AJNR

Indications for CT in Patients Receiving Anticoagulation after Head Trauma

Adam M. Gittleman, A. Orlando Ortiz, David P. Keating and Douglas S. Katz

AJNR Am J Neuroradiol 2005, 26 (3) 603-606
http://www.ajnr.org/content/26/3/603

AJNR Am J Neuroradiol 26:603–606, March 2005

Indications for CT in Patients Receiving Anticoagulation after Head Trauma

Adam M. Gittleman, A. Orlando Ortiz, David P. Keating, and Douglas S. Katz

BACKGROUND AND PURPOSE: **Head CT is frequently ordered for trauma patients who are receiving anticoagulation. However, whether patients with a Glasgow Coma Scale (GCS) score of 15 and normal findings on neurologic examination require CT is still debated. The purpose of our study was to assess the use of cranial CT in patients receiving anticoagulants after head trauma and to establish clinical criteria to identify those in this group who do not need emergency CT.**

METHODS: **We retrospectively reviewed patients receiving heparin or coumadin who had head trauma and who subsequently underwent cranial CT at a level I trauma center within a 4-year period. Patients were evaluated for mechanism of injury, clinical signs and symptoms of head injury, and type and reason for anticoagulation. Prothrombin time, international normalized ratio, partial thromboplastin time, GCS score, age, and head CT results were recorded for each patient.**

RESULTS: **A total of 89 patients fulfilled the enrollment criteria. Among them, 82 had no evidence of intracranial injury on CT. Seven patients had evidence of intracranial hemorrhage. Patients without hemorrhage had no significant focal neurologic deficits and presented with an average GCS score of 14.8. Patients with intracranial hemorrhage tended to have focal neurologic deficits and presented with an average GCS score of 12.0.**

CONCLUSION: **Patients with head injury, normal GCS scores, and no focal neurologic deficits and who are receiving the anticoagulants heparin or coumadin may not necessarily require emergency CT.**

CT of the head is frequently ordered for patients receiving anticoagulation who have a history of either a fall or trauma. Determining which patients with head trauma require emergency CT while they are in the emergency department is still a controversial topic in the medical literature. This controversy is characterized by the need to immediately identify patients with serious head injury while balancing the need to cut medical costs by reducing unnecessary imaging studies. Previous studies have shown that a significant number of patients with a Glasgow Coma Scale (GCS) score of 13 or 14 are more likely to have intracranial injury and benefit from immediate cranial CT, compared with patients with a normal GCS score of 15 (1, 2).

However, debate exists regarding the evaluation of patients with a GCS score of 15 and normal findings on neurologic examination. Patients with minor head injury and a GCS score of 15 represent a substantial number of those who are evaluated acutely in the hospital. This group of patients provides the opportunity to render cost-effective healthcare with a reduction in medical costs. It is generally believed that the subset of trauma patients who receive anticoagulation with heparin or coumadin may be at increased risk of intracranial hemorrhage. These are typically elderly patients who have falls or other injuries. To our knowledge, the use of cranial CT in this group has received little attention in the medical literature. The purpose of this study was to assess the use of cranial CT in patients receiving anticoagulation after head trauma and to determine if a set of clinical criteria can be used to identify patients in this group who do not require emergency CT examination.

Received March 8, 2004; accepted after revision July 6.

From the Department of Radiology, Winthrop-University Hospital, Mineola, NY.

Address reprint requests to Adam M. Gittleman, MD, Department of Radiology, Winthrop-University Hospital, 259 First Street, Mineola, NY 11501.

Methods

This retrospective study was conducted at a single tertiary care hospital and level I trauma center. All patients who were being treated with the anticoagulants heparin or coumadin and who had head trauma and subsequently underwent emergency cranial CT for that episode were identified. In the 4-year period from April 1997 to January 2002, these patients were identified by searching the hospital information system database and neuroradiology case log. Two radiology residents (D.P.K., A.M.G.) retrospectively reviewed the patients' charts for mechanism of injury, type of head injury, clinical signs and symptoms

