Preoperative Osteopathic Manipulative Therapy Improves Postoperative Pain and Reduces Opioid Consumption After Total Knee Arthroplasty: A Prospective Comparative Study

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Context: Pain is a therapeutic challenge after total knee arthroplasty (TKA), and it could lead to the overuse of opioids. Few methodologically robust clinical studies have been performed to assess the effectiveness of osteopathic manipulative therapy (OMTh; manipulative care performed by non–US-trained osteopaths) for postsurgical pain.

Objective: To evaluate the effectiveness of standardized preoperative OMTh on early postoperative pain and opioid consumption after TKA.

Methods: This comparative, nonrandomized study took place from 2013 to 2015 and included patients who had primary unilateral TKA for osteoarthritis in a knee that had not undergone any previous surgery. Patients were divided into 2 consecutive groups: 1 group received traditional preoperative management, and the other group received associated preoperative OMTh (general OMTh [rhythmic mobilization of all the body joints, from the ankles to the skull, using long-lever manipulation] and myofascial relaxation). The primary evaluation criterion was knee pain at rest 1 month after surgery: 0 (no pain) to 100 (the worst imaginable pain). The secondary evaluation criteria were: (1) knee pain while walking 1 month after surgery, (2) average weekly knee pain during the first month after surgery, (3) the presence of night pain and the consumption of sleeping pills and opioids or morphine at least once per week, (4) the International Knee Society scores and the Western Ontario and McMaster University Osteoarthritis index at postoperative 6 months and 1 year. The number of patients needed for a superiority trial was determined.

Results: No eligible patient refused OMTh when proposed. Seventy patients were evaluated (mean [SD] age, 75 [8] years; 47 women and 23 men). The 2 treatment groups contained 35 patients each. At postoperative month 1, the OMTh group had significantly less pain at rest (mean [SD], 6.8 [6] vs 20.9 [17.3]; P=.00001) and while walking (7.9 [9.4] vs 23.5 [20.6]; P=.0001) compared with the group that received traditional preoperative management. The consumption of opioids during the first postoperative week was significantly lower in the OMTh group (P=.0001). No statistically significant difference was found in the International Knee Society or Western Ontario and McMaster University Osteoarthritis scores between the 2 groups at 6 months and 1 year of follow-up.

Conclusion: Standardized preoperative OMTh was found to be effective in reducing pain in the first month after TKA for osteoarthritis and significantly reduced opioid consumption during the first postoperative week.

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Approximately 20% of patients who undergo total knee arthroplasty (TKA) are not satisfied with the results 1 year or more after surgery.[1,2] This dissatisfaction is mainly because of persistent pain or insufficient functional recovery. Pain with no apparent cause is a therapeutic challenge for surgeons after TKA.[3] The severity of preoperative pain and the preoperative consumption of opioids are risk factors for more severe immediate postoperative pain and increased morphine consumption.[4-7] The presence of severe postoperative pain after TKA increases the risk of postoperative pain 1 year after surgery by 10.[8] Studies about perioperative mobility have reported a strong relationship between the preoperative functional status of the knee and return to activities with the knee at 6 months of follow-up.[9]

Inflammation found in advanced osteoarthritis of the knee can cause preoperative pain in patients with osteoarthritis of the knee. Deterioration of articular tissue releases pronociceptive mediators that sensitize nociceptors.[6] Moreover, pain may be due to the myofascial tension of peripheral tissue, in particular in the gastrocnemius muscles.[10] Thus, improving preoperative status could significantly improve the patient's postoperative status.

According to the World Health Organization,[11] osteopathy, or a system of manipulative care provided by non–US-trained DOs, or osteopaths, is based on the use of manual contact for diagnosis and management. The practice of osteopathy and training is regulated in numerous countries outside the United States. Osteopaths take a holistic approach and use many different manual techniques to improve physiologic functions that have been modified by somatic dysfunctions. Osteopathy could reduce clinical inflammation, as well as tensions in joints. However, few methodologically robust clinical studies have been performed in this field.

