Computed tomography evaluation of patients with chronic headache

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**Objective:** To determine whether the rate of detecting a tumour, arteriovenous malformation (AVM) or aneurysm with the use of enhanced or unenhanced computed tomography (CT) is significant in patients with chronic headache and to calculate the cost.

**Design:** Case series.

**Setting:** Chronic headache clinic at a tertiary care referral centre.

**Patients:** All 373 consecutive patients with chronic headache (284 women, 89 men) referred for CT scanning from May 1987 to October 1992 who met one or more of the following criteria: increased severity of symptoms or resistance to appropriate drug therapy (287 patients [76.9%]), change in characteristics or pattern of headache (78 [20.9%]) or family history of intracranial structural lesion (8 [2.1%]).

**Interventions:** CT scans of the head were enhanced with nonionic contrast medium (292 scans), were unenhanced (70) or involved both methods (40).

**Outcome measures:** Number and nature of minor and major findings, and total price per scan.

**Results:** Of the 402 CT scans 14 (95% confidence interval [CI] 13.98 to 14.02) revealed minor findings that did not alter patient management: infarct (9 scans), cerebral atrophy (2), cavum vergae (1), hyperostosis frontalis interna (1) and communicating hydrocephalus (1). Four scans (95% CI 3.99 to 4.01) showed significant lesions: osteoma (2), low-grade glioma (1) and aneurysm (1); only the aneurysm was treated. There were no cases of AVM. An unenhanced scan cost \$82.63 and an enhanced scan \$204.05. The cost per significant finding was over \$18 000. In all, it cost \$74 243 to find one treatable vascular lesion.

**Conclusions:** The detection rate of CT scanning in patients with chronic headache is similar to that expected in the general population, provided the neurologic findings are normal. The cost of detecting intracranial lesions in this patient population is high.

**Objectif :** Déterminer si le taux de dépistage de tumeurs, de malformations artérioveineuses (MAV) ou d'anévrismes à l'aide de la tomographie par ordinateur améliorée ou non améliorée est important chez les patients qui souffrent de céphalée chronique, et en calculer le coût.

**Conception :** Série de cas.

**Contexte :** Clinique de traitement de la céphalée chronique à un centre de référence pour soins tertiaires.

**Patients :** Les 373 patients consécutifs souffrant de céphalée chronique (284 femmes, 89 hommes) ont subi une tomographie entre mai 1987 et octobre 1992 et qui répondaient à un ou plusieurs des critères suivants : aggravation des symptômes ou résistance au traitement approprié (287 patients [76,9 %]), modification des caractéristiques ou de la tendance des

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céphalées (78 [20,9 %]) ou antécédents familiaux de lésions des structures intracrâniennes (8 [2,1 %]).

**Interventions :** Les tomographies du crâne ont été améliorées à l'aide d'un agent contrastant non ionique (292 scanographies), n'ont pas été améliorées (70) ou ont fait l'objet des deux traitements (40).

**Mesures des résultats :** Nombre et nature des constatations mineures et majeures et coût total par scanographie.

**Résultats :** Sur les 402 scanographies, 14 (intervalle de confiance [IC] à 95 % de 13,98 à 14,02) ont révélé des constatations mineures qui n'ont pas modifié le traitement du patient : infarctus (9 scanographies), atrophie cérébrale (2), cavum vergae (1), hyperostose frontale interne (1) et hydrocéphalie communicante (1). Quatre scanographies (IC à 95 % de 3,99 à 4,01) ont révélé d'importantes lésions : ostéome (2), gliome d'évolution lente (1) et anévrisme (1); seul l'anévrisme a été traité. On n'a trouvé aucun cas de MAV. Une scanographie non améliorée a coûté 82,63 \$ et une scanographie améliorée, 204,05 \$. Chaque résultat important a coûté plus de 18 000 \$. En tout, il en a coûté 74 243 \$ pour trouver une lésion vasculaire traitable.

**Conclusions :** Le taux de dépistage des tomographies chez les patients qui souffrent de céphalée chronique ressemble à celui qu'on attend dans la population générale, à condition que les résultats neurologiques soient normaux. Le dépistage des lésions intracrâniennes dans cette population de patients coûte cher.

