Electromyography and Anticoagulation

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Abstract: Needle electromyography (EMG) is a common and safe diagnostic procedure. Although there are no absolute contraindications to performing an EMG, medically induced coagulopathy represents a relative contraindication. The purpose of this article is to discuss EMG safety for patients taking anticoagulants and antiplatelet agents, and to review the current literature regarding bleeding risks. Safety measures used to avoid serious bleeding complications are also discussed.

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INTRODUCTION

Needle electromyography (EMG) is a common and quite safe diagnostic investigation routinely performed by physiatrists and neurologists. As with any invasive procedure, risks do exist, and bleeding complications have been reported in the medical literature [1-5]. Although there are no absolute contraindications to performing an EMG, medically induced coagulopathy represents a relative contraindication [6]. Although most practitioners would acknowledge that the bleeding risk could be increased when patients are taking medications that affect coagulation (Table 1), specific questions about the degree of risk remain.

The purpose of this article is to review EMG safety as it pertains to patients who are taking anticoagulants and antiplatelet agents. In addition, we will attempt to familiarize practitioners with the current literature regarding bleeding risks and EMG, and discuss some of the measures commonly used to reduce these risks and avoid serious bleeding complications.

LITERATURE REVIEW

In 1999, the American Association of Neuromuscular and Electrodiagnostic Medicine addressed the issue of bleeding risks and EMG with a position statement, which recommended caution in patients with platelet counts less than 50,000/µL, an international normalized ratio (INR) higher than 1.5-2.0, or prothrombin time longer than 1.5-2.0 seconds [6]. The review suggested that, with patients at increased risk for bleeding, examiners should sample small superficial muscles, apply prolonged pressure to assist with hemostasis, and correct clotting functions if appropriate. They did not recommend refusing to examine patients who are taking certain medications or to avoid specific muscles. In 2003, however, the investigators of an invited review in Muscle and Nerve suggested that, when evaluating patients who are anticoagulated, practitioners should use the smallest gauge needle possible and perform a limited study, avoiding high-risk muscles [7]. The review defined high-risk muscles as those that are difficult to compress or those in which an expanding hematoma could result in compartment syndrome or neurovascular compromise (eg, posterior tibialis, flexor digitorum longus, paraspinal muscles, flexor pollicis longus, or ilioptoaos).

A survey of 60 academic EMG laboratories in 2006 confirmed that practice varied considerably and documented that, in fact, many laboratories limit needle EMG in patients who are anticoagulated. Although respondents did not uniformly avoid any particular muscles, they most commonly excluded the paraspinal muscles (72%). Nineteen percent of the respondents altered their EMG in patients taking antiplatelet medications, and 13% withheld these medications before performing the needle examination [8]. Also, respondents documented 5 serious bleeding complications, which spanned the collective memories of the 60 academic EMG laboratories. They provided no details of the complications,
but the paucity of such reports suggests that significant bleeding after EMG is a rare occurrence.

To date, the literature reveals only a handful of case reports of symptomatic bleeding complications after EMG. Excluding 1 case with coincident trauma thought to contribute to the bleeding, 4 clinically significant bleeds have been documented [1-5]. Of the occurrences in patients who are anticoagulated, there has been 1 report of retroperitoneal bleeding severe enough to warrant transfusion, and 1 calf hematoma that was managed conservatively [2,3]. Two separate cases of compartment syndrome after EMG have been reported, both of which required surgical intervention, although in neither case was the patient taking blood thinners at the time of the EMG [4,5].

In 1996, Caress et al [9] documented an asymptomatic paraspinal hematoma found incidentally on magnetic resonance imaging (MRI) after EMG. In the retrospective series that accompanied this index case, the investigators documented a relatively high incidence of paraspinal bleeding (5/45 muscles) in 17 patients who were not anticoagulated. The investigators concluded that bleeding after paraspinal EMG, although still uncommon, did warrant a cautious approach due to the theoretical risk of bleeding in patients who are anticoagulated [9]. However, other than the index case of a patient with a large but clinically apparent hematoma, the remaining 4 cases of hematoma were not identified on the initial radiology report and were found only on retrospective re-reading of the MRI.