The current study evaluated the effectiveness of standardized preoperative osteopathic manipulative therapy (OMTh; manipulative care provided by non–US-trained osteopaths) before TKA on early postoperative pain and opioid consumption and the effect of preoperative OMTh on pain and knee function at 1 year of follow-up. The main hypothesis was that this management protocol would result in less severe early postoperative pain.

Methods

A prospective, nonrandomized, comparative study was performed between 2013 and 2015. The study obtained patient consent and was approved by the institutional review board of *Comité de Protection des Personnes Ile de France VI*, recorded in an international register before including the first patient, and adhered to the applicable Consolidated Standards of Reporting Trials guidelines.

Primary TKA for osteoarthritis of the knee was the inclusion criterion. Exclusion criteria were a history of surgery on the operated knee, bilateral TKA in the same operation, and patient refusal. Patients were divided into 2 groups: the OMTh group, who received preoperative OMTh, and the non-OMTh group, who received traditional preoperative management. Patient groups were formed in 3 periods. For the first 3 months, OMTh patients were placed in the OMTh group. In the next 3 months, non-OMTh patients were placed in the non-OMTh group.

Preoperative OMTh Protocol

OMTh was performed by the same osteopath (P.B.), and 2 consultations were included in the protocol: 3 weeks and 1 week before TKA. General OMTh was used during the first visit[12,13] and involved the rhythmic mobilization of all of the body joints, from the ankles to the skull, using long-lever manipulation (**video**). During the second visit, all techniques for myofascial relaxation of the involved lower limb and the pelvis were used.[14] These techniques involved applying appropriate pressure to the areas being treated, allowing the practitioner to feel tissue movement, and continuing until the treated structures relaxed. The different anatomic regions were always treated in the same order: ankle, leg and interosseous membrane, knee, hip, and pelvis (**Figure 1**).

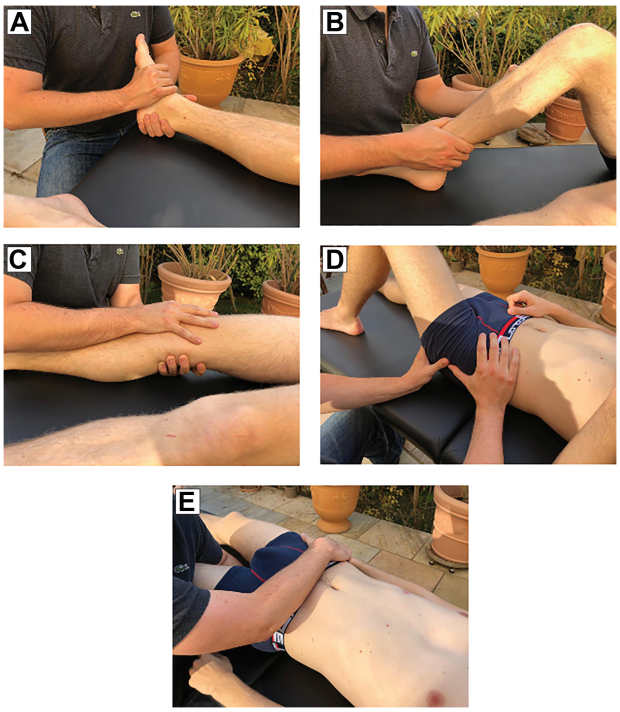

Figure 1.
Fascial techniques performed in chronological order: (A) ankle technique, talar-calcanear placement; (B) interosseous membrane technique, placement of the thumbs and the fingers of the cephalic hand between the tibia and the fibula; (C) knee technique, anteroposterior placement; (D) hip technique, the cephalic hand covers the iliac crest, the caudal hand is placed on the ischium, and both thumbs press on the great trochanter; (E) pelvic technique, one hand is placed under the sacrum and the forearm and the other hand encompasses the pelvis by resting on the anterior superior iliac spine.

