CORRESPONDENCE

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In Reply:—First, we would like to thank Drs. Hill and Whitten for their constructive and relevant criticism, in which they note three important points: (1) lack of control group not receiving red cell concentrates; (2) influence of anesthetic techniques; and (3) lack of control of blood storage length for the autologous and allogeneic red cell concentrates. We will discuss these points respectively.

Regarding their first point, we agree that it would be most interesting with a true control group receiving no blood products. However, total hip joint replacement surgery is associated with large intra- and postoperative blood loss. A total blood loss of at least 1,500–2,000 ml is common.[1] Most patients require some kind of blood transfusion. In the discussed study, 2 of 56 patients did not receive any blood transfusion. In a randomized clinical study, it is more or less impossible to include a randomized control group not receiving any blood transfusions because there simply are not enough patients and because it is impossible to ethically randomize patients to not receive blood transfusions when they are expected to need blood.

Surgical trauma leads to release of cytokines, which was also noted in the discussion.[2] The majority of IL-6 and IL-8 release is probably a result of the surgical trauma (an indication of this is the mentioned *post hoc* study of six patients not receiving blood products, in whom we found concentrations similar to those found in the allogeneic and the autologous group), but the *difference* between the groups cannot possibly be explained by the surgery.

Regarding their second point, it is true that local anesthetics may influence cytokine release. However, this has been shown *in vitro* and in concentrations of 0.00125–0.125% of bupivacaine,[3] which is at least 25 times a higher concentration than what is found after administration of 20 mg of bupivacaine in an adult (weight. 70 kg). Both groups were treated identically. No patients were converted to general anesthesia.

Regarding their third point, the blood storage time for both groups is given in table 1 in our article. No significant differences appeared between the groups.

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The Intensity of the Current at which Sciatic Nerve Stimulation Is Achieved Is More Important Factor in Determining the Quality of Nerve Block than the Type of Motor Response Obtained

To the Editor:—We read with interest the study by Benzon *et al.*,[1] which was published in the September 1997 issue of ANESTHESIOLOGY. Using the peripheral nerve stimulator technique, Benzon *et al.* attempted to determine whether there is a correlation between the type of observed motor response and the ability to block all divisions of the sciatic nerve. Benzon *et al.* defined a successful sciatic nerve localization as a motor response to nerve stimulation using a Braun Stimuplex DIG peripheral nerve stimulator (B. Braun Medical, Bethlehem, PA) when the stimulating current was <1.0 mA. The proximity of the needle to the nerve was confirmed when an injection of 1 or 2 ml of local anesthetic abolished the elicited motor response. The authors concluded that elicitation of foot inversion was associated with the most complete sciatic nerve blockade.

Because of several inherent methodologic flaws in this study, we are compelled to comment on their methods and offer an alternative explanation for the obtained results.

1. *What was the exact current at which the response was obtained for every one of the four elicited responses?*

   The Braun Stimuplex DIG peripheral nerve stimulator is a constant current generator with a built-in LCD display allowing current adjustment in 0.01-mA increments for precise current delivery. The authors should report the exact current at which every one of the four different responses was obtained. In the absence of this information, the differences in the number of sciatic nerve branches that were blocked could simply be a function of different needle-to-nerve distances at which the local anesthetics were injected.

2. *Confirmation of the placement of the needle in the vicinity of the nerve by observing the disappearance of the motor response to nerve stimulation as used by Benzon* et al. *is unreliable.*[2,3]

   Because an immediate cessation of this response cannot be the result of local anesthetic uptake by the nerve and the resultant instantaneous Na channel blockade, this phenomenon is most likely the result of a physical displacement of the tissues, along with the nerve, away from the needle. As such, this phenomenon is observed at any distance from the nerve.[3]

3. *The authors began nerve localization using the current intensity of 2–3 mA and decreased the current to <1.0 mA before injecting the local anesthetic.*

