Does Mechanical Massage of the Abdominal Wall After Colectomy Reduce Postoperative Pain and Shorten the Duration of Ileus? Results of a Randomized Study

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The aim of this study was to determine the effectiveness of mechanical abdominal massage on postoperative pain and ileus after colectomy. We hypothesized that parietal abdominal stimulation could counteract induced pain and postoperative ileus, through common spinal-sensitive pathways, with nociceptive visceral messages. After preoperative randomization, 25 patients (age 52 ± 5 years) underwent active mechanical massage by intermittent negative pressure on the abdominal wall resulting in aspiration (Cellu M50 device, LPG, Valence, France), and 25 patients (age 60 ± 6 years) did not receive active mechanical massage (placebo group). Massage sessions began the first day after colectomy and were performed daily until the seventh postoperative day. In the active-massage group, amplitude and frequency were used, which have been shown to be effective in reducing muscular pain, whereas in the placebo group, ineffective parameters were used. Visual analogue scale (VAS) pain scores, doses of analgesics (propacetamol), and delay between surgery and the time to first passage of flatus were assessed. Types and dosages of the anesthetic drugs and the duration of the surgical procedure did not differ between groups. From the second and third postoperative days, respectively, VAS pain scores ($P < 0.001$) and doses of analgesics ($P < 0.05$) were significantly lower in patients receiving active massage compared to the placebo group. Time to first passage of flatus was also significantly shorter in the active-massage group (1.8 ± 0.3 days vs. 3.6 ± 0.4 days, $P < 0.01$). No adverse effects were observed. These results suggest that mechanical massage of the abdominal wall may decrease postoperative pain and ileus after colectomy. (J GASTROINTEST SURG 2002;6:43–49.)

KEY WORDS: Colectomy, postoperative ileus, mechanical massage

Gastrointestinal motility and transit are transiently impaired following abdominal surgery leading to bloating, distention, visceral pain, and emesis. This paralytic state is longer when surgery involves the distal rather than the proximal digestive tract.[1]

The pathogenesis of digestive ileus has not been completely clarified and it appears to be multifactorial. Animal studies have demonstrated that ileus could be related to an inflammatory process—that is, surgical manipulation of the small intestine leads to intense leukocyte infiltration of the intestinal muscularis within 24 hours[2,3] and significant inducible nitric oxide (NO) synthase induction.[4] On the other hand, ileus in the immediate postoperative phase also seems to be the result of an inhibitory nervous reflex facilitating inhibitory autonomic and enteric neural activity, which may lead to inhibition of both small intestine motility and gastrointestinal transit. Sensory input from the gut could promote corticotropin-releasing factor[5] within the paraventricular nucleus of the hypothalamus and the dorsal vagal complex through capsaicin-sensitive afferent reflex pathways.[6] This central neural activity may stimulate an efferent inhibitory motor pathway, thus causing ileus through an increase in adrenergic and nitrergic neuromuscular activity.[7,8]

The modulation of peripheral sensory inputs affects ileus; fedotozine, a kappa-opioid agonist, has been shown to reverse experimental ileus via an action at the peripheral kappa-opioid receptor level.[9,10] Spinal afferent fiber nerve ablation has been reported to reverse postoperative delay of gastrointestinal transit.[11] Immunoneutralization of calcitonin gene-related peptide, a widely distributed neuropeptide in the intrinsic and extrinsic neurons of the gastrointestinal wall involved

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in nociception, has been shown to have a similar effect.[11,12]

Anatomically, digestive primary afferent neurons are connected at the spinal dorsal horn level with somatosensory neurons. This may explain why spinal dorsal horn neuron activity involved in the transmission of nociceptive signals was found to be inhibited by heterotophic noxious conditioning stimuli.[13] Human studies have also demonstrated that painless somatic stimulation can reduce perception of gut distention leading to discomfort without affecting gut tone or reflex gut response.[14] These results were the basis of this study. We hypothesized that somatic stimulation begun in the early postoperative period could interact with digestive sensory input and modify the inhibitory nervous reflex leading to ileus. Abdominal massage could be useful to promote somatic stimulation via nerve stimulation of the skin. Previous studies have shown that massage is effective in relieving somatic pain, that is, cutaneous pain for burn tissues,[15,16] and also lower back pain[17] or premenstrual symptoms.[18]

