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Original Article

Effectiveness of Osteopathic Manipulative Treatment versus Tai Chi on Mobility, Balance, and Pain Alleviation in Elderly Patients with Knee Osteoarthritis

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ABSTRACT

Background: Knee osteoarthritis is a common degenerative joint disorder in older adults, frequently associated with chronic pain, stiffness, impaired mobility, poor balance, reduced gait performance, and functional limitation. Non-pharmacological rehabilitation strategies such as Osteopathic Manipulative Treatment and Tai Chi may offer clinically useful benefits by targeting different mechanisms of impairment. Objective: To compare the effectiveness of Osteopathic Manipulative Treatment and Tai Chi on pain, physical function, mobility, balance, and gait speed in elderly patients with knee osteoarthritis. Methods: A single-blind randomized controlled trial included 60 elderly participants aged 60–80 years with clinically and radiographically confirmed knee osteoarthritis. Participants were allocated equally into Osteopathic Manipulative Treatment, Tai Chi, and standard-care control groups. The intervention groups received 45-minute sessions twice weekly for 12 weeks. Outcomes were assessed at baseline and post-intervention using the Western Ontario and McMaster Universities Osteoarthritis Index, Timed Up and Go test, Berg Balance Scale, Numeric Pain Rating Scale, and 10-meter walk test. Results: Both Osteopathic Manipulative Treatment and Tai Chi produced greater improvements than standard care. Osteopathic Manipulative Treatment showed larger descriptive reductions in WOMAC pain, WOMAC function, and Numeric Pain Rating Scale scores, while Tai Chi showed greater descriptive improvements in Timed Up and Go performance, Berg Balance Scale score, and gait speed. Conclusion: Both interventions were effective non-pharmacological approaches for elderly patients with knee osteoarthritis. Osteopathic Manipulative Treatment may be more beneficial for pain and stiffness reduction, whereas Tai Chi may be preferable for improving balance, gait, and functional mobility. Keywords: Knee osteoarthritis; Osteopathic Manipulative Treatment; Tai Chi; elderly; pain; balance; mobility; gait speed; WOMAC.

INTRODUCTION

Knee osteoarthritis is one of the most common degenerative musculoskeletal disorders affecting older adults and remains a major contributor to chronic pain, impaired mobility, functional limitation, and reduced quality of life. The condition is characterized by progressive articular cartilage degeneration, osteophyte formation, synovial inflammation, periarticular muscle weakness, and altered joint biomechanics, all of which contribute to pain, stiffness, reduced walking capacity, and impaired postural

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control in elderly individuals (1). As the global population ages, knee osteoarthritis has become an increasingly important public health concern because it restricts independence, increases fall risk, limits participation in daily activities, and contributes to long-term disability among older adults (2).

Conventional management of knee osteoarthritis commonly includes patient education, analgesics, non-steroidal anti-inflammatory drugs, therapeutic exercise, and physical rehabilitation. Although pharmacological treatment may provide symptomatic relief, long-term use of analgesics and non-steroidal anti-inflammatory drugs in elderly populations is limited by gastrointestinal, renal, cardiovascular, and medication-interaction risks (3). These concerns have increased interest in safe, non-pharmacological and integrative interventions that can reduce pain while also improving functional mobility, balance, and gait performance. Rehabilitation strategies that address both symptoms and movement dysfunction are particularly important because pain-related inactivity and impaired neuromuscular control may accelerate functional decline and increase the likelihood of falls in older adults with knee osteoarthritis (4).

Osteopathic Manipulative Treatment is a hands-on therapeutic approach designed to improve musculoskeletal function through techniques targeting joint mobility, soft-tissue restrictions, myofascial dysfunction, and neuromuscular regulation. In patients with musculoskeletal pain, manual and osteopathic interventions may reduce nociceptive input, improve local tissue mobility, enhance proprioceptive feedback, and restore more efficient movement mechanics (5). For elderly patients with knee osteoarthritis, these effects may be clinically relevant because pain, stiffness, periarticular soft-tissue restriction, and altered lower-limb mechanics are central contributors to disability. However, despite growing interest in manual therapy for osteoarthritic conditions, the evidence specifically examining Osteopathic Manipulative Treatment for knee osteoarthritis remains comparatively limited, particularly in older adults and in trials that include balance and mobility outcomes alongside pain measures (6).