Many patients suffer from recurrent headaches, which have been classified under a number of terms, including migraine and cluster, mixed, muscle-contraction or atypical headache. Waltimo, Hokkanen and Pirskanen<sup>1</sup> reported that the prevalence rate of chronic headache may be as high as 95% among women and 69% among men. Others have been more conservative, giving estimates for common migraine of 10% to 20%<sup>1,2</sup> and for classic or unilateral migraine of 1% to 2%.<sup>2,3</sup> None the less, many physicians and patients are concerned that an intracranial structural lesion such as an arteriovenous malformation (AVM), aneurysm or tumour may be responsible for the chronic headache. Persistently unilateral headaches generate even more suspicion.

Concern has certainly been fostered by case reports and series suggesting a cause-effect relation between AVM and unilateral or complicated vascular headache.<sup>1,3-5</sup> Others have reported the same association with cluster headache.<sup>6-9</sup> It is difficult to substantiate such a relation because of the low prevalence rate of AVM. Stein and Soloman<sup>10</sup> stated that despite the low prevalence rate the diagnosis of AVM is paramount because of the ability to treat many lesions successfully. They pointed out that these lesions often occur in young people, during the most productive portion of their life. Mohr and associates<sup>11</sup> suggested that at the very least all patients with migraine should undergo contrast-enhanced computed tomography (CT).

These recommendations might represent the ideal if funds were unlimited, but is the association of migraine with AVM strong enough to justify the cost of CT examination? Recent studies have not substantiated such a relation.<sup>3,12-15</sup> Troost and Newton,<sup>15</sup> in a review of 26 cases of occipital AVM, stated that these cases "should not be confused with migraines" because there are elements of the patients' medical history or findings on physical ex-

amination that differentiate the diagnosis of AVM from migraine. They further stated that "the few cases reported of classic migraine in patients with AVM is not more than would be expected for the general incidence of migraine." In 1988 the International Headache Society's Headache Classification Committee concluded that "the relationship of migraine and other headaches [to AVM] is poorly substantiated."<sup>12</sup>

Other case reports and small series have described intracranial neoplasms or aneurysms in patients with cluster or atypical migraine headache.<sup>16-19</sup> These cases are most often associated with other neurologic symptoms or signs or have atypical headache features.

The prevalence of space-occupying lesions in the general population has been estimated to be low. Tumours of the central nervous system (CNS), dura and meninges were found in 1.2% of general autopsies.<sup>20</sup> The prevalence of AVM, although not well established, has recently been estimated to be 0.05% in a large population-based study<sup>3</sup> and as high as 0.59% in a series of 4069 consecutive autopsies.<sup>2</sup> Cerebral aneurysms were found in 1.5% of general autopsies.<sup>21,22</sup> However, most of these autopsy findings did not necessarily become clinically relevant, and not all might have been seen on CT scans. Subarachnoid hemorrhage has been estimated to occur at a rate of 16 per 100 000 population annually, 8 to 12 cases being due to aneurysm and 1 or fewer to AVM.<sup>2,23,24</sup> The annual incidence rate of CNS neoplasm in a large population study was 4.2 to 5.4 per 100 000.<sup>25</sup> With these figures in mind, one would expect 10% to 20% of patients with intracranial lesions to have coincidental, unrelated, chronic headache.

Most recent series support no association between AVM and migraine,<sup>3,12-15</sup> and others show few abnormal findings on CT scans in patients with normal neurologic findings.<sup>26-29</sup> Based on the results of these studies, the need for CT scanning in patients with chronic headache

is questionable. Despite this evidence, it is common to refer such patients for CT scanning, perhaps in part to reassure the patient and the physician.

The present study was designed (a) to examine the use of CT scanning of the head in patients with chronic headache in the hope of accurately demonstrating a low prevalence of structural intracranial lesions in this population and (b) to estimate the cost of detecting such disorders in this population.

## Methods

We reviewed the charts of consecutive patients referred to the chronic headache clinic at the Victoria Hospital, London, Ont., and who underwent CT scanning from May 1987 to October 1992. Patients were referred to the clinic with a history of recurrent headache ranging from 6 months to several years. Those with a recent onset of headache or interictal neurologic findings were referred to a neurology clinic and were excluded from the study. The presence or absence of intercurrent neurologic findings was determined from the results of a screening examination, which consisted of the following: assessment of mental status, assessment of cranial nerves 2 through 8, fundoscopic examination, measurement of deep-tendon reflexes, gait, strength in the extremities, blood pressure and range of motion of cervical spine, and determination of points of tenderness. Patients with a known intracranial neoplasm, vascular lesion or seizure disorder were excluded.