The aim of this randomized controlled study was to determine if mechanical abdominal massage during the postoperative period after colectomy was effective in reducing postoperative abdominal pain and ileus. To test this hypothesis, two groups of patients were randomized to receive active mechanical massage or sham nonactive mechanical massage (placebo group).

METHODS

Patients

After preoperative randomization on the day before colectomy and after giving informed consent, 25 patients received active mechanical massage of the abdominal wall with a Cellu M50 device (LPG, Valence, France), and 25 patients underwent sham nonactive mechanical massage (placebo group). Patients were excluded from randomization if they were under 18 or over 75 years of age, if they had undergone previous surgery or had to undergo noncurative surgery for their colonic lesions, or if they had had severe neuromuscular, dermatologic, cardiovascular, or psychiatric disease. Obese patients (body mass index >35) were also excluded because effective mechanical massage of the abdomen would be difficult. All types of colectomies (total, right and left) were included. Indications for surgery were colon cancer, diverticular disease, or inflammatory disease (Table 1).

Anesthetic and Surgical Methods

Patients remained in the fasting state for 8 hours before surgery and were premedicated with oral hydroxyzine (1 mg/kg) (UCB Pharma, Nanterre, France) 1 hour before surgery. During general anesthesia, the same drugs were used in all patients including a postsedative inducer (propofol; Diprivan, Zeneca Pharma, Cergy, France) at a dosage of 5 mg/kg/hr after an initial dose of 2 mg/kg; opiates (fentanyl; Fentanyl, Janssen Cilag SA, Issy les Moulineaux, France) by intravenous injection of 2 mg/kg every 20 minutes after an initial dose of 3 mg/kg; and a curaremimetic (Norcuron, Organon-Teknika, Fresnes, France), 0.02 mg/kg every 20 minutes after an initial dose of 0.08 mg/kg. Anesthesia was maintained with isofluorane.

Colectomy was performed through a median laparotomy. After left, right, or total colonic resection, digestive continuity was restored by colocolic, ileocolic, or ileorectal anastomosis, respectively, without ileostomy or colostomy.

Mechanical Massage Device

The massage was performed with a Cellu M50 device (LPG, Valence, France), which powers a computer-driven hand-held massage head that produces intermittent aspiration and induces the formation and mobilization of skin folding. This technique results in the same mechanical massage as a manual massage, but is easier to reproduce.

Massage heads were connected to the vacuum pump by a flexible tube. The vacuum pump creates a

Table 1. Characteristics of patients and features of surgical procedure

	Active massage (n = 25)	Sham massage (n = 25)
Age (yr)	52 ± 5	−60 ± 6
Hamilton test*		
Before surgery	13.6 + 1.1	12.2 + 1.2
7 days after surgery	12.1 + 0.9	12.9 + 1.9
Indications for surgery		
Colon cancer	18	20
Diverticular disease	4	2
Inflammatory bowel disease	3	2
Surgical procedures		
Total colectomy	2	1
Left colectomy	17	19
Right colectomy	6	4
Doses of anesthetic drugs†		
Fentanyl (μg)	1350 ± 132	1210 ± 125
Diprivan (mg)	220 ± 9	232 ± 8
Norcuron (mg)	32 ± 4	29 ± 3
Duration of surgery (min)	145 ± 46	133 ± 14

Values are means ± SEM; no statistical difference was observed between patients receiving active massage and the sham group.
*Determines the anxiety scale by evaluating 14 somatic and psychological items calibrated from 0 (minimal) to 4 (maximal).
†Total preoperative doses of anesthetic drugs.