Tai Chi is a low-impact mind–body exercise involving slow, controlled, rhythmic movements coordinated with breathing, weight shifting, postural alignment, and focused attention. It is increasingly used in rehabilitation for older adults because it targets several domains relevant to knee osteoarthritis, including lower-limb strength, proprioception, balance, gait coordination, joint range of motion, and confidence in movement (7). Previous research suggests that Tai Chi may improve walking function, postural control, pain, and quality of life in individuals with knee osteoarthritis, particularly when practiced consistently over several weeks (8). Its emphasis on controlled weight transfer and dynamic balance makes it especially relevant for elderly patients who experience instability, reduced mobility, and increased fall risk as a consequence of knee osteoarthritis.

Although both Osteopathic Manipulative Treatment and Tai Chi are non-pharmacological interventions with potential benefits for elderly patients with knee osteoarthritis, they differ substantially in therapeutic mechanism and clinical emphasis. Osteopathic Manipulative Treatment primarily targets pain modulation, joint and soft-tissue mobility, and musculoskeletal dysfunction through therapist-applied manual techniques, whereas Tai Chi emphasizes active neuromuscular training, balance control, postural stability, and functional movement through patient-performed exercise. This distinction creates an important comparative question: whether a manual therapy approach or a movement-based mind–body intervention produces greater improvements in pain, mobility, and balance among older adults with knee osteoarthritis. Direct comparative evidence between these two interventions remains scarce, limiting clinicians' ability to select the most appropriate non-pharmacological strategy for specific functional goals (9).

Therefore, this randomized controlled trial was designed to compare the effectiveness of Osteopathic Manipulative Treatment, Tai Chi, and standard care in elderly patients aged 60–80 years with radiographically confirmed knee osteoarthritis. Using a PICO framework, the population consisted of elderly individuals with knee osteoarthritis; the intervention was Osteopathic Manipulative Treatment;

the comparator was Tai Chi and standard care; and the outcomes included pain, physical function, mobility, balance, pain intensity, and gait speed. The objective of the study was to determine whether Osteopathic Manipulative Treatment or Tai Chi produces superior improvements in mobility, balance performance, and pain alleviation in elderly patients with knee osteoarthritis. It was hypothesized that both interventions would improve pain and functional outcomes compared with standard care, with Osteopathic Manipulative Treatment producing greater pain reduction and Tai Chi producing greater improvements in balance and gait-related performance.

MATERIALS AND METHODS

A single-blind, parallel-group randomized controlled trial was conducted to compare the effects of Osteopathic Manipulative Treatment, Tai Chi, and standard care on pain, mobility, balance, physical function, and gait performance among elderly patients with knee osteoarthritis. The trial was carried out in an outpatient rehabilitation setting at a university medical center, where eligible participants were recruited, screened, enrolled, randomized, treated, and assessed over a 12-week intervention period. The study design was selected to allow direct comparison of two non-pharmacological rehabilitation approaches with standard care while controlling for baseline functional status and repeated outcome measurements over time.

Participants were elderly men and women aged 60–80 years with clinically and radiographically confirmed knee osteoarthritis classified as Kellgren–Lawrence grade II or III. Eligible participants had chronic knee pain lasting more than three months and were able to ambulate independently with or without an assistive device. Participants were excluded if they had undergone knee surgery within the previous six months, had received intra-articular knee injections within the previous three months, had systemic inflammatory arthritis, or had cognitive impairment that could interfere with understanding instructions, providing consent, or complying with the intervention protocol. Participants meeting the eligibility criteria were enrolled after receiving a complete explanation of the study procedures and providing written informed consent.

A total of 60 participants were randomized into three equal groups: Osteopathic Manipulative Treatment, Tai Chi, and standard-care control, with 20 participants allocated to each group. Random allocation was performed after baseline assessment to reduce selection bias and ensure that group assignment did not influence initial outcome measurement. The outcome assessor was blinded to group allocation to minimize measurement bias during post-intervention assessment. Participants were instructed not to disclose their treatment allocation during outcome testing. Baseline demographic and clinical variables, including age, sex, body mass index, knee osteoarthritis diagnosis, pain status, mobility, balance, and functional ability, were recorded before the intervention began.