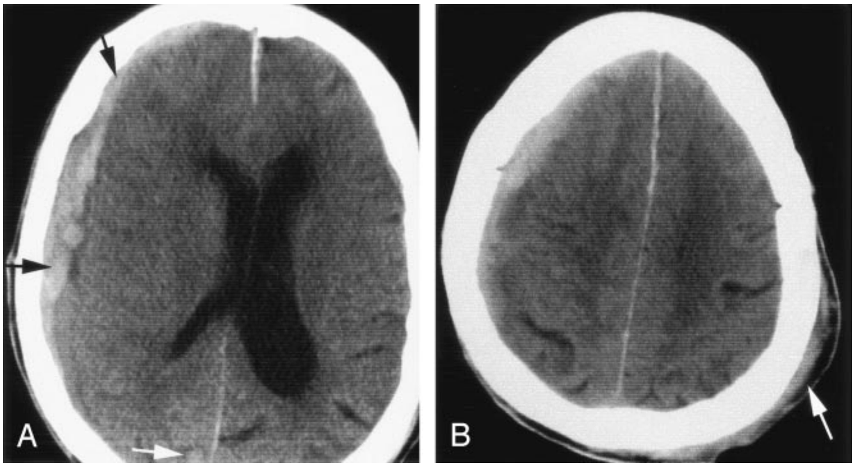

FIG 1. Images obtained in a 93-year-old woman treated with coumadin for atrial fibrillation. She fell and hit her head at home and presented with nausea, vomiting, a positive left-sided Babinski reflex, and a GCS score of 13.

A, Axial nonenhanced CT scan reveals acute right frontoparietal subdural hematoma (*black arrows*) with a moderate degree of midline shift. Image also shows a small occipital hemorrhagic contusion on the right (*white arrow*).

B, More cephalic CT scan shows a soft tissue hematoma on the left (*arrow*) consistent with a contrecoup traumatic subdural hematoma. The patient's anticoagulation status was reversed with vitamin K and fresh frozen plasma. The patient's clinical condition deteriorated further. She was not a neurosurgical candidate and therefore given conservative care at the request of her family.

of head injury, and reason for anticoagulation. Variables examined in this group of patients included prothrombin time, international normalized ratio, activated partial thromboplastin time, GCS score, age, and cranial CT results. Normal mental status, including mentation and alertness, was defined as a GCS score of 15. If the GCS score was less than 15, the patient's mental status was considered abnormal. Cranial CT was used as the criterion standard for diagnosing an acute intracranial hemorrhage.

All CT scans were performed by using one of two hospital-based CT scanners (Hi-Speed Advantage, GE Medical Systems, Milwaukee, WI; MX 8000; Phillips Medical Systems, Cleveland, OH). Bone, brain, and subdural windows were obtained in all patients. The prospective final reading of the attending neuroradiologist (A.O.O.) was used as the official result. An abnormal CT examination was defined as one showing an acute hemorrhagic intracranial lesion (epidural hematoma, subdural hematoma, subarachnoid hemorrhage, contusion, or parenchymal hematoma).

All statistical calculations were performed by the hospitals' statisticians using computer software (SAS, version 6.12; SAS, Cary, NC). Continuous variables (age, GCS score, etc) were compared for those with bleeding and those without bleeding by using the rank sum test. Binary variables (GCS score <15 vs. GCS score = 15, sex, etc) were analyzed by means of the Fisher exact test. Relative risk and 95% confidence intervals [CI] were also provided. P values of <.05 are considered to indicate a statistically significant difference. For the purpose of power analysis, we assumed that the percentage of patients who had positive CT results was low, perhaps 1%. For patients with a GCS score less than 15, the rate of positive CT results was expected be at least 30%. To achieve 80% power at the 5% level of significance, we needed to consider charts from at least 29 patients with a GCS score of 15 and charts from at least 29 with a GCS score of less than 15, for a total of 58 charts.

Our institutional review board approved our retrospective review of medical records and images and did not require the patients' written informed consent.