depression effect, and the level is adjusted and permanently controlled by an electronic regulation system. The smallest massage head was used because there is intermittent suction in the depression chamber resulting in gentler massages. Mechanical stimulation was rhythmic because previous studies have shown that this is less invasive with deeper effects that are not limited to local cutaneous muscular tissue.[19] This device can induce chamber depression ranging from 50 mbar (level 0) to 500 mbar (level 10). The frequency of stimulation varies from 0.08 Hz (depression for 12.2 seconds: level 1) to 12.5 Hz (depression for 0.08 seconds: level 99). Finally, the "on/off" ratio ranged from 1 to 9, with level 5 representing an equal amount of on and off time. The intensity and frequency of stimulation were effective in the active-massage group but were not effective in the placebo group. Efficiency levels were determined according to results obtained during muscular massage to relieve pain. For active massage, the depression intensity was 3 (300 mbar), the frequency was 85 (2.17 Hz), and the on/off ratio was 7. For sham massage, the intensity was 120 mbar (level 1), the frequency was 55 (0.38 Hz), and the on/off ratio was 1. With these parameters there was no suction of the abdominal wall, but patients had a slight sensation of the head rolling on their skin. The device was used according to the manufacturer's instructions throughout the study.

Study Design

Massages were begun on the first day after colectomy and were performed by a single operator (C.B.) once a day until postoperative day 7 with patients in a supine position. The massage head was placed successively along the diaphragm insertions, on the lower abdominal wall along the crural arcades, and finally along the median incision by making concentric ellipses. Each session lasted 15 minutes.

Walking during the postoperative period was standardized, and as of postoperative day 2, patients walked twice a day—once in the morning before the massage session and once in the afternoon.

The level of postoperative pain was assessed by a visual analogue scale (VAS) with scores ranging from 0 (absence of pain) to 10 (significant pain)[20] and by daily doses of chlorhydrate or propacetamol (Pro-dafalgan, UPSA, Rueil Malmaison, France) administered intravenously (2 grams per injection). Pain was assessed on the VAS before mechanical massage, 30 minutes after the end of massage, and then at 2-hour intervals until 12 P.M. On the first two postoperative days, patients routinely received 6 grams of propacetamol per day. When more analgesics were needed to control pain, the total dose could be increased to 8 grams per day. After the second postoperative day, analgesics were only given (2 grams doses) on request by the patient and/or when routine pain evaluation (every 2 hours) showed VAS pain scores above 2. Doses of propacetamol never exceeded 8 grams per day.

The day of the first passage of flatus and/or stool was used to define the duration of postoperative ileus. The duration of postoperative ileus (hours) was defined as the interval between the end of surgery and the first passage of gas or stool through the anus. Eating was allowed once the first gas occurred. No prokinetic drugs were given during the postoperative period.

The following adverse effects of mechanical massage were evaluated: acute painful sensations during or after massage, skin modification, parietal hematomas, and functional digestive symptoms.

Evaluation of outcome was blinded and included assessement of pain scores, daily doses of propacetamol, and the day of first passage of flatus or stool. Evaluations were performed by a clinician (B.C.) who was unaware of the randomization and who did not perform any of the massages (C.B.).

Finally, to determine the patient's degree of anxiety, the Hamilton score was used.[21] This test provides a quantitative evaluation of anxiety based on 14 items (somatic and psychic) scored from 0 (absence) to 4 (maximal intensity) with possible scores ranging from 0 to 60. The Hamilton score was determined in each patient on the day before surgery and at the end of the study on day 7.

Statistical Analysis

No previously published data could be used to accurately calculate the sample size for this trial. In a preliminary study, pain intensity was determined for the first seven postoperative days in 20 colectomized patients. Mean ($\pm$ SEM) VAS pain scores were 8.1 ± 0.9, 7.2 ± 1.1, 7.0 ± 0.8, 5.4 ± 0.6, 5.1 ± 0.3, 4.3 ± 0.2, and 3.1 ± 0, respectively, during the 7 days after surgery. The number of patients in both groups was determined to detect a 25% pain scale difference with 5% alpha and beta error risks.