Participants allocated to the Osteopathic Manipulative Treatment group received standardized 45-minute treatment sessions twice weekly for 12 weeks. Each session focused on improving knee joint mechanics, reducing periarticular soft-tissue restriction, improving regional mobility, and addressing lower-limb and adjacent musculoskeletal asymmetry. Treatment was directed toward the knee joint and related myofascial structures of the lower limb, with attention to biomechanical relationships involving the hip, ankle, pelvis, and surrounding soft tissues. Techniques were applied in a controlled clinical manner according to participant tolerance, pain response, and functional presentation, with the therapeutic aim of reducing pain, improving joint mobility, and enhancing neuromuscular function.

Participants allocated to the Tai Chi group completed a structured Yang-style Tai Chi program consisting of supervised 45-minute sessions twice weekly for 12 weeks. The program emphasized slow, controlled lower-limb movements, weight shifting, knee flexion and extension control, postural alignment, breathing coordination, balance drills, and functional movement transitions. Exercises were performed within a pain-tolerable range and progressed according to participant capacity, postural control, and movement confidence. The intervention was designed to improve dynamic balance, gait stability, lower-

limb coordination, proprioceptive control, and functional mobility in elderly patients with knee osteoarthritis.

Participants allocated to the standard-care control group continued routine conservative management consisting of education and usual physical therapy care. Standard care focused on maintaining activity within tolerance, joint protection guidance, basic therapeutic exercise advice, and routine clinical management for knee osteoarthritis. Participants in the control group did not receive Osteopathic Manipulative Treatment or supervised Tai Chi sessions during the 12-week study period. All groups were followed over the same intervention duration to allow comparable pre- and post-intervention assessment.

Outcome measurements were collected at baseline and after completion of the 12-week intervention period. Pain and physical function were assessed using the Western Ontario and McMaster Universities Osteoarthritis Index, which measures pain, stiffness, and functional limitation related to knee osteoarthritis. Mobility was assessed using the Timed Up and Go test, recorded in seconds, with lower values indicating better functional mobility. Balance performance was measured using the Berg Balance Scale, with higher scores indicating better balance ability. Pain intensity was assessed using the Numeric Pain Rating Scale, and gait speed was evaluated using the 10-meter walk test, reported in meters per second. These outcomes were selected because they represent clinically relevant domains affected by knee osteoarthritis, including pain severity, functional limitation, walking capacity, balance control, and movement efficiency.

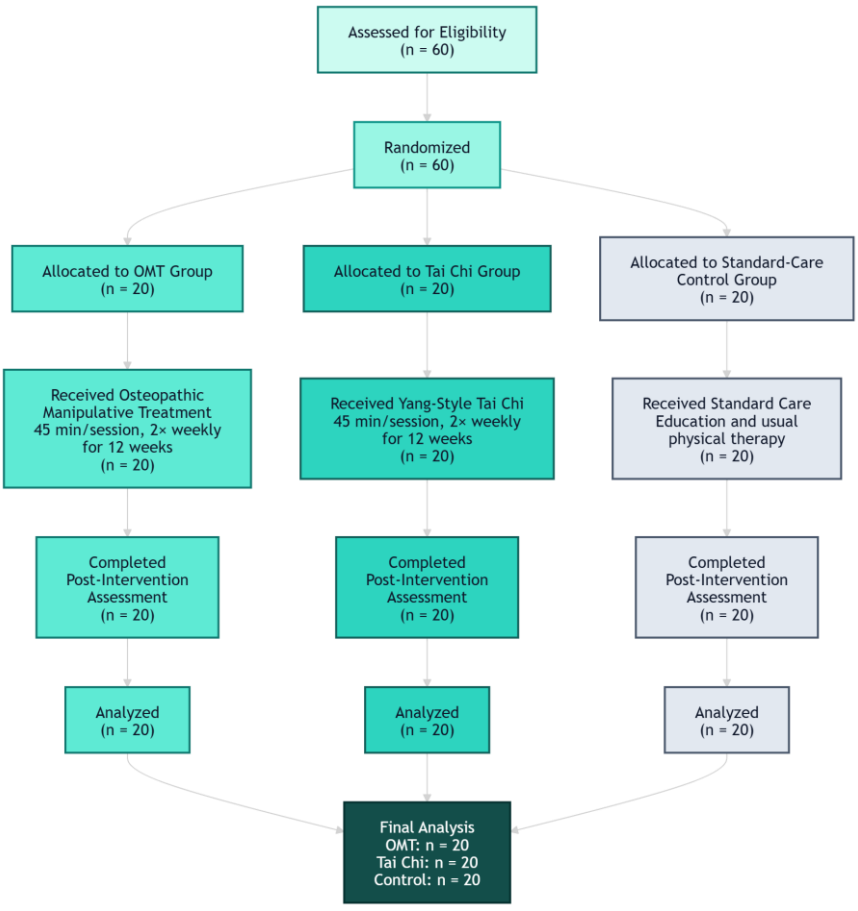

Figure 1. CONSORT Flow Diagram of Participant Allocation, Intervention, Follow-Up, and Analysis

