per cent bupivacaine plain with 0.3 mg buprenorphine is given epidurally to provide postoperative pain relief. The epidural injection is given early in the operating room while the subarachnoid block exists in order to minimize cardiovascular changes and to allow the patients to be monitored for additional time in the operating room where full facilities are available to deal with any problems. The epidural catheter is removed at the end of operation. The postoperative pain relief obtained is usually of 8 to 12 hours duration. Further postoperative analgesia is obtained by oral or intramuscular analgesics.

Two cases of post-spinal headache of a mild nature have been seen in 300 cases. Headache only occurred when repeated punctures of the dura were performed, due to technical difficulties in defining the distinct feel of dural punctures. The subsequent epidural injections were not given due to fear of extension of block.

My use of this technique has led to the following observations. First, the dose requirement of local anaesthetic to achieve a satisfactory level of anaesthesia for Caesarean section was low, compared to another study[4] where a "single shot" spinal was administered. Secondly, the incidence of post-spinal headache was very low and the headaches were of a minor nature.

One possible explanation for the reduced requirement of local anaesthetic for the CSE technique is that the epidural pressure becomes atmospheric and this change in pressure somehow interferes with the circulation and volume of the cerebrospinal fluid and hence better spread. The injection of local anaesthetic through the narrow and long spinal needle is very slow and hence better "fixing" of the local anaesthetic likely occurs.

The incidence of post-spinal headache associated with use of a 25-gauge needle has been reported to be between 1 per cent[5] and 20 per cent.[6] Although the number of cases in my study is not sufficient to come to a scientific conclusion the low incidence (1:150 cases) must be recognized. This low incidence of spinal headache could be due to the technique of meticulous puncture of the dura with a fine needle, avoiding possible repeated dural puncture with the "single shot" technique in an attempt to elicit free flow of cerebrospinal fluid. The injection of fluid into the epidural space is a reported method for prophylaxis after dural puncture.[7] Perhaps the injection of local anaesthetic into the epidural space, for postoperative pain relief, might exert a protective effect against further loss of cerebrospinal fluid.

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Efficacy of priming with atracurium

To the Editor:

In their paper on priming with atracurium, Naguib *et al.*[1] conclude that a priming dose of 0.05 $mg \cdot kg^{-1}$ is optimal. The authors used a three-minute interval between the priming dose and the intubating dose, on the basis of a previous study on priming intervals.[2] That study, however, evaluated a priming dose of 0.06 $mg \cdot kg^{-1}$. The optimal priming interval for the 0.05 $mg \cdot kg^{-1}$ dose may not be the same as that for the 0.06 $mg \cdot kg^{-1}$ dose.

Another discrepancy is that in their earlier study Naguib *et al.*[2] list the time to onset of maximum neuromuscular blockade using single twitch stimuli at 1 Hz as 90.9 seconds for atracurium 0.5 $mg \cdot kg^{-1}$, whereas in their more recent study,[1] employing train-of-four stimuli every ten seconds, it was 141.4 seconds for the same dose. Such a large difference may not be explainable on the basis of the type of stimulus employed.[3]

The authors' conclusion that a 0.05 $mg \cdot kg^{-1}$ priming dose of atracurium given three minutes prior to the main dose of 0.45 $mg \cdot kg^{-1}$ gives a reduction of 50 per cent in onset time compared to that of a 0.50 $mg \cdot kg^{-1}$ bolus is rather surprising in light of two other studies. Ramsey *et al.*[4] evaluated a 0.05 $mg \cdot kg^{-1}$ priming dose of atracurium given 4.4 minutes before an intubating dose of 0.35 $mg \cdot kg^{-1}$. As compared to a group receiving a 0.40 $mg \cdot kg^{-1}$ bolus, onset time was not reduced. Weinberg *et al.*[5] found that a 0.05 $mg \cdot kg^{-1}$ priming dose of atracurium given five minutes before a 0.10 $mg \cdot kg^{-1}$ dose again provided no reduction in the time to maximal

neuromuscular blockade, as compared to a single dose of $0.15\ mg \cdot kg^{-1}$.

In light of these inconsistencies and a report by our own[6] group, we feel that priming with atracurium is complicated, time-consuming and not likely to improve intubating conditions, as compared with a single bolus technique. Priming should therefore not be viewed as an established technique. Furthermore, priming doses of vecuronium have been shown to cause serious complications when administered to awake patients.[7,8] A recent case of aspiration due to priming has been reported.[9] A priming dose of $0.05\ mg \cdot kg^{-1}$ of atracurium is not comparable to a defasciculating dose of $0.05\ mg \cdot kg^{-1}$ of d-tubocurarine, as is often given prior to succinylcholine, since the former represents the ED_5[10] while the latter is less than ED_1[11] of the respective relaxants. Thus a degree of clinical paralysis is to be expected with $0.05\ mg \cdot kg^{-1}$ of atracurium, especially in sensitive individuals.[12]

In view of the fact that no study evaluating the effects of $0.05\ mg \cdot kg^{-1}$ of atracurium on awake patients has yet been done, and the several reports questioning the efficacy of priming with this drug, I feel that clinical use of this technique should await further studies.

