THE RISK OF HEMATOMA FOLLOWING EXTENSIVE ELECTROMYOGRAPHY OF THE LUMBAR PARASPINAL MUSCLES

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ABSTRACT: *Introduction:* The purpose of this study is to provide a controlled trial looking at the risk of paraspinal hematoma formation following extensive paraspinal muscle electromyography. *Methods:* 54 subjects ages 55–80 underwent MRI of the lumbar spine before or shortly after electromyography using the paraspinal mapping technique. A neuroradiologist, blinded to the temporal relationship between the EMG and MRI, reviewed the MRIs to look for hematomas in or around the paraspinal muscles. *Results:* Two MRIs demonstrated definite paraspinal hematomas, while 10 were found to have possible hematomas. All hematomas were < 15 mm, and none were close to any neural structures. There was no relationship between MRI evidence of hematoma and either the timing of the EMG or the use of aspirin or other nonsteroidal anti-inflammatory drugs. *Conclusions:* Paraspinal electromyography can be considered safe in the general population and those taking nonsteroidal anti-inflammatory drugs.

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The skeletal muscles have a rich vascular supply, and there are many small or medium sized blood vessels deep within the paraspinal musculature that cannot be visualized or palpated easily. Despite this, no clear case of symptomatic bleeding complications of standard lumbar paraspinal needle electromyography (EMG) has been reported. There are, however, reports in the literature of asymptomatic MRI-confirmed paraspinal hematomas following paraspinal electromyography.[1–3] In at least one of these cases, the patient had suffered a fall before the MRI, suggesting the possibility that the hematoma may not have been the direct result of the electrodiagnostic test.

Patients with bleeding disorders and those on therapeutic doses of pharmacologic anticoagulants may be at higher risk for the above-described complications, but the magnitude of this risk is unknown. Nine percent of 47 EMG laboratories surveyed reported at least 1 severe bleeding complication in an anticoagulated patient that required medical or surgical intervention.[4] The specific complications were not described, so it is unknown whether paraspinal needle examination was the culprit. 66% of laboratories surveyed reported that they were unwilling to perform needle electromyography on the paraspinal muscles of anticoagulated patients.[4] The rationale for avoiding the paraspinal muscles is that they are located at a noncompressible site, and large hematomas could compromise adjacent nerve roots or the spinal cord. Practitioners may counsel patients to discontinue anticoagulants before electromyography, thereby increasing the risk of thrombotic complications.[5]

Before the safety of paraspinal electromyography in therapeutically anticoagulated patients can be assessed, it makes sense to establish the extent of bleeding in low risk patients. If standard electromyography results in frequent asymptomatic paraspinal hemorrhages, it would be reasonable to speculate that bleeding complications would be more severe in an anticoagulated patient population. In a review of 370 patients who had paraspinal EMG and an MRI scan within a week, no radiographic evidence of paraspinal hematoma was identified.[6] Although these results are reassuring, the degree of paraspinal exploration in the subjects was not standardized. It is common practice to perform needle electromyography on one lumbar paraspinal muscle as part of a standard electrodiagnostic examination, so it is likely that the burden of paraspinal needle examination in the patients in this series was minimal.[7]

Paraspinal mapping is a needle electromyography technique that has been shown to have a high sensitivity for the diagnosis of clinical lumbar spinal stenosis and lumbar radiculopathy.[8–10] This technique requires needle insertion at multiple levels on both sides of the back. The purpose of our study was to assess for MRI evidence of paraspinal hematomas following paraspinal mapping. With such a high burden of needle exploration, this technique should give us a sensitive appraisal of the bleeding risks of paraspinal electromyography.

Important flaws in the past literature are a lack of masking and a lack of a control population. Biases can occur. It is important to have a study in which the examiner of the imaging study is truly blinded to the condition of the patient.

METHODS

Subjects were selected based on participation in the NIH funded Michigan Spinal Stenosis Study

Abbreviations: EMG, electromyography; MRI, magnetic resonance imaging; NSAID, nonsteroidal anti-inflammatory drug; T, Tesla

Key words: complications, electromyography, hematoma, paraspinal mapping, paraspinal muscles