Figure Description: The diagram illustrates the flow of 60 elderly participants with knee osteoarthritis through the randomized controlled trial. All eligible participants were randomized equally into three groups: Osteopathic Manipulative Treatment, Tai Chi, and standard-care control, with 20 participants in each arm. Each intervention was delivered over 12 weeks, followed by post-intervention assessment and

final analysis. No participant attrition was reported in the available dataset, and all 60 randomized participants were included in the final analysis.

The primary outcomes were changes in WOMAC pain and function scores, Timed Up and Go performance, and Berg Balance Scale score from baseline to post-intervention. Secondary outcomes were changes in Numeric Pain Rating Scale score and gait speed. Operationally, improvement in pain was defined as a reduction in WOMAC pain and Numeric Pain Rating Scale scores, improvement in physical function was defined as a reduction in WOMAC function score, improvement in mobility was defined as a reduction in Timed Up and Go completion time, improvement in balance was defined as an increase in Berg Balance Scale score, and improvement in walking performance was defined as an increase in 10-meter walk-test gait speed.

To reduce bias and improve consistency, baseline assessment was completed before group allocation, post-intervention outcomes were measured using the same instruments as baseline, and the same testing procedures were applied across all groups. Participants were assessed under similar clinical conditions, and outcome measurements were recorded using standardized instructions. The intervention duration and session frequency were kept identical for the Osteopathic Manipulative Treatment and Tai Chi groups to reduce performance-related imbalance between active treatments. Group allocation was concealed from the outcome assessor, and participants were reminded during follow-up assessment not to reveal their intervention group.

Data were analyzed using repeated-measures analysis of variance to examine within-group changes over time, between-group differences, and group-by-time interaction effects across the three study arms. Post hoc comparisons were used to identify pairwise differences between the Osteopathic Manipulative Treatment, Tai Chi, and standard-care control groups when significant main or interaction effects were present. Continuous variables were summarized as mean and standard deviation, while categorical variables were summarized as frequencies and percentages. Statistical significance was set at $p<0.05$. Effect sizes were calculated using Cohen's d to estimate the magnitude of intervention-related change. The analysis plan included comparison of baseline and post-intervention values for WOMAC, Timed Up and Go, Berg Balance Scale, Numeric Pain Rating Scale, and gait speed, with interpretation based on both statistical significance and clinical direction of change.

Ethical conduct was maintained throughout the study by obtaining written informed consent from all participants before enrollment, preserving participant confidentiality, and ensuring that all assessments and interventions were conducted in accordance with accepted clinical research principles. Participants were allowed to continue routine care as appropriate and were monitored during intervention sessions for pain aggravation, fatigue, dizziness, instability, or other adverse responses. Data integrity was maintained by using standardized outcome forms, consistent timing of assessments, secure data recording, and predefined statistical procedures. The study procedures were designed to allow reproducibility by clearly specifying the population, intervention dose, comparator condition, outcome measures, assessment timing, and statistical analysis approach.

RESULTS

A total of 60 elderly participants with knee osteoarthritis were included and allocated equally into three groups: Osteopathic Manipulative Treatment, Tai Chi, and standard-care control, with 20 participants in each group. The mean age was comparable across the groups, ranging from 70.6 ± 6.4 years in the Tai Chi group to 71.8 ± 5.4 years in the control group. Female participants represented 70% of the OMT group, 65% of the Tai Chi group, and 68% of the control group. Mean body mass index was also similar across groups, ranging from 27.9 ± 3.8 kg/m² in the Tai Chi group to 28.7 ± 3.2 kg/m² in the OMT group. Baseline comparison showed no meaningful difference in age or body mass index among the three groups.