Anesthesia and Postoperative Pain Management Protocol

General anesthesia was administered during the operation, but in case of a contraindication, spinal anesthesia was used. A femoral catheter was placed with ultrasonography guidance, and 20 mL of ropivacaine 7.5 mg/mL was administered. The patients received 2 to 3 mg/kg of propofol at induction, During the operation, 0.2 to 0.3 µg/kg of sufentanil, 0.5 mg/kg of atracurium, and 0.15 mg/kg of ketamine were administered as needed. Anesthesia was maintained by inhalation of sevoflurane or desflurane (1 minimum alveolar concentration) in a mixture of 50% oxygen and 50% nitrous oxide. Patients received 8 mg of dexamethasone to prevent postoperative nausea and vomiting. Spinal anesthesia was performed in the operating room with a 27-gauge, cone-shaped needle with the patient in the sitting position. The patient was administered a slow injection of 2 to 2.5 mL of hyperbaric bupivacaine 0.5%. Prophylactic antibiotics were administered according to the usual recommendations, with 1.5 g of cefazoline or 600 mg of clindamycin by slow intravenous delivery.

Administration of analgesic treatment began 45 minutes to 1 hour before the end of surgery and included 1 g of paracetamol, 20 mg of nefopam, and 100 mg of ketoprofen in the absence of contraindications to nonsteroidal anti-inflammatory drugs. The surgeon also administered a local infiltration of 20 mL of ropivacaine 3.75 mg/mL in the posterior capsule. In the recovery room, patients received a titration of morphine with 1 mg/mL of droperidol at 6 to 8 bolus/hour

and 2 mg/mL of ropivacaine in the femoral catheter at 8 mL/hour.

The postoperative femoral catheter was maintained for 72 hours, and morphine was administered on demand. Oral analgesic treatment was as follows: 1 g of paracetamol 3 times per day, 20 mg of nefopam up to 4 times per day, and 100 mg of ketoprofen 2 times per day for the first 72 hours in the absence of any contraindications. If necessary, the daily analgesic protocol for the first month included 1 g of paracetamol 4 times, 20 mg of nefopam 4 times, and 100 mg of tramadol twice.

Surgical Protocol

A medial parapatellar midvastus approach was used. The HIFIT (Ceraver) cemented prosthesis was used in all patients in the study. The incision was closed on an articular Redon drain which was kept in place for a maximum of 2 days. The patients placed weight on their knee on day 1 and started physical rehabilitation with a physical therapist.

Study Design and Data Collection

Patients were invited to participate in the study during the anesthesia consultation when there was an indication for TKA. Prospective data collection alone was performed in the non-OMTh group. These patients were unaware of the existence of the OMTh group. OMTh was only offered to the patients in the OMTh group, and the osteopath contacted them to organize 2 consultations. At inclusion, a notebook was provided to all patients with a visual analogic scale (VAS) from 0 (no pain) to 100 (the worst imaginable pain) for pain.

During the first postoperative month, patients had to fill out the VAS daily on awakening and at the end of the day. Patients noted the presence or absence of night pain, any consumption of sleeping pills, and the name and quantity of analgesics consumed. Patients returned for 1 month, 6 months, and 1 year of follow-up. The IKS (International Knee Society) knee and function scores,[15] and the WOMAC (Western Ontario and McMaster Universities Osteoarthritis) index,[16] were filled out by the patients and the surgeon before surgery and 6 months and 1 year after surgery.

Evaluation

The primary evaluation was having pain in the operated knee at rest and 1 month after surgery on the VAS. The secondary evaluation included (1) knee pain while walking 1 month after surgery, (2) average weekly knee pain during the first month after surgery, (3) the presence of night pain and the consumption of sleeping pills and opioids or morphine at least once per week, and (4) IKS scores and the WOMAC index at 6 months and 1 year postoperative.

Statistical Analyses

Stata/IC software, version 10.0 (StataCorp) was used. Because of the absence of published results, we based the number of patients necessary on a difference that was considered to be clinically pertinent in mean (SD) VAS score at rest of 15 (20), an α risk of .05, and a power of .80. A per-protocol analysis was planned, and researchers included only data from patients who strictly adhered to the protocol. Patients who had an adverse event during follow-up that was likely to modify the pain assessment were excluded from analysis. The hypotheses of normality and equality of variance were confirmed by the Shapiro-Wilk and Bartlett tests, respectively. Quantitative variables were tested by the *t* test for independent groups or paired groups (before/after) and binary variables by the χ^2 test. An analysis of variance of repeated measures was performed to compare mean pain between the 2 groups for the first month. $P<.05$ was considered to be significant.