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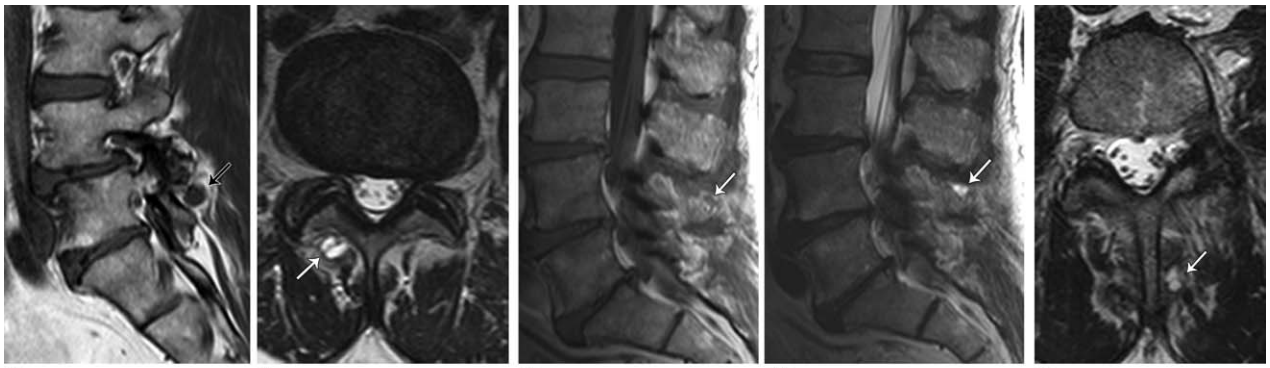

FIGURE 1. (1) Definite hematoma. Sagittal T1-weighted (**a**) and axial T2-weighted (**b**) MR scans through the lower lumbar spine demonstrate a 4 × 4 × 8 mm T1 isointense and T2 hyperintense lesion with a hypointense rim (arrow) located behind the right L4 lamina at the L5 level; imaging characteristics are consistent with old blood products (proteinaceous fluid) with a rim of hemosiderin staining. (2) Possible hematoma. Sagittal T1-weighted (a) and sagittal (b) and axial (c)T2-weighted MR scans through the lower lumbar spine demonstrate a 5 mm T1 isointense and T2 hyperintense lesion (arrow) located in the immediate left paraspinous region at the L4 level; imaging characteristics are consistent with complex chronic fluid collection.

and Michigan Spinal Stenosis Study II (Haig AJ, Principle Investigator, Paraspinal Denervation in Low Back Pain. R01HD052959 and 5 R01 NS41855-02, from the Eunice Kennedy Shriver National Institute of Child Health & Human Development.) The study was approved by the institutional review board, and a signed informed consent was obtained from each subject before participation in the study. Subjects recruited for the study included those with clinical lumbosacral spinal stenosis and asymptomatic controls, ages 55–80. Some of the subjects were taking aspirin or other nonsteroidal anti-inflammatory drugs, but none were being treated with oral or parenteral anticoagulation. All subjects underwent nerve conduction studies and needle electromyography including the standardized paraspinal mapping protocol. All EMG studies were performed and interpreted by physiatrists or neurologists with board certification in electrodiagnostic medicine. A 50- to 75-mm monopolar needle was inserted at each of 4 sites (L2, L3, L4, and L5) with 3 different orientations. The needle was inserted at approximately 5 mm increments from the most superficial aspect of the muscle to the spinous process or the hub of the needle.[8]

All subjects were imaged on a 1.5 Tesla (T) MRI scanner (GE Signa or Siemons Acheiva) including sagittal T1-weighted, T2-weighted, fat-suppressed T2-weighted ("STIR"), and axial T1-weighted and T2-weighted scans through the lumbosacral spinal region. Axial T2-weighted scans were angled through individual intervertebral discs. Axial T1-weighted scans were obtained as contiguous sections oriented perpendicular to the long axis of the spine. All sagittal scans and the axial T1-weighted scans were performed with 4-mm-thick sections with a 1-mm "gap." No contrast enhanced scans were obtained. For several patients, outside institution studies were used if at least T1-weighted and T2-weighted scans in at least 2 planes were supplied. Some subjects underwent MRI scanning before EMG, and some afterward. The MRI scans were reviewed by a neuroradiologist who was blinded to the temporal relationship between the EMG and MRI. The neuroradiologist was asked to comment on the presence, size, and location of any hematomas in or around the paraspinal muscles. To be considered a hematoma, a lesion was required to be > 2 mm in size and visible on more than one imaging sequence and in more than one plane. Lesions were considered definite hematomas if they were isointense/hyperintense to muscle on T1-weighted scans and hyperintense on T2-weighted scans, with a hemosiderin rim (dark on T2-weighted scans).

Lesions located immediately behind and contiguous with facet joints were considered possible hematomas, as such lesions may also represent synovial cysts arising from degenerative facet joints. Hemorrhage within synovial cysts is a known phenomenon, and the MR imaging characteristics of a hemorrhagic synovial cyst would be identical to those of a posttraumatic hematoma. Even a nonhemorrhagic cyst with synovial joint proteinaceous fluid extending from the facet joint may be difficult to distinguish from a hematoma, although the latter would be expected to eventually develop a hemosiderin rim. Therefore, we considered a lesion to be a definite hematoma only if the lesion demonstrated both fluid signal consistent with blood products and a hemosiderin rim. In the absence of a hemosiderin rim, lesions were only considered to be possible hematomas (Fig. 1)[11]

When a possible hematoma was discovered in a previously symptomatic subject, a chart review was performed to look for clinic notes or phone notes

Table 1. Description of cases of hematoma.