More recently, several larger-scale imaging studies devoted to documenting the risk of bleeding after EMG have been published. Lynch et al [10], in 2008, looked at the incidence of ultrasonographically detectable hematomas in the tibialis anterior in patients taking warfarin and aspirin and/or clopidogrel compared with controls. They found 3 subclinical slivers of blood (all measured 19-30 mm × 2.5-2.8 mm). No statistically significant increase in bleeding occurred between the groups, and the overall incidence was 1.45% [10].

In January 2012, Boon et al [11] published a follow-up ultrasound study that looked at “high-risk” muscles. They again compared controls with those patients taking warfarin, clopidogrel, and aspirin, as well as documenting nonsteroidal anti-inflammatory drug (NSAID) and herbal supplement use. They scanned the muscles at least 15 minutes after EMG and noted only a few tiny, asymptomatic hematomas. Again, they observed no statistically significant increase in bleeding risk compared with that in the control group, and the absolute risk of bleeding was 0.62% [11].

Gertken et al [12] published the largest study to date, which reviewed 431 spine MRIs no more than 7 days after EMG. In this retrospective review, 2 neuroradiologists reviewed and interpreted the MRIs independently, with instructions to look for paraspinal bleeding. They found no hematomas. There were 139 patients taking aspirin and 8 on clopidogrel, and 14 were anticoagulated (INR range, 1.5-2.9). The study offered the most compelling evidence to date that significant bleeding after paraspinal EMG occurs very rarely [12].

Soon after the study by Gertken et al [12], London et al [13] published a smaller comparative study that evaluated paraspinal muscles by using MRI. In this study, the radiologist was blinded to whether the EMG had been performed before the MRI. The study observed no definite hematomas in the 29 patients who had an EMG before the MRI, including the 8 patients who were taking aspirin and the 10 patients on NSAIDs. However, 2 hematomas were found in the non-EMG group. Some equivocal findings were labeled “possible hematomas,” although these were distributed equally among both groups. This study provided further evidence that paraspinal EMG was unlikely to cause bleeding and should be considered safe for the general population, although the investigators did not make recommendations regarding patients who were anticoagulated [13].

When taken in aggregate, the imaging studies document only 10 definite hematomas in the 1037 total muscles imaged after EMG, with an absolute risk of approximately 1%. The risk is 1.35% (3/222) in patients who were anticoagulated (INR range, 1.2-4.2), and, for those on antiplatelet medica-
tions, the risk is 0.61% (2/328) (Table 2). There were no paraspinal bleeds found in patients who were anticoagulated.

DISCUSSION

The summary of results provided here is not meant to make a direct or comprehensive comparison of these disparate studies, yet pooling of these results does help to generate a starting point for overall risk estimates. It is worth reiterating that none of the hematomas in these imaging studies was clinically evident. With the exception of the review by Caress et al[9], the documented bleeds consisted of tiny linear collections measured in millimeters. As evidenced by the case reports, serious bleeding complications can occur after EMG whether or not a patient is anticoagulated. However, the literature also substantiates what many practitioners anecdotally suspect: bleeding after EMG is rare. The imaging studies support this notion, even in historically high-risk muscles and in patients on anticoagulants (INRs ranging from 1.2 to 4.2) or antiplatelet medications. The absolute risk of bleeding for all muscles imaged is approximately 1%, and the incidence does not appear to be significantly higher in patients taking blood thinners.