Results

Patient Characteristics

During the study period, 81 patients were eligible and were included in the study. Seventy patients were evaluated at 1 month of follow-up, 35 in each group (**Figure 2**). None of the patients in the OMTh group

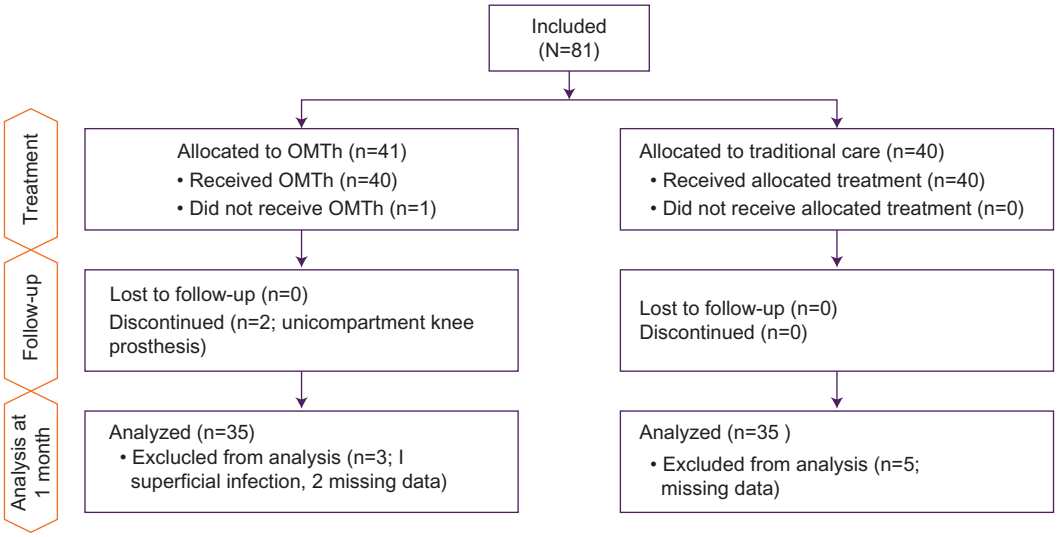

Figure 2.
Study flow-chart. Flow chart of study to evaluate the effectiveness of standardized preoperative OMTh (osteopathic manipulative therapy; manipulative care provided by non–US-trained osteopaths). vs traditional care on early postoperative pain and opioid consumption after total knee arthroplasty.

refused OMTh. Patients were comparable at inclusion (**Table 1**). Mean (SD) pain at rest the day before the intervention was significantly lower in the OMTh group compared with pain before the osteopathy consultation (15.9 [18.8] vs 29 [27.5]; *P*=.006) but not while walking (37.1 [27.5] vs 43.8 [25.3]; *P*=.22).

Primary Evaluation Criteria

Knee pain was significantly less severe at 1 month of follow-up in the OMTh group at rest (mean [SD], 6.8 [6] vs 20.9 [17.3]; *P*=.001) and while walking (7.9 [9.4] vs 23.5 [20.6]; *P*=.001). The mean pain was 3 times more severe in the non-OMTh group compared with the OMTh group at rest and while walking.

Secondary Evaluation Criteria

During the first postoperative month, mean weekly knee pain was significantly less severe in the OMTh group both in the morning and evening (**Table 2**). Analysis of variance of repeated measures showed a significant difference in the progression of pain between the 2 groups (*P*=.001; **Figure 3**). In the first postoperative week, 15 patients in the OMTh group (43%) used morphine to manage pain compared with 34 of the patients in the non-OMTh group (97%). At the same time, 16 patients in the OMTh group (46%) used opioids compared with 26 patients in the non-OMTh group (74%). Patients in the OMTh group took significantly less level-2 and -3 analgesics during the first week, but this difference was not found in the next 3 weeks. There was no difference between the 2 groups in night pain or for the consumption of sleeping pills in the first month. The results of the secondary evaluation criteria are shown in **Table 3**.