Data are given as mean $\pm$ SEM. The chi-square test with the Yate's correction was used to analyze qualitative parameters. The Mann-Whitney U test was used to compare quantitative data between the two groups, and the paired Wilcoxon signed-rank test was used to compare quantitative data within each group. One-way analysis of variance was used to assess the influence of postoperative delay on pain intensity and the need for propacetamol, and to investigate significant variations in pain scores and analgesic dosages after each massage session.

RESULTS

The groups did not differ with regard to patient's age, anxiety level before surgery, indications for colectomy and type of colectomy, doses of anesthetic drugs (propofol, fentanyl, curare), and duration of surgery (see Table 1).

The mean VAS pain score was lower from the second to the fifth postoperative day ($P < 0.001$) in the active-massage group compared to in the sham group (Fig. 1). Between the fifth and the seventh day, the pain scores remained lower in the active-massage group, but the difference was not significant. One-way analysis of variance showed that in patients receiving active massage, a significant decrease in the VAS pain score was observed between day 1 and day 4 ($P < 0.04$), whereas in the sham group, the VAS pain score was significantly decreased in comparison to the day after surgery after the fifth postoperative day only ($P < 0.05$).

On each postoperative day, pain intensity varied only slightly with standard errors for interindividual VAS pain scores ranging from 0.7 to 1.3 on day 1 and from 0.2 to 0.3 on day 7. Nevertheless, patients who received active mechanical massage had the lowest daily pain scores 45 minutes after the beginning of massage ($P < 0.05$) (Fig. 2). Moreover, in this group, during the first three postoperative days, the VAS pain score progressively increased in relation to the time (hours) between massage and pain assessment ($P < 0.05$). Pain intensity tended to decrease more slowly in the sham group (see Fig. 2).

Propacetamol doses were lower in the active-massage group than in the placebo group until postoperative day 3 ($P < 0.05$) (Fig. 3). Doses of propacetamol progressively decreased from day 1 to day 4 in patients receiving active massage ($P < 0.03$) (see Fig. 3). In the sham group, doses of analgesic did not decrease significantly during this period.

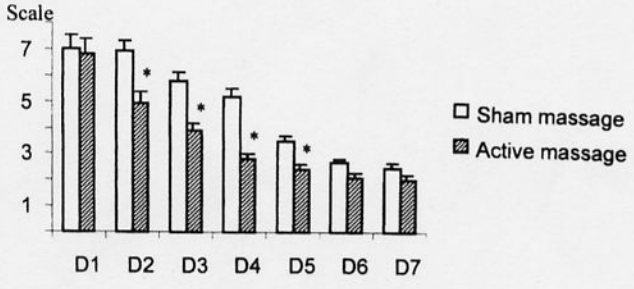

Fig. 1. Pain intensity assessed by visual analogic scale (VAS) during the postoperative period. D = day after surgery. $P < 0.001$ vs. placebo group. By one-way analysis of variance: VAS score decreased when postoperative delay increased; from day 1 to day 4 in the active-massage group ($P < 0.04$), until day 5 in the placebo group ($P < 0.05$).

Flatus preceded the emission of stool in all patients. Time to first passage of flatus was shorter in patients who received active massage than in the placebo group (1.8 ± 0.3 days vs. 3.6 ± 0.3 days, $P < 0.01$). Fig. 4 shows a trend toward a relationship between the early onset of flatus and a low pain score.

Time to discharge from the hospital did not differ between the two groups: 8.1 ± 0.1 days in the active-massage group and 7.6 ± 0.1 days in the placebo group.

No significant changes in the Hamilton anxiety scores were observed between the day before surgery and postoperative day 7 in either group, and at the end of the study anxiety scores did not differ between the two groups.