   Although the manufacturer of the Stimuplex DIG suggests that the initial current should be "approx. 1.0 mA and reduced until visible muscle contractions occur at lower current levels (approx. 0.2 mA)," Benzon *et al.* considered nerve localization successful when a response was obtained using the current intensity that was almost five times greater than that recommended by the manufacturer. Although Benzon's method of nerve stimulation was based on the report by Singelyn *et al.*,[4] the nerve stimulator used by Singelyn *et al.* featured a pulse width of 40 μs, whereas the Stimuplex DIG used by Benzon *et al.* has a pulse width of 100 μs. This presents a substantial difference because the unit of electrical stimulation (Coulomb) can be defined as a function of current and time (electric charge = current [mA] × time [s]).[3] Because the 1.0-mA stimulus intensity used by Benzon *et al.* can be estimated as being 2.5 times stronger than the 1.0-mA stimulus in the report by Singelyn, this could not indicate adequate nerve localization. Additionally, the use of a stimulating current of an intensity >1.0 mA is frequently associated with a burning sensation during needle advancement as a result of the high current density at the tip of the insulated needle.[3]

In our practice we use a nerve stimulator identical to the one used in the study by Benzon *et al.* However, we inject a local anesthetic only after a response is obtained using a stimulating current of 0.4 mA or less in healthy patients. Using this endpoint, we have a nearly 100% success rate in achieving surgical anesthesia after a sciatic nerve block, regardless of the type of motor response obtained.[5,6*] For instance, in our prospective study comparing two different approaches to sciatic nerve block at the popliteal fossa,[7] the response to nerve stimulation significantly varied between the two techniques, with stimulation of the common peroneal nerve (dorsiflexion) being the most common first response (72%) in the lateral approach group, and the tibial nerve response (plantar flexion) being the most common response (76%) in the posterior approach group. Regardless of the type of motor response, using a stimulating current of ≤0.4 mA, we obtained blocks of all branches of the sciatic nerve in 49 (98%) of 50 patients undergoing ankle and foot surgery. Importantly, in addition to the sensory and motor evaluations, the quality of the blocks in our study were also confirmed by the ultimate test—lower extremity surgery with bone incision. The differences in the success rates between the Benzon study and our reports[5*] is likely a result of the use of lower intensity stimulating current and the consequent closer needle–nerve distance at the time of local anesthetic injection in our series. In return, this could result in injection of local anesthetic within the common epineural sheath[8] and resultant blockade in the distribution of both divisions of the sciatic nerve, regardless of the level of sciatic nerve division.[9]

In conclusion, we suggest that the results of Benzon *et al.* should be interpreted within the limits of the methods that they used. For those who use a low intensity stimulating current (more than half of US anesthesiologists who use nerve blocks in their practice use current intensity <0.6 mA),[10] their findings may not have significant practical implications. Based on our clinical experience and experimental data, the intensity of the current at which the nerve stimulation is achieved is the most important factor determining the quality and extent of the block, rather than the type of motor response obtained using higher stimulating currents. In addition to higher success rates, the use of a lower stimulating current is associated with greater patient comfort during the block placement. It is a fact to which we can attest having performed a series of sciatic nerve blocks on each other.†

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In Reply:—In our study,[1] we connected the negative (cathodal) electrode of the nerve stimulator to the insulated needle. We reported that we considered our "stimulating needle to be close to the nerve when the stimulating current that elicited a motor response was <1 mA." This was the same current reported by Pither *et al.*,[2] Singelyn *et al.*,[3] and Mansour.[4] We actually used currents less than 1 mA. I reexamined our data and found that the currents used ranged from 0.5 to 0.8 mA (mean ± SD, 0.71 ± 0.1 mA). The stimulation intensities used for each elicited motor response were as follows: (1) eversion: 0.63 ± 0.12 (range, 0.5-0.8 mA); (2) inversion: 0.75 ± 0.12 (range, 0.5-0.8 mA); (3) plantar flexion: 0.7 ± 0; and (4) dorsiflexion: 0.77 ± 0.10 (range, 0.7-0.8 mA).