At 6 months of follow-up, the IKS scores for 62 patients (88.6%) were available and could be analyzed, and the WOMAC index scores for 48 patients (68.6%) were available. At 1 year of follow-up, both scores were available for 36 patients (51.4%). There was no statistically significant difference between these scores at 6 months or 1 year of follow-up, including for pain on the WOMAC index (**Figure 4**).

Discussion

This study found significantly less knee pain in patients in the OMTh group both at rest and walking 1 month

Table 1.
OMTh and Non-OMTh Group Patient Data the Day Before Total Knee Arthroplasty Surgery

	Patient group		
Characteristic	**OMTh (n=35)**	**Non-OMTh (n=35)**	***P* value**
Age, y, mean (SD)	73.9 (8.4)	74.6 (6.6)	.73
Gender, No. (%)			.79
Women	23 (34.3)	24 (68.6)	…
Men	12 (34.3)	11 (31.4)	…
Pain score, No. (%)			.78
ASA	6 (17.1)	6 (17.1)	…
IKS	24 (68.6)	22 (62.9)	…
WOMAC	5 (14.3)	7 (20)	…
Preoperative flexion, degrees	111 (3.8)	108.9 (14.5)	.53
Pain at rest[a]	15.9 (18.8)	21.7 (20.1)	.24
Pain while walking[a]	37.1 (27.5)	46.1 (20.4)	.13
IKS score			
Function[a]	51.5 (18.3)	60.3 (12.5)	.02
Knee[a]	44.6 (16.1)	53.5 (19.2)	.05
WOMAC score			
Pain[b]	204.7 (102.5)	185.1 (77.1)	.37
Stiffness[c]	87.3 (51.4)	71.5 (46.5)	.18
Function[d]	690.5 (313.4)	614.4 (244.1)	.27

[a] Visual analog scale score: 0 (no pain) to 100 (the worst imaginable pain). Measured out of 100.
[b] 5 items rated on visual analog score: 0 (no pain) to 100 (extreme pain). Measured out of 500.
[c] 2 items rated on visual analog score: 0 (no stiffness) to 100 (extreme stiffness). Measured out of 200.
[d] 17 items rated on visual analog scale: 0 (no difficulty) to 100 (extreme difficulty). Measured out of 1700.

Abbreviations: ASA, American Society of Anesthesiologists; IKS, International Knee Society; OMTh, osteopathic manipulative therapy (manipulative care provided by non–US-trained osteopaths); WOMAC, Western Ontario McMaster osteoarthritis index.

after surgery, as well as mean pain throughout the first postoperative month. Patients in the OMTh group also took significantly fewer level-2 and -3 analgesics during the first postoperative week. There was no significant difference between the 2 groups in functional scores at 6 months or 1 year of follow-up.

During the first postoperative week, 43% of patients in the OMTh group used morphine to manage pain compared with 97% of the patients in the non-OMTh group. At the same time, 46% of the patients in the OMTh group consumed opioids compared with 74% of patients in the non-OMTh group (Table 3). This result is important concerning the existing opioid epidemic since abusive consumption of these drugs often begins with a medical prescription, in particular, for joint prostheses.[17]

A 2018 review[18] analyzed the influence of postoperative osteopathic management. Numerous OMTh techniques were evaluated in that review for diverse diseases and surgical interventions. The significant heterogeneity of these variables made it impossible for the authors to respond to the question. A randomized

Table 2.
Knee Pain in the First Postoperative Month After Total Knee Arthroplasty in OMTh and Non-OMTh Groups