None of the patients complained of acute abdominal pain during massage, and no adverse effects from massage were observed.

DISCUSSION

This randomized controlled study shows that after colectomy, in comparison to standard management with analgesics alone, mechanical massage of the abdominal wall reduced both the duration of ileus and the intensity of postoperative pain assessed directly by

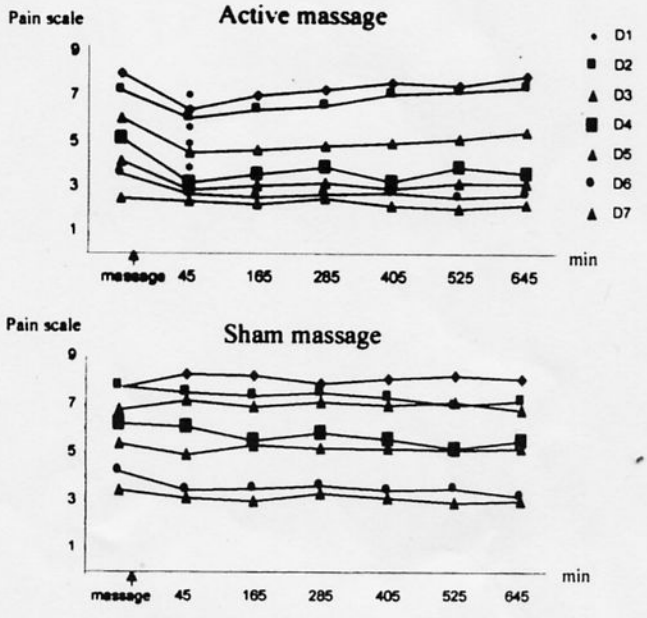

Fig. 2. Daily variations in pain intensity assessed by visual analogic scale (VAS) for each postoperative day in patients receiving active massage and in the sham group. D = day after surgery. $P < 0.05$ vs. VAS pain score before massage. By one-way analysis of variance: In the actives massage group, VAS scores increased as the delay after massage increased ($P < 0.05$).

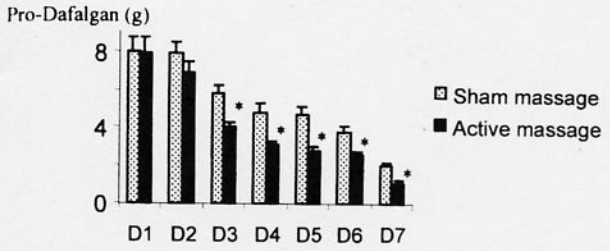

Fig. 3. Propracetamol doses during the postoperative period. D = day after surgery. $P < 0.05$ vs. sham-massage group. By one-way analysis of variance: Doses of propacetamol decreased as the postoperative delay increased (between day 1 and day 4) in the active-massage group ($P < 0.05$).

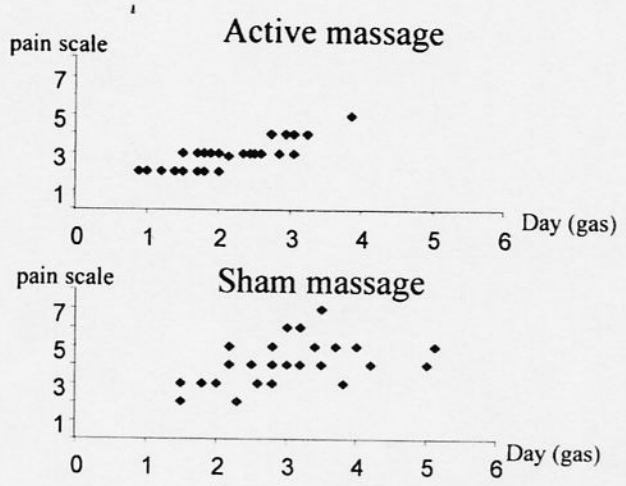

Fig. 4. Relation between duration of ileus and VAS pain scale.