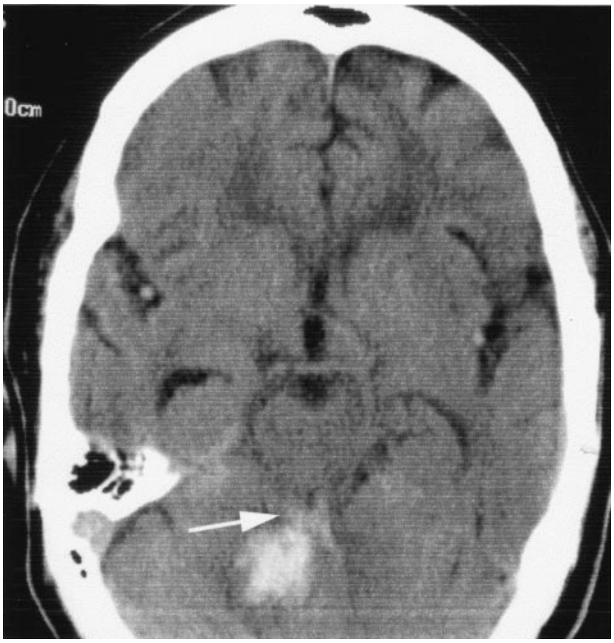

FIG 2. Images obtained in a 75-year-old woman who fell at home and presented with nausea, vomiting, and lethargy. On neurologic examination, she was lethargic but arousable, opening her eyes, responding to voice, and following simple commands. She had a right-sided Babinski sign and a GCS score of 14. Her medical history was significant for atrial fibrillation, for which she was receiving coumadin. Nonenhanced CT scan shows a right cerebellar hemorrhage that extends into the fourth ventricle (*arrow*). The patient's coagulation status was reversed with vitamin K and fresh frozen plasma. A few days later, she developed hydrocephalus, which responded to treatment with a ventriculostomy tube. Her condition improved, and she was discharged to a skilled nursing facility.

Results

A total of 89 patients met the inclusion criteria (50 women, 39 men). They included 82 patients with normal cranial CT scans on which no intracranial hemorrhage or other injury was present. Seven patients had abnormal CT results with an intracranial hemorrhage (Figs 1 and 2). Most of the patients, 77, were taking coumadin. Eight patients were taking heparin, and four patients were receiving both heparin and coumadin.

The most common indication for anticoagulation was atrial fibrillation (n = 48), followed by thromboembolic disease (n = 15), ischemic heart disease (n = 8), and cerebral infarction or transient ischemic attacks (n = 5). The major mechanism of injury was a documented or witnessed slip and fall. Seventy-four patients were evaluated in the emergency department

TABLE 1: Data in patients receiving anticoagulation

Characteristic	Patients without Hemorrhage (n = 82)	Patients with Hemorrhage (n = 7)
Age (y)	78.1 ± 10.4	83.0 ± 8.3
GCS score	14.8 ± 0.4	12.0 ± 2.4
Prothrombin time (sec)	27.9 ± 12.7	24.8 ± 11.2
International normalized ratio	2.5 ± 1.2	2.2 ± 1.1
Activated partial thromboplastin time (sec)	46.9 ± 22.3	57.5 ± 36.8

TABLE 2: GCS scores

GCS Score	Patients without Hemorrhage	Patients with Hemorrhage	Total
15, normal	66	0	66
<15, abnormal	16	7	23

after a fall at home, whereas 15 patients experienced falls during their hospital admission (Figs 1 and 2). Four of the intracranial hemorrhages were subdural, whereas three were cerebellar. The imaging findings in the cerebellar hemorrhages suggested a nontraumatic etiology. These 3 patients had hypertension; therefore their cerebellar hemorrhages had a probable hypertensive etiology.

Table 1 shows a comparison of the patients with and those without intracranial hemorrhage. We found no significant differences between the two groups with respect to age or coagulation profile. Patients with a normal CT scan had a higher GCS score (i.e., 14.8) than that of the patients with intracranial hemorrhage (GCS score = 12.0). GCS score and CT findings of intracranial hemorrhage were strongly correlated ($P < .0001$, Fisher exact test). All patients with intracranial hemorrhage presented with varying degrees of lethargy. In addition, patients with abnormal CT findings were significantly more likely than the others to have symptoms often observed after head trauma (e.g., nausea, vomiting, headache, and dizziness). A GCS score of less than 15 was found more often in patients with abnormal head CT results ($n = 7$) than in those with normal CT results ($n = 82$; 100% vs. 19.5%; $P < .0001$, two-tailed Fisher exact test) (Table 2). None of the 62 patients with a normal GCS score of 15 had an abnormal CT scan, whereas seven patients (30.4%) had an abnormal CT with a GCS score of less than 15 (0% vs. 30.4%; $P < .0001$, two-tailed Fisher exact test). Univariate analysis showed that only GCS score was predictive of CT outcome in this group ($P = .0001$). Patients with an abnormal GCS score of 15 were 42 times more likely than those with normal scores to have an intracranial hemorrhage on CT (95% CI: 2.49, 705.69).