	Knee pain, mean (SD)		
Postoperative week	OMTh (n=35)	Non-OMTh (n=35)	*P* value
Morning			
1	12.3 (11.7)	39.4 (20.9)	.001
2	11 (11.4)	31.5 (21.6)	.001
3	9.6 (9.5)	27.6 (21.4)	.001
4	6.9 (5.6)	23.3 (19.4)	.001
Evening			
1	15.8 (14)	40.3 (22.5)	.001
2	16.1 (16)	34.4 (23)	.001
3	11.9 (10.2)	30.3 (23.3)	.001
4	8.8 (8.1)	25.6 (22.1)	.001

Abbreviations: OMTh, osteopathic manipulative therapy (manipulative care provided by non–US-trained osteopaths).

comparative study by Licciardone et al[19] evaluated the role of postoperative osteopathic manipulative treatment (treatment provided by US osteopathic physicians) after knee or hip arthroplasty. There were numerous evaluation criteria and only the functional autonomy score was significant between the 2 groups.

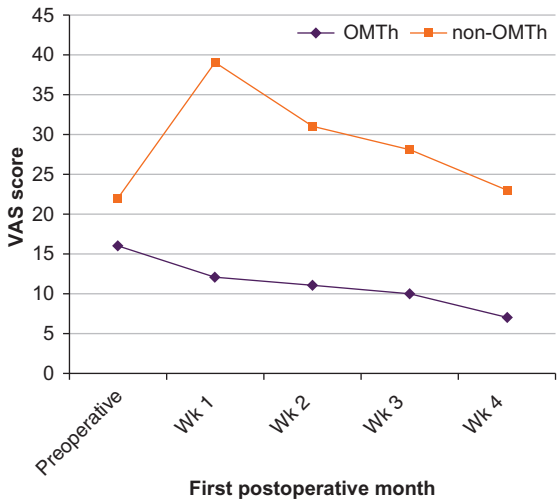

Figure 3.
Evolution of pain during the first month in the osteopathic manipulative therapy (OMTh; manipulative care provided by non–US-trained osteopaths) and non-OMTh groups. The progression of pain was assessed based on visual analogic scale (VAS) from 0 (no pain) to 100 (worst imaginable pain).

Table 3.
Percentage of OMTh and Non-OMTh Patients Who Consumed Pain Medication, Sleeping Pills, or Had Night Pain During the First Postoperative Month After Total Knee Arthroplasty

	Patient group, No. (%)		
Postoperative week	OMTh (n=35)	Non-OMTh (n=35)	*P* value
Morphine derivatives			
1	15 (42.9)	34 (97.1)	.001
2	3 (8.6)	5 (14.3)	.45
3	3 (8.6)	3 (8.6)	.99
4	1 (2.9)	3 (8.6)	.30
Level-2 analgesics			
1	16 (45.7)	26 (74.3)	.01
2	13 (37.1)	18 (51.4)	.23
3	12 (34.3)	17 (48.6)	.22
4	12 (34.3)	16 (45.7)	.33
Sleeping pills			
1	8 (22.9)	13 (37.1)	.19
2	7 (20)	9 (25.7)	.57
3	5 (14.3)	9 (25.7)	.23
4	5 (14.3)	7 (20)	.53
Night pain once per wk			
1	29 (82.9)	32 (91.4)	.28
2	18 (51.4)	24 (68.6)	.14
3	21 (60)	19 (54.3)	.63
4	17 (48.6)	18 (51.4)	.81

Abbreviation: OMTh, osteopathic manipulative therapy (manipulative care provided by non–US-trained osteopaths).

Osteopathic manipulative treatment and OMTh include numerous techniques and is applied to the area being studied according to a specific protocol.[19-21] Other studies[19,22,23] allowed the health care professional to choose the different techniques and areas to be worked on for each patient and included a varying number of manipulations for each patient. While individualized management is an integral part of osteopathic practice, it is also an important bias in a study. The OMTh protocol used in the current study was standardized for the entire body. This made it possible to treat soft, periarticular tissue and somatic dysfunctions that were anatomically at a distance from the knee.[24] The goal of the first session with general OMTh was to promote good vascular and lymphatic physiologic function to improve inflammation in the knee. Manipulation of the fascia was added for similar reasons, although it was only applied to the leg that was operated on and the pelvis. The second session, including fascial techniques, reinforced the results of the first session while more specifically focusing on the structures that were undergoing surgery.