Case	Timing of MRI	Imaging features consistent with hematoma	Size and location
1	Before EMG	Yes	14 mm, behind right L5/S1 facet
2	Before EMG	Yes	8 mm, behind right L4 lamina
3	Before EMG	Possible	8 mm, behind right L5 lamina
4	Before EMG	Possible	2 mm, immediately behind and contiguous with right L4/5 facet
5	Before EMG	Possible	4 mm, behind degenerated left L4/5 facet joint
6	< 1 week after EMG	Possible	5 mm, contiguous with and immediately behind left L5/S1 facet
7	< 1 week after EMG	Possible	8 mm, behind right L5 lysis defect 5 mm, behind left L5 lysis defect
8	< 1 week after EMG	Possible	4 mm, behind right L4/5 facet
9	< 1 week after EMG	Possible	3 mm, behind right L4/5 facet 3 mm, behind left L3/4 facet
10	< 1 week after EMG	Possible	6 mm, behind right L2/3 facet joint
11	< 1 week after EMG	Possible	5 mm, left paraspinous process, L4 level
12	< 1 week after EMG	Possible	4 mm, behind right L4/5 facet

suggesting that the subject had reported new back pain, radicular pain, limb numbness, or limb weakness.

Statistical Analysis. PASW Statistics 18 (SPSS Inc., Chicago, Illinois) was used for analyzing data after importing the cleaned Excel data into SPSS. A *t*-test for 2 group-comparisons was used for continuous measures.

Chi-square tests were performed to examine the relationship between categorical variables, for example, patients' medication usage (on aspirin or not) and the clinical findings (likelihood of developing paraspinal hematomas, yes or no). A P value of < 0.05 was considered significant in all analyses.

RESULTS

The population consisted of 25 (46.3%) men and 29 (53.7%) women with a mean age of 62.4 ± 5.7 years for men and 62.7 ± 8.1 years for women. A total of 54 MRIs were reviewed. Twenty-nine of the MRIs were of subjects who had undergone EMG with paraspinal mapping in the 7 days before their respective MR scanning. The remaining 25 MRI scans were performed on subjects who had not yet had an EMG at the time of MRI scanning.

Two MRIs demonstrated definite evidence of paraspinal hematoma, while 10 were found to have possible hematomas (Table 1). Six of the possible hematomas were found in patients who had undergone recent EMG, and 6 of the definite or possible hematomas were discovered in patients who had not yet undergone EMG. No subject had more than 2 regions suspicious for abnormality. We used *t*-tests and Chi-square tests to examine the relationship between MRI evidence of paraspinal hematomas and the timing of the EMG, the use of aspirin or other NSAIDs, subject demographics, response to pain measurements, paraspinal mapping scores, and other clinical factors that might have affected hematoma formation (Table 2). No significant ($P > 0.05$) differences in these variables were observed between subjects with paraspinal hematoma and those without hematoma.

Table 2. Patient demographic and clinical factors relating to paraspinal hematomas.

	Hematomas	*N*	Mean	Std. deviation	Std. error mean	*t*-test	Sig (two-tailed)
Age at study, year	No	42	63.13	7.464	1.152	0.971	0.336
	Definite/Possible	12	60.87	5.487	1.584		
Paraspinal mapping score right side total	No	42	4.00	8.094	1.249	0.651	0.518
	Definite/Possible	12	2.42	4.122	1.190		
Paraspinal mapping score left side total	No	42	3.40	4.623	0.713	0.151	0.880
	Definite/Possible	12	3.17	5.458	1.576		
Paraspinal mapping score tested/symptomatic side	No	42	3.95	6.541	1.009	1.142	0.259
	Definite/Possible	12	1.75	2.137	0.617		
Paraspinal mapping score not tested/asymptomatic side	No	42	3.45	6.645	1.025	−0.177	0.860
	Definite/Possible	12	3.83	6.337	1.829		
Body Mass Index	No	42	29.79	5.362	0.827	−0.347	0.730
	Definite/Possible	12	30.39	4.892	1.412		

Table 3. Comparative risk of hematoma in subgroups.