Table 1. Baseline Demographic Characteristics of Participants

Variable	OMT Group (n=20)	Tai Chi Group (n=20)	Control Group (n=20)	Between-Group p-value
Age, years	71.2 ± 5.9	70.6 ± 6.4	71.8 ± 5.4	0.815
Female, %	70%	65%	68%	
BMI, kg/m²	28.7 ± 3.2	27.9 ± 3.8	28.3 ± 3.5	0.772

Pain and functional outcomes improved more prominently in the OMT and Tai Chi groups than in the control group. WOMAC pain decreased from 12.8 ± 3.1 to 7.2 ± 2.8 in the OMT group, representing a mean reduction of 5.6 points and a large standardized effect size of 1.90. The Tai Chi group also improved, with WOMAC pain decreasing from 12.3 ± 3.4 to 8.6 ± 3.1, corresponding to a 3.7-point reduction and an effect size of 1.14. In contrast, the control group showed only a 0.7-point reduction. WOMAC function improved by 14.1 points in the OMT group and 10.1 points in the Tai Chi group, compared with a 1.5-point improvement in the control group. These findings indicate larger functional gains in both active intervention groups, with the greatest descriptive improvement observed after OMT.

Table 2. Changes in WOMAC Pain and Functional Scores After 12 Weeks

Outcome	Group	Baseline Mean ± SD	Post-Intervention Mean ± SD	Mean Change	Standardized Effect Size	Reported p-value
WOMAC Pain	OMT	12.8 ± 3.1	7.2 ± 2.8	-5.6	1.90	<0.05
WOMAC Pain	Tai Chi	12.3 ± 3.4	8.6 ± 3.1	-3.7	1.14	<0.05
WOMAC Pain	Control	12.6 ± 3.2	11.9 ± 3.3	-0.7	0.22	
WOMAC Function	OMT	46.5 ± 7.8	32.4 ± 6.9	-14.1	1.92	<0.05
WOMAC Function	Tai Chi	45.9 ± 8.1	35.8 ± 7.0	-10.1	1.33	<0.05
WOMAC Function	Control	46.2 ± 7.5	44.7 ± 7.6	-1.5	0.20	

Mobility improved in both intervention groups, as shown by reductions in Timed Up and Go completion time. The OMT group improved from 14.9 ± 2.8 seconds to 12.8 ± 2.6 seconds, with a mean reduction of 2.1 seconds and a moderate-to-large effect size of 0.78. The Tai Chi group improved from 15.1 ± 2.6 seconds to 12.2 ± 2.3 seconds, showing a larger mean reduction of 2.9 seconds and a large effect size of 1.18. The control group demonstrated minimal change, decreasing from 15.0 ± 2.5 seconds to 14.7 ± 2.7 seconds. Balance performance also improved substantially in both active groups. Berg Balance Scale scores increased by 5.8 points in the OMT group and 8.7 points in the Tai Chi group, compared with only 0.5 points in the control group. Tai Chi showed the largest descriptive gain in balance performance.

Table 3. Changes in Mobility and Balance Outcomes After 12 Weeks

Outcome	Group	Baseline Mean ± SD	Post-Intervention Mean ± SD	Mean Change	Standardized Effect Size	Reported p-value
TUG, seconds	OMT	14.9 ± 2.8	12.8 ± 2.6	-2.1	0.78	<0.05
TUG, seconds	Tai Chi	15.1 ± 2.6	12.2 ± 2.3	-2.9	1.18	<0.05
TUG, seconds	Control	15.0 ± 2.5	14.7 ± 2.7	-0.3	0.12	
BBS, score /56	OMT	42.8 ± 5.2	48.6 ± 4.8	+5.8	1.16	<0.05
BBS, score /56	Tai Chi	42.6 ± 5.5	51.3 ± 4.6	+8.7	1.72	<0.05
BBS, score /56	Control	43.1 ± 5.0	43.6 ± 4.9	+0.5	0.10	

Pain intensity and gait speed also improved after active intervention. Numeric Pain Rating Scale scores decreased from 6.8 ± 1.4 to 4.1 ± 1.3 in the OMT group, representing a 2.7-point reduction and a large effect size of 2.00. In the Tai Chi group, NPRS decreased from 6.9 ± 1.5 to 4.8 ± 1.4, giving a 2.1-point reduction and an effect size of 1.45. Gait speed increased from 0.91 ± 0.12 m/s to 1.03 ± 0.11 m/s in the OMT group, while Tai Chi improved from 0.92 ± 0.13 m/s to 1.08 ± 0.10 m/s. The mean gain in gait speed was 0.12 m/s after OMT and 0.16 m/s after Tai Chi, suggesting a larger descriptive improvement in walking performance in the Tai Chi group.