Considerable practice variability still exists and affects which patients, or muscles, will be examined [8]. Some providers may defer the examination in patients who are taking blood thinners, avoid high-risk muscles, or even advise patients to discontinue the medication before the study. Routinely deferring or limiting examinations may deny patients valuable diagnostic information, and, if practitioners discontinue anticoagulation, then patients are exposed to potentially devastating thrombotic complications[7,14,15]. At the institution where 2 of us (J.T.G., A.J.B.) trained, guidelines regarding anticoagulation include examining all patients with an INR/H110213.0, and in patients with an INR/H110223.0, the study is completed at the discretion of the electromyographer[11].

In our opinion, there is no reason to limit the examination in patients who are on antiplatelet agents, NSAIDs, or herbal supplements, or to discontinue anticoagulants or antiplatelet agents exclusively for the purpose of performing needle EMG.

<table>
<thead>
<tr>
<th>Study, y</th>
<th>Imaging Modality</th>
<th>Muscles Tested</th>
<th>Total No. Muscles</th>
<th>No Blood Thinners vs Anticoagulants or Antiplatelet Agents, no. subjects</th>
<th>No. Definite Hematomas</th>
<th>Symptoms From Bleeding</th>
<th>Risk of Bleeding After EMG, No. Total Patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caress et al (9), 1996</td>
<td>MRI</td>
<td>Paraspinal</td>
<td>45</td>
<td>45 Controls; 0 warfarin; 0 ASA/clopidogrel</td>
<td>5</td>
<td>None reported</td>
<td>5/45 (11.1)</td>
</tr>
<tr>
<td>Lynch et al (10), 2008</td>
<td>Ultrasound</td>
<td>Tibialis anterior</td>
<td>209</td>
<td>52 Controls; 101 warfarin (INR range, 1.5-4.2); 57 ASA/clopidogrel‡; 10 NSAIDs; 3 herbal</td>
<td>3†</td>
<td>None reported</td>
<td>3/209 (1.44)</td>
</tr>
<tr>
<td>Gertken et al (12), 2011</td>
<td>MRI</td>
<td>Paraspinal</td>
<td>431</td>
<td>270 Controls; 10 warfarin (INR range, 1.2-2.9); 4 heparin/LMWH; 147 ASA/clopidogrel</td>
<td>0</td>
<td>None reported</td>
<td>0/431 (0)</td>
</tr>
<tr>
<td>Boon et al (11), 2012</td>
<td>Ultrasound</td>
<td>High-risk muscles</td>
<td>323</td>
<td>100 Controls; 107 warfarin (INR range, 1.6-4.0); 116 ASA/clopidogrel; 15 NSAIDs</td>
<td>2‡</td>
<td>None reported</td>
<td>2/323 (0.62)</td>
</tr>
<tr>
<td>London et al (13), 2012</td>
<td>MRI</td>
<td>Paraspinal</td>
<td>29§</td>
<td>21 Controls; 0 warfarin; 8 ASA; 10 NSAIDs</td>
<td>0</td>
<td>None reported</td>
<td>0/29 (0)</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td></td>
<td>1037</td>
<td>488 Controls; 222 anticoagulants; 328 ASA/clopidogrel; 35 NSAIDs; 3 herbal</td>
<td>10</td>
<td>None reported</td>
<td>Total 10/1037 (0.96); control 5/488 (1.02); antiplatelet‡ 2/328 (0.61); anticoagulant 3/222 (1.35)</td>
</tr>
</tbody>
</table>

EMG = electromyography; MRI = magnetic resonance imaging; ASA = aspirin; INR = international normalized ratio; NSAID = nonsteroidal anti-inflammatory drug; LMWH = low-molecular-weight heparin.

*One patient was counted in both the warfarin and antiplatelet groups.

†Hematoma no. 1 (which measured 32.1 × 2.6 mm) was in a patient who was taking ASA, ibuprofen, and naproxen; hematoma no. 2 (which measured 32.7 × 2.8 mm) was in a patient on warfarin, INR of 3.9; hematoma no. 3 (which measured 19.0 × 2.9 mm) was in a patient on warfarin, INR of 2.9. All were located in the tibialis anterior.