Variables	N	Definite or possible hematoma	Chi square	*P* value
Recent EMG	29	6	0.085	0.770
No recent EMG	25	6		
Clinical spinal stenosis	24	5	0.048	0.826
No clinical spinal stenosis	30	7		
Taking aspirin	16	3	0.159	0.690
Not taking aspirin	38	9		
Recent EMG and aspirin	8	1	0.452	0.502
Recent EMG and no aspirin	21	5		
Taking other NSAID	24	6	0.193	0.661
Not taking other NSAID	30	6		
Recent EMG and other NSAID	10	3	0.806	0.309
Recent EMG and no other NSAID	19	3		

Seven subjects with no known history of clinical spinal stenosis were found to have possible hematomas. All of these subjects had their EMGs performed within 1 week before MRI imaging. A review of their subsequent medical records did not reveal any documented history of pain or sensory or motor deficits after the EMG, with an average follow-up of 20.6 months (range, 11–31 months). Five subjects with a known clinical history of spinal stenosis were found to have definite or possible hematomas. None of them had undergone paraspinal electromyography at the time of their MRI imaging.

DISCUSSION

With or without extensive needle electromyography of the lumbar paraspinal muscles, significant bleeding complications are uncommon. This study indicates that the overall risk of definite or possible paraspinal hematoma formation does not correlate with whether or not subjects had undergone recent paraspinal electromyography, or whether they were taking aspirin or other nonsteroidal anti-inflammatory drugs (NSAIDS) (Table 3). Underscoring this is the observation that only 2 definite hematomas were found in our series, and both were small lesions in persons who had not had EMGs at the time of the MRI. The etiology of these 2 hematomas is unknown. These subjects had not undergone recent epidural or facet injections or other procedures that cause local trauma to the paraspinal muscles. Both subjects had a known history of clinical spinal stenosis, however, and this raises the question of whether stenosis itself is a risk factor for subclinical paraspinal hematomas. Neurogenic claudication appears to be the consequence of venous congestion in the pelvic veins and the Batson venous plexus.[12] Perhaps venous hypertension coupled with traction on the veins along the neural foramina leads to small venous tears. Whatever the cause, the finding of hematomas in patients with no history of trauma draws into question all previous studies concerning this issue.

No hematomas, definite or possible, were > 15 mm in size, and none of them were located near neural structures. None of the previously asymptomatic subjects with possible hematomas subsequently presented to our medical system with new pain or sensory or motor deficits after the procedure. Although we found a relatively large number of possible hematomas, it, therefore, is not likely that any of the lesions in this series were clinically significant. It is also important to note that, because possible hematomas occurred equally in subjects who had undergone recent paraspinal EMG and those who had not, it is possible that these fluid collections represent synovial joint fluid from nearby degenerated facet joints rather than blood.

Although we found no evidence that EMG of the paraspinal muscles causes clinically significant bleeding complications, a single case report to the contrary could contradict this conclusion. However no such case report exists in the literature.

There is a discrepancy between the findings of this study and the large series published by Gertken et al., in which no hematomas were found in 370 MRI scans.[6] In that series, a hematoma was defined as subacute or acute blood products at the approximate level of the EMG, but imaging characteristics or minimum size of the hematoma were not defined further. It is unknown whether the radiologists who reviewed the images in this series identified fluid collections similar to those we found in our study, or whether they discounted them for being too small or inconsistent with blood products. Both the Gertken study and ours include a similar T1-weighted imaging technique, but they did not perform the more sensitive sagittal fat-saturated T2-weighted scans as part of their routine protocol. Furthermore, they performed

thicker axial sections with a large "gap" between axial sections (5 mm axial sections with 5 mm between sections), which would result in a lower sensitivity for detecting smaller lesions.

There are a few potential limitations of our study. Sixteen of the 54 subjects in this study had MRI scans within 24 h after the EMG study. While unlikely, it is possible that traumatic sequelae were missed in this population, as a hematoma might not have fully formed at the time the MRI scan was performed.

Chart review suggested that previously asymptomatic subjects with possible hematoma on MRI did not report any new pain, sensory loss, or motor deficits in the lower extremities following their EMGs. However, it is possible that the hematomas were symptomatic, and that the subjects did not seek medical attention, or they sought medical attention from a provider outside of the University of Michigan system, and we were therefore unable to review the pertinent records. We did not attempt to perform a chart review on subjects with known stenosis, because it may be difficult to discriminate between pre-existing symptoms and new symptoms referable to a paraspinal hematoma. Therefore, it is possible that the subjects in this group were, in fact, symptomatic from their small hematomas.

The paraspinal mapping technique used in this study is performed using a 28-gauge monopolar needle. Many electrodiagnostic physicians choose to examine the paraspinal muscles with a concentric needle electrode. These are usually slightly larger (26 gauge) and may theoretically carry a higher risk of bleeding.

Paraspinal electromyography including the paraspinal mapping technique can be considered safe in the general population and in those taking nonsteroidal anti-inflammatory drugs. This study does not address the safety of paraspinal needle examination in patients who are receiving therapeutic anticoagulation. Given the diagnostic importance of the paraspinal muscles in the evaluation of common neuromuscular disorders and the high frequency of anticoagulation usage, a study of needle electromyography on therapeutically anticoagulated patients should be undertaken.[13]

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