VAS scores and indirectly by the dosages of analgesics required by the patients. These differences were obtained in comparison to a control group in which postoperative pain and the duration of ileus were similar to what was reported in the literature.[1,22] Furthermore, this study emphasizes that, even in the early postoperative period, massage was well tolerated, as evidenced by the fact that none of the patients complained of acute abdominal pain during massage and no adverse effects were observed. The design of this study does not allow us to calculate a cost/benefit ratio or to demonstrate any decrease in time to discharge because the duration of the hospital stay was 7 days for all patients even when, as was the case in several patients, significant improvement in pain and a short duration of ileus would have allowed hospital discharge before the seventh postoperative day.

The trial was performed in patients undergoing curative colectomy only. By chosing a single, well-standardized surgical procedure, we were able to evaluate the effects of massage in a homogeneous group of patients without taking into account possible differences related to various types of surgery. The lack of difference in the duration of the surgical procedure and the dosages of anesthetic received during surgery also facilitate comparisons between the groups. Colonic surgery was selected because we thought it would be the best way to demonstrate the potential benefits of this technique. Indeed, the paralytic state is usually longer when surgery affects the distal rather than the proximal gastrointestinal tract.[1]

This study was performed in patients with severe abdominal pain. Data on the pain scores in our preliminary study were confirmed in this trial by showing that in the early postoperative period, VAS pain scores varied from 7 to 8 on a scale of 0 to 10. Therefore, for ethical reasons, we did not propose massage therapy alone for patients in the active-massage group. Patients systemically received a daily dose of analgesics of 6 grams for the first 2 days of the study. Thus in the early postoperative period, the results obtained were based on a combination of abdominal massage and analgesics.

The duration of daily massage was set at 15 minutes because we believed that prolonged massage might not be well tolerated by patients with a recent laparotomy scar. This duration was chosen in reference to the duration of massage for other pathologic situations such as the treatment of burn scars.[19] A short duration of treatment is also a feature of nonpharmaceutical treatments such as acupuncture.[23,24] This study showed the therapeutic benefit of massage on pain and ileus with this duration of treatment, and changes in the VAS pain score in the first 4 days after surgery suggest that a second session of massage, in the late afternoon, could have been beneficial to avoid the progressive increase in pain when the delay between massage and pain assessment was longer. The parameters selected for the Cellu M50 device (intensity and frequency of vacuum depression, on/off ratio for the use of the device) were also chosen on the basis of parameters to improve muscular pain.[19] In two pilot studies that assessed the efficacy of massage to improve pain in irritable bowel syndrome [25,26] or in the treatment of pelvic pain,[27] patients had global massages involving both the anterior and the posterior abdominal walls. For reasons of tolerance we only performed an anterior abdominal massage in patients in a supine position to avoid moving the patient in the very early postoperative period.

The mechanism involved in the clinical efficacy of massage remains unclear. Several massage studies have shown reduced pain associated with decreased stress and anxiety for painful procedures and conditions including labor pain,[27] debridement procedures (skin brushing) for burn patients,[15,16] and low back

pain.[17] The patients enrolled in this study had low anxiety levels assessed by the Hamilton score on entry in the study. Moreover, if massage really had a beneficial effect on abdominal pain due to the potential for stress reduction, an improvement in the anxiety score should have been observed after active-massage sessions. However, anxiety scores did not change during this study and remained nonsignificantly different between the two groups. This suggests that massage therapy may not only act as a stress reduction tool. These results also suggest that a somatic stimulation in the early phase after surgery might interact with digestive sensory inputs and modify the inhibitory nervous reflex leading to ileus. Indeed, human studies have demonstrated that painless somatic stimulation can reduce an uncomfortable perception of gut distention without affecting gut tone or reflex gut responses.[14] Somatic stimulation was different in the two groups. In the active-massage group, the stimulation parameters led to gut wall aspiration. In contrast, in the sham group the head of the device only induced a slight rolling sensation. Stimulation of the anterior abdominal wall from the epigastrium to the crural area stimulated T6 to T12 dermatomas. In these dermatomas, sensitive fibers are connected in the dorsal horn of the medulla at the same level as sensitive afferences from the small and large intestines. Although our hypothesis on the putative effects of massage on pain are plausible, the design of this study does not allow us to draw definite conclusions. Moreover, we also speculated that the effects of massage on ileus could be related to its effects on pain, but our results do not support this hypothesis as we did not show that ileus ended when the intensity of pain was the lowest. Motor effects could also be due to a somatovisceral reflex induced by the dermatomal stimulation.[28]