Discussion

Patients with minor head injury are frequently evaluated in emergency departments. However, recommendations for the use of emergency cranial CT are unclear and vary from institution to institution. Traditionally, alternatives for the evaluation of head trauma included skull radiography, CT, and observation in the emergency department. Several earlier studies have documented a low rate of abnormal cranial CT findings for patients with a GCS score of 15, normal mental status, and no symptoms or neurologic signs (3, 4). For example, in a prospective study of 1382 patients who presented with a GCS score of 15 and a history of minor head trauma and either loss of consciousness or amnesia to the event, only 0.2% had findings on cranial CT that indicated a need for surgery (3). When neurologic symptoms or signs of a depressed skull fracture were absent, the rate of abnormalities on cranial CT was only 3%, and no patient in this group required medical or surgical intervention (3). Other researchers concluded that the use of CT to image patients with minimal head trauma is inefficient and adds to the increasing financial burden on trauma centers (5). Our findings support the notion that patients receiving anticoagulation who have minor head injury and a normal GCS score may not necessarily require emergency cranial CT.

The goal of our study was to develop a set of clinical criteria that can be used prospectively to identify patients taking anticoagulants with head trauma who do not need emergency CT. To our knowledge, only one group has specifically examined these patients, who are frequently elderly and commonly have minor trauma (especially that due to falls) and who may be at increased risk of intracranial hemorrhage despite the relatively minor trauma because of their anticoagulation status (6). Several recent groups have concluded that patients with normal neurologic findings and a normal CT scan after minor head trauma can be safely discharged from the emergency department (2, 5, 7, 8). In a series of 2143 patients with a history of loss of consciousness or amnesia, cranial CT was performed within 24 hours after blunt head trauma (9). All patients had a normal mental status at the time of clinical examination in the emergency department. By using four risk factors (headache, nausea, vomiting, and a depressed skull fracture), the investigators obtained 65% sensitivity and 63% specificity in detecting abnormal CT results when one or more of these risk factors was present (9). Similarly, in another series, the small percentage of patients who had a normal GCS score after minor head trauma and who had a positive finding on head CT also had one or more of seven findings, including headache, vomiting, drug or alcohol intoxication, seizure, or physical evidence of trauma above the clavicles (7). Patients without such findings had negative cranial CT scans. In contrast, Shackford et al (2) reported that patients with a GCS score of 13 are significantly more likely than patients with a GCS score of 14 or 15 to have intracranial injury, and Stein and Ross (1) reported that 40% of patients with a GCS score of 13 have abnormal CT findings. Had cranial CT been performed in only those patients with a GCS score of less than 15, only 23 of our patients would have undergone cranial CT. In our study, use of the criterion of a GCS score of less than 15 for ordering a head CT would have yielded a sensitivity of 100% (95% CI: 59.0%, 100%), a specificity of 80.5% (95% CI: 70.3%, 88.4%) for the detection of intracranial hemorrhage.

One study of 39 patients with minor head trauma who were receiving anticoagulants demonstrated that none of the patients who underwent cranial CT had any evidence of intracranial hemorrhage (6). On examination, none of the patients had loss of consciousness or acute neurologic abnormality. Similarly, in our series of 89 patients, seven (30%) of the 23 patients with a GCS score of less than 15 had an abnormal CT scan, and none of the 66 patients with a normal GCS score of 15 did. Moreover, patients were 42 times more likely to have an abnormal CT when their GCS score was less than 15 than when their score was 15.

Each year, more than 400,000–450,000 patients are examined for head trauma in emergency departments across the United States (9). Most of these patients present with a GCS score of 15. Reinus et al (10) reported that a 10% reduction in the number of examinations performed for minor head trauma could save our healthcare system over $21 million dollars per year, assuming a cost of roughly $500 for a non-enhanced cranial CT study. Given that medical imaging is a major contributor to rising healthcare costs, it is worthwhile to determine clinical criteria that could be used to reduce the number of unnecessary CT examinations while still accurately determining which patients may benefit from this test.