Table 4. Changes in Secondary Pain and Gait Outcomes After 12 Weeks

Outcome	Group	Baseline Mean ± SD	Post-Intervention Mean ± SD	Mean Change	Standardized Effect Size	Reported p-value
NPRS, score	OMT	6.8 ± 1.4	4.1 ± 1.3	-2.7	2.00	<0.05
NPRS, score	Tai Chi	6.9 ± 1.5	4.8 ± 1.4	-2.1	1.45	<0.05
Gait speed, m/s	OMT	0.91 ± 0.12	1.03 ± 0.11	+0.12	1.04	<0.05
Gait speed, m/s	Tai Chi	0.92 ± 0.13	1.08 ± 0.10	+0.16	1.38	<0.05

Overall, both active interventions produced clinically favorable changes across pain, function, mobility, balance, and gait-related outcomes. OMT produced the largest descriptive reductions in pain-related outcomes, including WOMAC pain and NPRS, with reductions of 5.6 and 2.7 points, respectively. Tai Chi produced the largest descriptive improvements in balance and walking-related outcomes, with an 8.7-point increase in Berg Balance Scale score and a 0.16 m/s increase in gait speed. The control group demonstrated only small changes in WOMAC pain, WOMAC function, TUG, and BBS over the same 12-week period, supporting the greater observed benefit of the two active non-pharmacological interventions.

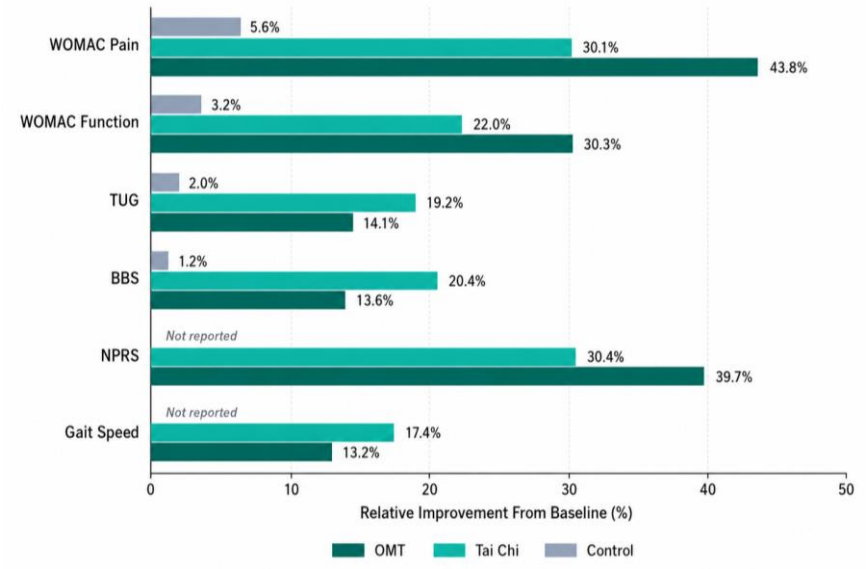

Figure 1. Relative Improvement Profile Across Clinical Outcomes After 12 Weeks in Elderly Patients with Knee Osteoarthritis

The figure presents the percentage improvement from baseline across pain, function, mobility, balance, and gait-related outcomes after 12 weeks of intervention. OMT demonstrated the greatest relative improvement in pain-focused outcomes, including WOMAC pain at 43.8% and NPRS at 39.7%, compared with Tai Chi at 30.1% and 30.4%, respectively. Tai Chi showed larger improvements in mobility- and balance-oriented outcomes, including TUG at 19.2%, BBS at 20.4%, and gait speed at 17.4%, compared with OMT at 14.1%, 13.6%, and 13.2%, respectively. The control group showed only small improvements in reported outcomes, ranging from 1.2% for BBS to 5.6% for WOMAC pain, while control values for NPRS and gait speed were not reported. Overall, the figure highlights a clinically meaningful response pattern in which OMT showed stronger pain-related benefit, whereas Tai Chi showed greater gains in balance and functional mobility.