CONCLUSION

These results suggest that aspiration massage in the abdominal wall may decrease pain and the duration of ileus after colectomy. Nevertheless, further studies are required to determine the mechanism of action of this promising therapeutic option, to test whether other massage modalities (longer duration, stimulation of another area, particularly dorsal massage) could be beneficial and to determine the cost/benefit ratio of this technique in clinical practice.

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Discussion

Dr. H.C. Sax (Rochester, NY.): The Program Committee should be congratulated for bringing this type of a study to the program as we study mind-body interactions. I have two questions: First, did every patient have a midline incision or were there any instances where a transverse incision was used for the right colon where muscle is cut?

The second question is for those of us who do, for example, bariatric surgery, where a patient may be excited about having surgery, it is really surprising how little analgesia is needed. Were all patients counseled ahead of time that this massage would help postoperative pain, even if they were going to be randomized to the sham group, and among those who did received a sham massage, did they really understand that this was a sham? In other words, could they tell the difference?

Dr. P. Ducrotte: Concerning your first question, the incision was standardized and all patients had a midline incision.

I need to describe what constitutes a sham massage, because patients were unaware of whether they had a sham or active massage. Indeed, during the sham massage, the massaging head of the device rolled on the abdominal wall without creating any depression.

Dr. B.L. Bass (Baltimore, Md.): I am wondering about the logistics of the procedure. How much will this treatment cost and how much time will it take a nurse or therapist to administer? What was the duration of each massage and how long did the effect last? How much does the massage device cost? Is this conceivably a treatment patients could do for themselves as opposed to having someone else do it for them?

Dr. Ducrotte: Concerning the first question, we observed a significant decrease in pain scores in the active-massage group immediately after the massage session. This decrease and the improvement of pain lasted for several hours after the massage session, but we observed each day a trend toward a slow increase in the pain score during the latter part of the day. So we believe that a second session could be beneficial.

Dr. Bass: How long does it take to do the massage?

Dr. Ducrotte: We standardized the duration of the massage to 15 minutes. It is quite empirical because we only considered the usual massage parameters proposed to relieve postoperative pain after burn injuries. Perhaps a longer massage, 20 or 25 minutes, would be more beneficial than a 15-minute massage. This needs to be tested.

Concerning the cost, I do not know what the cost is in the United States. I do not know if this device is distributed in the United States.

Dr. Bass: My third question is whether this could be a self-administered treatment, whether patients can do this massage themselves to avoid having to use nurses or therapists of some sort.

Dr. Ducrotte: I believe it is possible. The technique is quite simple. You have only to roll the massage head on the abdomen and the mechanical massage is automatically delivered by the device.

Dr. M.G. Sarr (Rochester, Minn.): I would be surprised if, in the United States, we would be allowed to give our patients only Tylenol (or paracetamol) for postoperative pain after a celiotomy. My question is, do you think you would achieve the same effect if the patient also had an epidural catheter or was given intravenous morphine. Would the massage have the same beneficial effects?

Dr. Ducrotte: This is a very relevant question, but one that I am unable to answer. I believe it is possible, but we wanted to avoid opiates in this study because we believe that this technique could be an alternative to opiate treatment in the early postoperative period. That is why the patients in our study did not receive opiates.