The ideal stimulus intensity required to stimulate a nerve has not been clearly defined. Pither *et al.* stated that movement is elicited in the appropriate muscle when the needle tip is likely to be 1-2 cm from the nerve and that 0.5-1 mA is required when the needle is touching or very close to the nerve.[2] Magora *et al.* showed that 0.5 mA was needed for direct stimulation of the obturator nerve and that their blocks were unsuccessful when 1-3 mA were needed to elicit a motor response.[5] Riegler found that currents ranging from 0.2 to 1.5 mA were sufficient for localization of the brachial plexus whether the interscalene, supraclavicular, or axillary approach was used.[6] A review of the minimum currents used by Riegler showed 0.66 ± 0.4 mA for the interscalene, 0.71 ± 0.03 mA for the supraclavicular, and 0.72 ± 0.03 mA for the axillary approach. These stimulating intensities are the same as the ones we used in our study. Shannon *et al.* accepted 0.6 mA as their endpoint with their lateral femoral cutaneous block.[7] In the new edition of Cousins and Bridenbaugh, a stimulus intensity of 0.5 mA was recommended.[8]

Our hesitancy to use currents less than 0.3 mA was precipitated by the occurrence of an intraneural injection with 0.2 mA during one of our trial blocks, before we formally started our study. The subject had severe shooting pain to his foot during the initial injection of 2 ml, and although the needle was withdrawn 1 mm, he had paresthesias for 1 week. Singelyn *et al.* noted the occurrence of paresthesias with stimulating currents "less than 1 mA."[3] In our clinical practice, we use stimulating intensities of 0.3-0.8 mA.

Bridenbaugh and Crews stated that the "injection of 1 to 2 ml of local anesthetic will immediately abolish nerve stimulation and muscle contraction if the tip of the needle is at the site of the nerve."[8] This has been our experience, as well as that of other investigators.[2,9,10] As stated by Dr. Vloka, this rapid response is the result of the nerve being displaced away from the needle tip. This phenomenon has been confirmed in studies wherein air produced the same response as the local anesthetic.[11] If the needle tip is beyond the nerve and if the shaft of the needle is causing the stimulation, then the injection will not change the motor response. In this case, the needle should be withdrawn slightly and the test repeated.

In our initial study sessions, we used initial currents of 2-3 mA because these were the currents recommended by Riegler.[6] We then decreased the current output as we approached the target nerve. After four study sessions, we used initial currents of 1.5-2 mA because 3 mA was painful. Dr. Vloka will probably agree that the initial current used is less important than the actual current when the injection was made.

Dr. Vloka made calculations based on "1.0-mA stimulus intensity used by Benzon" when we stated clearly that we used currents "less than 1 mA." Perhaps it was our fault and may be we should have been more specific.

The 98% success rate of Vloka and Hadzic is to be expected because they "stimulated the division of the popliteal nerve that predominantly innervated the surgical area."[12] It was also not surprising that the common peroneal nerve was the nerve that was usually stimulated first in their lateral approach group because the common peroneal nerve is located laterally, in relation to the tibial nerve. These two points emphasize the importance of knowledge of the anatomy involved; simply demonstrating nerve stimulation at low current is not enough to ensure adequate block.[2,13]

Dr. Vloka stated that they performed sensory evaluations in their study.[12] However, they did not assess, in detail, the sensory blockade of the areas in the foot innervated by the different branches of the sciatic nerve, *i.e.*, the posterior tibial, deep peroneal, superficial peroneal, and sural nerves. Incomplete blockade of some of the areas innervated by the branches of the sciatic nerve may have been masked by adequate sensory anesthesia in the operative area.

Although there may be a common epineural sheath as Dr. Vloka mentioned, there may also be a sheath within the nerves. In two study sessions in our study,[1] we found that partial blockade of the posterior tibial nerve involved the area innervated by the medial calcaneal branch of the tibial nerve, with no blockade of the medial and lateral plantar branches.

Based on Dr. Vloka's publications, it appears that the lateral approach to sciatic nerve blockade in the popliteal fossa is reliable and should be used more frequently. We use the posterior approach simply because of familiarity with the technique. We have used this approach even in patients in the lateral position and found it simple and effective. If we find that inversion or combined inversion/plantar flexion (the two elicited foot movements associated with complete sensory blockade of the foot[1]) is difficult to elicit, then we use the double injection technique.[14] In this technique, we inject two 15-ml injections after identification of the tibial (elicited plantar flexion) and peroneal components (elicited dorsiflexion or eversion) of the sciatic nerve.

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