DISCUSSION

The present randomized controlled trial demonstrated that both Osteopathic Manipulative Treatment and Tai Chi produced favorable changes in pain, functional limitation, mobility, balance, and gait performance among elderly patients with knee osteoarthritis after 12 weeks of intervention. Compared with standard care, both active interventions showed larger improvements across the principal clinical domains assessed by WOMAC, Timed Up and Go, Berg Balance Scale, Numeric Pain Rating Scale, and gait speed. The response pattern was not identical across interventions: Osteopathic Manipulative

Treatment produced greater descriptive reductions in pain-related outcomes, whereas Tai Chi produced greater descriptive gains in balance, mobility, and walking performance. This differential profile is clinically meaningful because knee osteoarthritis in elderly individuals is not limited to pain alone but also involves stiffness, reduced postural control, altered gait mechanics, fear of movement, and progressive functional decline (10).

Pain reduction was more pronounced in the Osteopathic Manipulative Treatment group, as shown by a 5.6-point reduction in WOMAC pain and a 2.7-point reduction in Numeric Pain Rating Scale score. These changes suggest that manual therapeutic approaches may provide meaningful short-term symptom relief in elderly patients with knee osteoarthritis. The potential mechanisms include improved periarticular soft-tissue mobility, reduction of myofascial restriction, modulation of nociceptive input, enhancement of local circulation, and improvement in joint mechanics. Manual therapy may also influence proprioceptive feedback and neuromuscular control around the knee joint, thereby reducing pain-related movement inhibition and improving tolerance to functional activity (11). The larger reduction in WOMAC function score in the Osteopathic Manipulative Treatment group further suggests that pain relief may have contributed to improved performance in daily activities, particularly those limited by stiffness and mechanical discomfort.

Tai Chi also reduced pain, although the magnitude of pain reduction was descriptively smaller than that observed with Osteopathic Manipulative Treatment. This finding is consistent with the therapeutic nature of Tai Chi, which is not primarily a passive pain-modulation technique but an active mind–body exercise integrating slow movement, breathing control, postural alignment, and weight transfer. Pain improvement following Tai Chi may result from enhanced lower-limb strength, improved joint range of motion, reduced fear of movement, better body awareness, and gradual exposure to controlled functional loading. In elderly individuals with knee osteoarthritis, these effects may decrease pain sensitivity during movement and improve confidence in performing weight-bearing activities (12).

The strongest relative advantage of Tai Chi was observed in balance and mobility-related outcomes. The Tai Chi group showed an 8.7-point improvement in Berg Balance Scale score and a 2.9-second reduction in Timed Up and Go performance, exceeding the descriptive gains observed in the Osteopathic Manipulative Treatment group for these outcomes. Tai Chi requires repeated practice of controlled weight shifting, semi-flexed knee positioning, trunk rotation, single-limb loading transitions, and coordinated upper- and lower-limb movement. These elements directly train dynamic balance, anticipatory postural adjustment, and proprioceptive control, which are essential for fall prevention and safe ambulation in older adults with knee osteoarthritis (13). The improvement in gait speed from 0.92 m/s to 1.08 m/s in the Tai Chi group further supports its functional relevance, as walking speed is a practical indicator of mobility, independence, and physical reserve in geriatric rehabilitation.

The improvement in Timed Up and Go performance in both intervention groups indicates that pain reduction and neuromuscular training can each contribute to better functional mobility, although through different therapeutic pathways. Osteopathic Manipulative Treatment may improve mobility by reducing pain, stiffness, and soft-tissue restriction, enabling patients to rise, turn, and walk with less discomfort. Tai Chi may improve the same outcome through repeated training of postural transitions, coordinated stepping, lower-limb control, and movement confidence. The presence of improvement in both groups supports the concept that elderly patients with knee osteoarthritis benefit from interventions that target both impairment-level symptoms and task-level movement performance (14).

The relatively small changes observed in the standard-care control group highlight the added value of structured, supervised non-pharmacological interventions. Control participants showed only modest changes in WOMAC pain, WOMAC function, Timed Up and Go, and Berg Balance Scale scores over 12 weeks, suggesting that usual conservative care alone may be insufficient to produce meaningful multidimensional improvement in elderly patients with established knee osteoarthritis. This finding is important because older adults often require interventions that are not only analgesic but also

restorative, functional, and feasible over time. The contrast between active intervention groups and standard care supports the clinical role of structured rehabilitation strategies that are delivered with adequate frequency, duration, and therapeutic intent (15).