This study had a few limitations. For instance, the number of patients in our series was relatively small. Although the power analysis suggested the need for at least 29 patients for each group (those with GCS score <15 and those with GCS score = 15), we were able to sample only 23 patients with a score of less than 15 in our 4-year period. However, this was more than compensated for by the fact that we considered many more than 29 patients for the group with a GCS score of 15, (i.e., 66 patients). In fact, a post-hoc power analysis (based on our sample sizes of 66 and 23) yielded a power of 91%, indicating more-than-adequate power. Also, it is not possible to be completely certain that all neurologic findings and historical data were completely and consistently documented in the medical record, in contrast to data from a prospective study. For example, patients may have been missed because of a lack of documentation about their anticoagulant use. Furthermore, relatively few cases had abnormal CT results. In addition, clinical selection bias of patients for CT may have introduced errors. In patients who did not undergo cranial CT examinations, intracranial hemorrhages might have been identified if the studies were performed, although these hemorrhages would presumably be small if present and without major clinical sequelae; otherwise, they would have been identified in our review of the medical records. Finally, our patients were not followed up after their discharge from the hospital; therefore data on possible delayed complications were not available.

Conclusion

Of the 89 patients receiving anticoagulation who underwent emergency cranial CT, seven had an intracranial hemorrhage when their GCS score was less than 15. Four of these patients had clinically significant subdural hematomas. The imaging findings in the three patients with cerebellar hemorrhages suggested a nontraumatic etiology. These elderly patients had hypertension, and therefore, their cerebellar hemorrhages had a probable hypertensive etiology. However, no patient with a normal GCS score had an intracranial hemorrhage. Furthermore, patients were 42 times more likely to have an abnormal CT when their GCS was less than 15 than when it was not. Our data suggest that a substantial number of emergency CT scans ordered for patients who are receiving anticoagulants and who have minor head trauma might be avoidable if they have a normal GCS score and no focal neurologic deficits. If results of further prospective studies confirm these findings, routine cranial CT may be avoidable in most of these patients.

Acknowledgments

We thank the biostatistical department, specifically Martin Feuerman, and the CT technologists at our institution for their assistance with this project.

References

1. Stein SC, Ross SE. **The value of computed tomographic scans in patients with low-risk head injuries.** *Neurosurgery* 1990;26:638–640
2. Shackford SR, Wald SL, Ross SE, et al. **The clinical utility of computed tomographic scanning and neurologic examination in the management of patients with minor head injuries.** *J Trauma* 1992;33:385–394
3. Miller EC, Derlet RW, Kinser D. **Minor head trauma: is computed tomography always necessary?** *Ann Emerg Med* 1996;27:290–294
4. Feuerman T, Wackym PA, Gade GF, Becker DP. **Value of skull radiography, head computed tomographic scanning, and admission for observation in cases of minor head injury.** *Neurosurgery* 1988;22:449–453
5. Mohanty SK, Thompson W, Rakower S. **Are CT scans for head injury patients always necessary?** *J Trauma* 1991;31:801–804
6. Garra G, Nashed AH, Capobianco L. **Minor head trauma in anticoagulated patients.** *Acad Emerg Med* 1999;6:121–124
7. Haydel MJ, Preston CA, Mills TJ, Luber S, Blaudeau E, DeBlieux PMC. **Indications for computed tomography in patients with minor head injury.** *N Engl J Med* 2000;343:100–105
8. Nagy KK, Joseph KT, Krosner SM, et al. **The utility of head computed tomography after minimal head trauma.** *J Trauma* 1999;46:268–270
9. Miller EC, Holmes JF, Derlet RW. **Utilizing clinical factors to reduce head CT scan ordering for minor head trauma patients.** *J Emerg Med* 1997;15:453–457
10. Reinus WR, Wippold FJ Jr, Erickson KK. **Practical selection criteria for noncontrast cranial computed tomography in patients with head trauma.** *Ann Emerg Med* 1993;22:1148–1155