Patients were referred for CT scanning if they met one or more of the following criteria: increased severity of symptoms or resistance to appropriate drug treatment (limiting analgesics, prophylactic medications), change in characteristics or pattern of headaches or family history of intracranial structural lesion. Patients who did not meet the criteria when they first came to the clinic were later referred for CT scanning if they subsequently met one of the criteria. Scans were performed with the use of

a Picker CT scanner (Picker International Canada Inc., Brampton, Ont.) or a Siemen's scanner (Siemen's Medical Systems, Iselin, NJ).

The costs of unenhanced, contrast-enhanced and combined CT scanning were calculated with the use of a micro-costing technique, which considered all aspects such as technician and clerical staff time, medical and nonmedical supplies, film, capital equipment, intravenous contrast medium and professional fees (Table 1). These figures were based on the expenses and professional fees in 1991 Canadian dollars and on the use of 100 mL of nonionic contrast medium for enhanced scans. Contrast medium was administered to exclude AVM. Patients with previous allergic reaction to an iodinated contrast medium and those who refused to give consent for the use of the contrast medium underwent unenhanced scanning. Contrast medium was also withheld in cases of severe asthma in order to avoid bronchospasm.

## Results

A total of 373 patients (284 women, 89 men) underwent 402 CT scans. This group represented about 10% of the clinic population. They ranged in age from 13 to 86 (mean 39.3) years. Of the referral criteria, increased severity of symptoms or resistance to appropriate drug treatment was met by 287 patients (76.9%), a change in characteristics or pattern of headache by 78 (20.9%) and a family history of intracranial structural lesion by 8 (2.1%).

Migraine or vascular headache was the presenting symptom in 284 (76.1%) of the patients, tension or atypical headache in 86 (23.1%) and cluster headache in 3 (0.8%).

Of the 402 CT scans 292 (72.6%) were contrast enhanced (performed on 271 patients), 70 (17.4%) were unenhanced (performed on 65 patients), and 40 (10.0%) were a combination (performed on 37 patients). Twenty-nine patients had more than one scan during the study

Table 1: Cost of computed tomography (CT) scanning for chronic headache

Expense	Type of scan; cost, \$*		
	Enhanced	Unenhanced	Both
Staff cost (and time)	12.80 (15 min)	12.80 (15 min)	22.80 (30 min)
Film processing	5.96	5.96	5.96
Medical supplies	101.33	0	101.33
Paper supplies	1.01	1.01	1.01
Equipment and service	22.75	22.75	45.50
Professional fees	60.20	40.10	70.30
Total cost per scan	204.05	82.62	246.90
No. of scans	292	70	40
Total cost	59 583.00	5 783.00	9 876.00

\*In 1991 Canadian dollars.

period because of a subsequent change in pattern, increase in severity of symptoms or resistance to medications.

Fourteen of the CT scans (95% confidence interval [CI] 13.98 to 14.02) revealed incidental or minor findings that did not alter management. Included in this category were nine patients with old infarcts, two with pronounced atrophy, one with cavum vergae, one with hyperostosis frontalis interna and one with communicating hydrocephalus (whose headaches resolved).

Four of the scans (95% CI 3.99 to 4.01) revealed findings that were considered significant to patient management. In one case a 39-year-old woman with a 13-year history of unilateral vascular headache, usually on the left side, began having episodes of loss of consciousness with her headaches. A 5-mm posterior communicating arterial aneurysm on the right side was detected on the enhanced scan only. Following cerebral angiography the aneurysm was successfully clipped. Two patients had a densely calcified mass diagnosed as osteoma; one was not followed up, and the other's condition was unchanged on follow-up scans. In the fourth case a 44-year-old woman had a 10-mm mass in her left frontal lobe detected on an unenhanced scan. The patient refused biopsy, and the lesion remained unchanged after three annual follow-up CT scans. The presumptive diagnosis was a low-grade glioma; a magnetic resonance scan confirmed this. Three of the four significant lesions were identified on unenhanced scans.

Three of the patients had a CT scan showing a significant finding but were excluded from the analysis because the condition was known before the scan. One had

a colloid cyst, and another had sinusitis but had facial pain and tenderness. The third patient had a pituitary adenoma but was excluded because she was known to have an elevated prolactin level.