The findings also support a more individualized approach to knee osteoarthritis rehabilitation. Patients whose main clinical presentation is pain, stiffness, soft-tissue restriction, or reduced tolerance to movement may benefit particularly from Osteopathic Manipulative Treatment as an initial or adjunctive intervention. Conversely, patients whose major impairments include poor balance, slow gait, instability, reduced postural confidence, or increased fall risk may benefit more from Tai Chi-based rehabilitation. Since knee osteoarthritis commonly presents with overlapping pain and functional impairments, combining therapist-applied manual treatment with progressive movement-based balance training may offer complementary benefits, although this combined strategy requires direct testing in future comparative trials before firm conclusions can be made (16).

The clinical interpretation of these findings should consider the multidimensional nature of the outcomes. WOMAC pain and NPRS primarily reflect symptom burden, whereas TUG, BBS, and gait speed reflect functional mobility, postural control, and real-world movement capacity. The observed pattern suggests that Osteopathic Manipulative Treatment and Tai Chi should not be viewed as interchangeable interventions but as approaches with partially distinct therapeutic strengths. Osteopathic Manipulative Treatment appeared more responsive for pain-dominant outcomes, while Tai Chi appeared more responsive for balance and mobility-dominant outcomes. This distinction can help clinicians align intervention selection with patient-specific goals, such as pain relief, fall-risk reduction, walking improvement, or functional independence.

Several limitations should be considered when interpreting the findings. The sample size was modest, with 20 participants in each group, which may limit statistical power for detecting smaller between-group differences. The study duration was limited to 12 weeks, and therefore the durability of treatment effects beyond the intervention period remains uncertain. The trial was conducted in a single outpatient rehabilitation setting, which may limit generalizability to other clinical environments, community-based programs, or patients with more severe osteoarthritis. In addition, participant blinding was not feasible because of the nature of the interventions, and therapist-related factors may have influenced treatment response. The absence of long-term follow-up also prevents assessment of whether pain reduction, balance gains, and gait improvements were maintained after supervised sessions ended.

Despite these limitations, the study provides clinically useful comparative evidence regarding two non-pharmacological interventions for elderly patients with knee osteoarthritis. Its strengths include a randomized controlled design, equal allocation across three groups, use of validated outcome measures, and assessment of multiple domains relevant to geriatric rehabilitation. By evaluating pain, function, balance, mobility, and gait speed together, the study offers a broader picture of rehabilitation response than pain-focused assessment alone. The findings emphasize that successful knee osteoarthritis management in elderly patients should address both symptom relief and functional restoration, particularly because mobility limitation and balance impairment contribute substantially to disability and fall risk in this population (17).

Overall, the results indicate that both Osteopathic Manipulative Treatment and Tai Chi can contribute meaningfully to conservative rehabilitation in elderly patients with knee osteoarthritis. Osteopathic Manipulative Treatment may be especially useful when pain alleviation and stiffness reduction are primary therapeutic goals, whereas Tai Chi may be particularly valuable when improving balance, gait speed, and functional mobility is the priority. These findings support the integration of structured non-pharmacological interventions into comprehensive knee osteoarthritis rehabilitation and provide a rationale for future trials examining longer-term outcomes, adherence, adverse events, cost-effectiveness, and combined treatment models.

CONCLUSION

Osteopathic Manipulative Treatment and Tai Chi both produced clinically favorable improvements in elderly patients with knee osteoarthritis after 12 weeks of intervention, with benefits observed across pain, physical function, mobility, balance, and gait-related outcomes. Osteopathic Manipulative Treatment showed greater descriptive improvement in pain-focused measures, including WOMAC pain and Numeric Pain Rating Scale scores, suggesting its value for patients whose primary limitation is pain and stiffness. Tai Chi demonstrated stronger descriptive gains in Berg Balance Scale, Timed Up and Go, and gait speed outcomes, indicating its particular usefulness for improving balance, postural control, functional mobility, and walking performance. These findings support the role of structured non-pharmacological rehabilitation in elderly knee osteoarthritis care and suggest that intervention selection may be guided by the dominant clinical goal, with Osteopathic Manipulative Treatment favored for pain alleviation and Tai Chi favored for balance and mobility enhancement.

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