‡Hematoma no. 1 (which measured 8.8 × 1.2 mm) was in a patient on clopidogrel and was located in the tibialis posterior; hematoma no. 2 (which measured 16 × 3 mm) was in a patient on warfarin, INR of 2.3, and was located in the flexor pollicis longus. High-risk muscles included the following: paraspinal muscles, flexor digitorum longus, tibialis posterior, flexor pollicis longus, and iliopsoas.

§Twenty-nine, including only those patients who had EMG before MRI and "definite hematomas."
(Clinical Pearls). Performing EMG while patients are receiving prophylactic dosages of heparin or low-molecular-weight heparin has not been evaluated in depth (although several patients in the study by Gertken et al [12] were receiving prophylactic dosages), and the safety of EMG when on therapeutic doses of these 2 medication classes has not been evaluated. We would anticipate these medications, when within the therapeutic window, not to increase the bleeding risk more than therapeutic doses of warfarin, although the actual risk is unknown. Practitioners may want to request that, for hospitalized patients, levels (or coagulation parameters) be assessed before the study. Future studies in this population of patients would be valuable. Studies have not evaluated the newer anticoagulants, such as dabigatran (Pradaxa; Boehringer Ingelheim Pharmaceuticals Inc, Ridgefield, CT) and rivaroxaban (Xarelto; Bayer HealthCare AG, Leverkusen, Germany) specifically, but one would expect them to exert similar overall effects on coagulation when compared with warfarin and therefore to carry similar risks [16,17]. Only a few of the studies documented use of NSAIDs and herbal supplements; however, it seems unlikely that these medications would confer a higher risk of bleeding than warfarin, clopidogrel, or aspirin [18].

As with most recommendations in medicine, these are not meant to supplant common sense. A cautious approach is necessary for all patients referred for an EMG, and providers should operate within their personal level of comfort and use general safety measures (Clinical Pearls). Examiners should take an appropriate history and inquire into unexplained bleeding or recent bruising, perform a physical examination with inspection of the skin, and explain the procedure as well as potential risks. In those patients thought to be at an increased risk for bleeding, it is reasonable to start with superficial muscles that are easy to tamponade, observe for excessive bleeding, and apply prolonged pressure at each site before proceeding [6]. When available, portable ultrasound can provide an additional safety measure. Ultrasound can be of use in localizing deep muscles by identifying large blood vessels with Doppler ultrasound and by examining a needle site after the study if there is concern for bleeding [10].

CONCLUSION

Few case reports document clinically relevant bleeding in patients after EMG. Results of recent imaging studies suggest that the absolute incidence of hematoma formation is low and is not significantly increased in patients who are taking commonly prescribed blood thinners. As the population ages, increasing numbers of patients will likely be referred for electrophysiological studies while taking these medications. Understanding the literature can enhance practice standards and improve EMG safety. Currently, there is no compelling evidence to support routinely deferring an EMG because of antiplatelet or therapeutic anticoagulant use, and these medications should not be discontinued before the needle examination. Nevertheless, electromyographers must remain cautious when examining patients who are taking medications that affect coagulation, and must weigh individual risks on a case-by-case basis.

CLINICAL PEARLS

Proposed EMG anticoagulation recommendations:

- Perform testing in patients with INR values < 3.0.
- If the INR is > 3.0, then the EMG may be performed at the discretion of the electromyographer.
- Perform testing in all patients who are taking antiplatelet agents.
- Anticoagulants and antiplatelet medications should not be routinely discontinued for the needle EMG.

Safety suggestions:

- Inquire into bleeding history, inspect the skin for excessive bruising.
- Explain the procedure, risks, and benefits.
- Use the smallest-caliber needle.
- Limit the number of passes through a muscle.
- Start with superficial muscles; apply prolonged pressure before proceeding.
- When available, portable ultrasound can be used to locate muscles, avoid vessels, and scan for hematomas.

REFERENCES