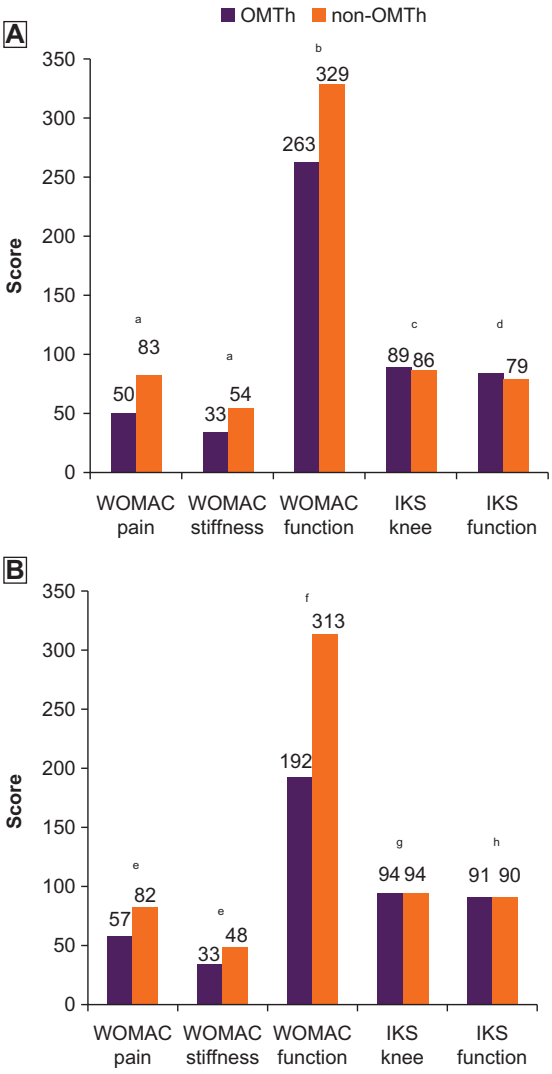

Figure 4.
Western Ontario and McMaster Universities Osteoarthritis (WOMAC) index and International Knee Society (IKS) scores at (A) 6 months and (B) 1 year of follow-up. [a]*P*=11; [b]*P*=.42; [c]*P*=.38; [d]*P*=.17, [e]*P*=.21; [f]*P*=.15; [g]*P*=.99; [h]*P*=.75. Abbreviation: OMTh, osteopathic manipulative therapy (manipulative care provided by non–US-trained osteopaths).

The effectiveness of other nonpharmacologic therapies was assessed in patients with osteoarthritic knee pain.[25] Helianthi et al[6] demonstrated in a randomized controlled trial that active laser acupuncture is effective in reducing pain and improving functional outcomes in geriatric patients with knee osteoarthritis. Aciksoz et al[27] found that both hot and cold applications resulted in a mild improvement in pain, functional status, and quality of life in patients with primary knee osteoarthritis. However, this difference was not significant compared with the non-OMTh group, which received standard osteoarthritis management.

The current study has several limitations. There was no placebo, because it is difficult to provide a credible manipulation technique that would have no physiologic effect on the patient. To compensate for this limitation, and because of the increase in the number of patients who now receive osteopathy in the general population, we did not inform the non-OMTh group about the OMTh group to avoid influencing their self-administered evaluations. Additionally, functional scores were not available for many patients at 6 months and 1 year of follow-up. Thus, we could not evaluate the power of OMTh on knee function. Finally, OMTh was standardized, which does not always correspond to the traditional OMTh used in daily practice.

Conclusion

This study's findings show that a standardized preoperative OMTh protocol performed before TKA significantly improved postoperative pain at 1 month of follow-up and during the first month after surgery. It also significantly reduced the consumption of morphine and opioids during postoperative week 1.

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Author Contributions

All authors provided substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; all authors drafted the article or revised it critically for important intellectual content; all authors gave final approval of the version of the article to be published; and all authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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