An unenhanced scan was \$82.63 and an enhanced scan \$204.05. The total cost of all the scans was \$75 243. The case-finding cost for a major abnormality was \$18 811.

## Discussion

Several studies have looked at the use of CT scanning in patients with headache.<sup>20,23,26-31</sup> A summary of their findings is presented in Table 2. Sargent and Solbach<sup>26</sup> found only one colloid cyst in 88 CT scans for migraine. Cuetter and Aita<sup>27</sup> found only one papilloma of the choroid plexus in 435 enhanced CT scans for classic migraine. Baker<sup>28</sup> examined 505 patients with acute or chronic headache (proportion of those with chronic headache not discussed) and found that only 7% had significant intracranial lesions, with a case-finding cost for tumours of \$8 076. The investigators in these three studies excluded patients with neurologic findings, as we did. However, even in the studies that did not exclude cases because of neurologic findings, few lesions were detected and almost always were found in patients with a long history or severe symptoms. Joseph and collaborators<sup>30</sup> found only 6 patients with an intracranial lesion in their population of 1900 migraine patients. Of these six, five had neurologic findings on physical examination, and the sixth had headache on exertion. Grosskreutz and Osborn<sup>20</sup> found 3 lesions in 100 patients with headache;

Table 2: Studies evaluating the use of CT scanning for headache

Study	Selection criterion	No. of CT scans (and % enhanced)	Type (and no.) of lesions detected	Comments
Sargent et al, 1983 <sup>26</sup>	Migraine	88	Colloid cyst (1)	
Cuetter et al, 1983 <sup>27</sup>	Classic migraine	435 (100)	Choroid plexus papilloma (1)	
Baker, 1983 <sup>28</sup>	Headache only symptom	505 (42)	Neoplasm (13) Subdural hemorrhage (4) Aneurysm (3)	
Joseph et al, 1985 <sup>30</sup>	Migraine	48 (100)	Neoplasm (5) Arteriovenous malformation (1)	5 had physical signs; 1 had headache on exertion
Grosskreutz et al, 1991 <sup>20</sup>	Headache	100 (75)	Meningioma (1) Epidural abscess (1) Metastasis (1)	Patient with abscess had frontal sinusitis; patient with metastasis had neurologic signs
Sontaniemi et al, 1991 <sup>29</sup>	Headache; no neurologic signs	247 (45)	Metastasis (1) Recurrent glioma (1)	Both patients had a significant history
Present study	Chronic headache	402 (83)	Osteoma (2) Aneurysm (1) Glioma (1)	

all lesions were identifiable on unenhanced scans, and only one was in a patient with chronic headache who had normal neurologic findings. Sontaniemi and colleagues<sup>29</sup> found only two significant lesions in 207 patients who underwent CT scanning for headache without neurologic findings; one of the patients had metastases and the other a recurrent glioma.

Some have suggested criteria for referring migraine patients for CT scanning, which range from Mohr's suggestion that all migraine patients undergo contrast-enhanced CT scanning<sup>11</sup> to the more conservative advice of Joseph and collaborators<sup>30</sup> that neurologic deficit, papilledema or resistance to therapy with change in headache characteristics, unilaterality or prolonged aura are reasons for referral. These latter criteria are similar to our own. Cuetter and Aita<sup>27</sup> felt that "unrelated pathology may rarely be discovered. . . . Most patients with classic migraine have a normal CT scan of the head." Grosskreutz and Osborn<sup>20</sup> suggested that CT scanning is not indicated in migraine patients with normal findings on physical examination. Baker<sup>28</sup> suggested an abbreviated three-slice scan as a cost-saving measure that would save on technical time; however, with newer machines, this time savings would no longer be significant. Reutens and Stewart-Wynne<sup>31</sup> felt that contrast enhancement is not very effective in picking up lesions not seen on unenhanced scans. In our study, only one of the four significant lesions was found by contrast-enhanced scan only.

In the current economic climate health care providers are being asked more and more to justify the use of financial resources, especially expensive technologies. In this study we examined the practice of examining a common symptom, the chronic recurrent headache, to detect an uncommon disorder. We found that the incidence of lesions was similar to that expected in the general population and that the cost of detection was high.