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REPLY

Thank you for the opportunity to reply to Dr. Sosis' letter.

It is not surprising that Dr. Sosis is questioning the efficacy of the priming principle with atracurium, since he has recently questioned the efficacy of the priming principle with vecuronium as well.[1] The efficacy of the priming principle in accelerating the onset of neuromuscular blockade has been established and substantiated by several authors in different studies.

Dr. Sosis appears to be contradicting his own citation of Blackman's reference. Blackman[2] concluded that "in the presence of tubocurarine, the degree of neuromuscular block was greater the higher the frequency of stimulation." Atracurium, being a nondepolarizing muscle relaxant is expected to behave like tubocurarine, and the difference in the frequency of stimulation employed in our studies can explain the difference in the onset times.[3,4] In these studies we sequentially investigated the priming intervals and the priming dose, and we believe that the priming interval will not be different if the priming dose varies between $0.05–0.06\ mg \cdot kg^{-1}$.

Surprisingly, we found Dr. Sosis in his letter trying to compare the results reported[5] with a much smaller second dose ($0.1\ mg \cdot kg^{-1}$ atracurium) with our results. Weinberg et al.[5] *stated in that study that "direct application or extrapolation of these results to clinical situations employing larger relaxant doses may not be justified, since the dose–response curves for atracurium at high and low doses may not be parallel." The discrepancy observed in the studies reported by Ramsey* et al.[6] *and Sosis* et al.[7] *could be attributed to differences in the methodology. Ramsey* et al.[6] *administered the priming doses of atracurium before the induction of anaesthesia and before the monitoring of neuromuscular function and stabilization of twitch response. Similarly, it appears that Sosis* et al.[7] *allowed only 30 seconds to stabilize the twitch height. This is not sufficient to obtain valid results.[8]*

Although the expression of the intubating conditions by Sosis et al.[7] *as means ±SD has no statistical validity, we agree with Dr. Sosis that the application of the priming principle per se does not improve the intubating conditions, unless an additional dose of thiopentone were to be administered before the intubating (second) dose of relaxant, in order to increase the depth of anaesthesia.[9]*

Dr. Sosis expressed his concern regarding the priming with atracurium as being complicated and time-consuming. However, anaesthetists sometimes administer the defasciculating dose of nondepolarizing muscle relaxants a few minutes prior

to the administration of succinylcholine. In both situations, one would expect to encounter patients who are very sensitive to the initial small dose of nondepolarizing muscle relaxants. Under nitrous oxide-oxygen-thiopentone-narcotic anaesthesia, Gibson et al.[10] *reported that the ED_{50} of atracurium was 0.126 $mg \cdot kg^{-1}$ (using a single dose technique). This was not strikingly less than that of d-tubocurarine (0.192 $mg \cdot kg^{-1}$) calculated under similar conditions.[11] The implication is that vigilance and appropriate precautions are required when employing these techniques. The three-minute priming interval will not necessarily prolong the induction time if the priming dose is given before initiating preoxygenation and induction of anaesthesia. Engbaek* et al.[12] *reported that vecuronium 10 $\mu g \cdot kg^{-1}$, only caused the train-of-four ratio to decrease to 0.86 (range 0.76–0.94), which is well within previously reported limits for adequate respiratory function.[13] Furthermore, Engbaek* et al.[12] *found no significant changes in respiratory frequency, vital capacity, and inspiratory force after vecuronium 10 $\mu g \cdot kg^{-1}$. Peak expiratory flow was decreased from 475 to 460 $L \cdot min^{-1}$ in these patients. These results suggest that adequate ventilation and airway protection should be present in patients who receive vecuronium 10 $\mu g \cdot kg^{-1}$ as a priming dose. This dose was found to be the optimal priming dose for the administration of vecuronium in divided sequence.[14] For vecuronium, ED_{50} during neurolept anaesthesia was found to be 28 $\mu g \cdot kg^{-1}$ with the single bolus injection technique.[15] The optimal priming dose recommended in our study[4] for atracurium is equipotent to that recommended for vecuronium.[14] Therefore, the effects of 0.05 $mg \cdot kg^{-1}$ atracurium on awake patients are not expected to be different from those observed with vecuronium.[12]*

Furthermore, the case reported by Musich and Walts[16] did not convince us that pulmonary aspiration occurred because of the priming technique. Their patient weighed 102 kg, had consumed an unknown quantity of alcohol one hour before an accident and was premedicated with meperidine 100 mg and hydroxyzine 50 mg IM one hour before surgery. This patient was at a higher risk for pulmonary aspiration because of the above mentioned factors and we believe that it is unjustifiable to indicate that the aspiration occurred because of the priming dose of vecuronium, without mentioning the other contributing factors.

The priming principle has been established beyond doubt for various nondepolarizing muscle relaxants by different authors[17–20] and we do not think that the studies cited by Dr. Sosis invalidate the effectiveness of the priming principle. Nevertheless, we believe that the routine clinical application of the priming technique, especially in emergency situations should await further studies.

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