One of the limitations of this study was its retrospective design, which is predisposed to some errors. As described earlier, referral to the clinic was not tightly controlled and some clinic patients were excluded retrospectively from the study, usually because of known neoplasm or physical findings. Also, because only about 10% of the patients were referred for CT scanning and there was no randomly assigned control group, referral bias was possible, even though the referral pattern was well described. Interpretation of each scan was subject to interpreter bias because there was no blinding of the interpreters to the clinical history of the patient. Contrast medium was withheld if patients had previous allergic reactions to it or if they refused it. This decision by the patient could have been influenced by the radiologist's explanation that contrast-enhanced scanning is not much more effective than unenhanced scanning, and thus some lesions may have been missed on the 17.4% of scans that were unenhanced.

We did not calculate a cost-benefit ratio, which would have taken into account the number and quality of years of life saved and would have been more meaningful than a simple cost estimate, mainly because the only treated lesion was felt to be unrelated to the patient's headaches. One could argue that patients having had a CT scan may be reassured about their headaches and visit their physician less often, which would thus reduce the relative cost of the CT scan and further confound the meaningfulness of a cost estimate.

Finally, although no gold standard is available to determine the false-negative rate and some of the patients in our study may have had lesions that were not detected by CT scanning, it is doubtful that any such lesions would be responsible for their headaches.

## Conclusions

The cost of finding a major intracranial lesion in our study population exceeded \$18 000 per case. In all, it cost \$75 243 to detect one treatable vascular lesion. The detection rate in our patients with chronic headache was similar to that expected in the general population, provided the neurologic findings are normal. Currently we are recommending CT scanning for patients with abnormal neurologic findings on physical examination, those who have loss of consciousness with headache and those with exertional or morning headaches. Since we did not find a relation between intracranial lesions and progression of severity, resistance to appropriate therapy or change in characteristics or pattern of headache, we do not recommend CT scanning in these cases.

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## Conferences

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**May 12-14, 1995:** General Practice Psychotherapy Association (Canada) 8th Annual Educational Conference  
Mississauga, Ont.

Greg Dubord, First Canadian Medical Centre, First Canadian Place, PO Box 225, Toronto, ON M5X 1C8; tel (416) 368-6787, fax (416) 203-6585

**May 14-16, 1995:** Canadian Life Insurance Medical Officers Association 50th Annual Meeting

Regina  
Darlene, Crown Life Canada, Regina; tel (306) 751-6044

**May 17-20, 1995:** Society for Obstetric Anesthesia and Perinatology 27th Annual Meeting

Montreal  
Society for Obstetric Anesthesia and Perinatology,  
PO Box 11086, Richmond, VA 23230-1086; tel (804) 282-5051, fax (804) 282-0090

**May 28-June 1, 1995:** 2nd International Heart Health Conference

Barcelona, Spain  
*Abstract deadline: Dec. 15, 1994*  
Official language: English  
Pacífico, S.A., Enric Granados St. 44, 08008 Barcelona, Spain; tel 011-343-454-5400, fax 011-343-451-7438

**May 30-June 3, 1995:** Child Health 2000: 2nd World Congress and Exposition

Vancouver  
*Abstract deadline: Nov. 30, 1994*  
*Study credits available.*  
Child Health 2000, 113-990 Beach Ave., Vancouver, BC V6E 4M2; tel (604) 682-6008 or (800) 515-6008, fax (604) 682-6771

**May 31-June 2, 1995:** 12th International Society for Quality in Health Care World Congress — Partnerships for Creating a Quality Health System: Users-Providers-Funders

St. John's  
12th ISQua World Congress, Organizing Secretariat, Beclin Building, 1118 Topsail Rd., PO Box 8234, St. John's, NF A1B 3N4; tel (709) 364-7704, fax (709) 364-6460

**June 1-3, 1995:** Oral-Motor Skills Workshop: the Development of Oral-Motor Skills in Children Receiving Nonoral Feedings

London, Ont.  
CPRI, 600 Sanatorium Rd., London, ON N6H 3W7; tel (519) 471-2540, ext. 2074; fax (519) 641-1922

**Aug. 7-11, 1995:** 4th International Congress on Amino Acids  
Vienna, Austria

*Abstract deadline: Apr. 30, 1995*  
Dr. Gert Lubec, Department of Paediatrics, University of Vienna, Währinger Gürtel 18, A-1090 Vienna, Austria; fax 011-431-40400-3238