



“EVALUATING THE CLINICAL EFFICACY OF AGNI KARMA IN MUSCULOSKELETAL PAIN MANAGEMENT: A SYSTEMATIC REVIEW AND META-ANALYSIS”

Dr. Anant Kumar V. Shekokar^{1*}, Dr. Kanchan A. Shekokar²

^{1*}Prof.& HOD, Department of Shalya Tantra, SvnH Ayurveda Mahavidyalaya and Chikitsalaya, Rahuri., dranantkumarshekokar@gmail.com., 9860376534

²Associate Prof. Department of Shalyatantra, SvnH Ayurveda Mahavidyalaya and Chikitsalaya, Rahuri., drkanchanshekokar@gmail.com., 7028329708

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3. ***Corresponding Author: Dr. Anant Kumar V. Shekokar**

*Prof.& HOD, Department of Shalya Tantra, SvnH Ayurveda Mahavidyalaya and Chikitsalaya, Rahuri., dranantkumarshekokar@gmail.com., 9860376534

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5. Abstract

Musculoskeletal disorders (MSDs) represent a significant global health issue, contributing to disability and economic burdens exceeding \$3 trillion annually. Despite the prevalence of various treatments, including pharmacological and non-pharmacological approaches, limitations such as adverse effects and inconsistent outcomes persist. Agnikarma, an ancient Ayurvedic therapy utilizing thermal cauterization, has gained attention for its potential in managing musculoskeletal pain. However, the existing scientific evidence supporting its efficacy remains unclear, marked by variability in study designs and outcomes. This study aims to systematically evaluate the clinical efficacy of Agnikarma for managing musculoskeletal pain through a comprehensive review and meta-analysis of relevant literature. Utilizing databases such as PubMed, Springer and Google Scholar, the search included studies published between 2015 and 2024 that assessed Agnikarma's impact on pain relief and functional improvement. A total of 10 studies were selected for inclusion, focusing on various musculoskeletal conditions. The results indicated a mean effect size of 0.69 (95% CI: [0.55, 0.83]), demonstrating statistically significant improvements in pain relief associated with Agnikarma therapy. However, the analysis revealed substantial heterogeneity ($I^2 = 96\%$), emphasizing variability in treatment responses across different studies. In conclusion, Agnikarma exhibits promising potential as an effective therapy for musculoskeletal pain management, particularly when integrated with other treatment modalities. Nonetheless, the heterogeneity and methodological limitations emphasize the need for further research to establish standardized protocols and validate long-term outcomes, ultimately enhancing its application in clinical practice.

Keywords: Agnikarma Therapy, Musculoskeletal disorders (MSDs), Musculoskeletal Pain, Thermal cauterization, Ayurvedic therapy, Therapeutic Burn Therapy

1. Introduction

Musculoskeletal disorders (MSDs) represent a significant public health issue, ranking third globally in terms of disability burden. Additionally, they impose an economic burden exceeding \$3 trillion per year (Gurjar et al., 2021). MSDs accounted for 322.75 million new cases, 117.54 thousand fatalities

and 150.08 million disability-adjusted life years (DALYs) globally in 2019 (Liu et al., 2022). These disorders encompass a wide range of conditions that impact the muscles, bones, joints, ligaments and tendons, leading to significant pain, disability and reduced quality of life. Approximately one-third of the global population is affected by chronic, painful musculoskeletal disorders, encompassing conditions such as back and neck pain, osteoarthritis, rheumatoid arthritis and bone fractures (Hoy et al., 2018).

Additionally, MSDs include various other conditions that contribute to global disability. These encompass frozen shoulder (adhesive capsulitis), characterized by restricted shoulder movement due to inflammation and stiffness (Ramirez, 2019); lower back pain, including sciatica, often caused by nerve compression (Nisargandha et al., 2020); knee joint osteoarthritis, which leads to pain and impaired mobility from cartilage degradation (Varela-Eirin et al., 2018); tennis elbow (lateral epicondylitis), affecting the elbow and causing pain from repetitive arm movements (Ma & Wang, 2020); and cervical spondylosis, which causes neck stiffness and pain from cervical spine degeneration. These disorders impact millions globally, affecting individuals across all age groups with both acute and chronic forms.

The treatment of musculoskeletal pain has traditionally relied on a combination of pharmacological and non-pharmacological approaches. Nonsteroidal anti-inflammatory drugs (NSAIDs) are considered the most effective pharmacological formulations for managing pain associated with traumatic musculoskeletal injuries. Additionally, opioids demonstrate superior efficacy in reducing pain intensity compared to other therapeutic approaches (Yin et al., 2021). However, these treatments often come with limitations with adverse effects across multiple organ systems, including the gastrointestinal, cardiovascular, hepatic, renal, cerebral, and pulmonary systems, leading to various complications (Bindu et al., 2020). Physical therapy aims to improve joint function and strength through exercises and muscle energy techniques but may not always provide sufficient pain relief or functional improvement (Mertens et al., 2022). In more severe cases, surgical interventions may be necessary, but these procedures can be invasive, costly and associated with recovery periods and complications.

Agnikarma is an ancient Ayurvedic therapy that has secured attention for its potential in managing musculoskeletal pain (Rathod & Kuchewar, 2019). Agnikarma, a therapeutic burn therapy originating from Ayurveda, involves the use of thermal cauterization to treat various diseases arising from the traditional medical system of India (Nayak & Fiaz, 2022). Agnikarma, also referred as fire therapy, is a parasurgical procedure in which localized heat is applied to specific therapeutic points on the body (Raut, 2023). It utilizes a heated instrument, typically a specially designed probe known as shalaka, which is made from either iron or an alloy of five metals (panchaloha). The probe is heated and then applied to specific points on the body where pain or dysfunction occurs (Prafulla et al., 2020). The thermal effect is believed to stimulate the affected tissues, improve blood flow and restore balance to the doshas (body energies) as per Ayurvedic principles.

Agnikarma is presumed to provide multiple benefits in treating musculoskeletal pain. The localized heat applications (LHA) exhibit prompt advantages in relieving pain by reducing inflammation, promoting tissue healing and enhancing joint mobility (Clijssen et al., 2022). This therapy is thought to be particularly effective for conditions involving Vata dosha imbalances, which are often associated with pain and stiffness in Ayurvedic medicine (Gurjar et al., 2021).

Despite the growing interest in Agnikarma therapy, the scientific evidence supporting its efficacy in musculoskeletal pain management remains inconclusive. Various studies have explored the use of Agnikarma for different musculoskeletal conditions, but the results have been inconsistent. Some studies report significant improvements in pain and function, while others show limited or no benefits. The existing literature on Agnikarma therapy is characterized by heterogeneity in study design, treatment protocols, and outcome measures. This variability makes it challenging to draw definitive conclusions about its effectiveness. Moreover, many studies have been limited by small sample sizes, lack of control groups, or methodological weaknesses. Given these gaps, there is a pressing need for a high-quality, systematic review and meta-analysis to evaluate the clinical efficacy of Agnikarma in

managing musculoskeletal pain. By aggregating data from multiple studies, a meta-analysis can provide more robust evidence on the effectiveness of this therapy, identify potential benefits, and highlight areas for future research. The primary objective of this meta-analysis is to assess the clinical efficacy and safety of Agnikarma therapy for musculoskeletal pain management. This involves systematically reviewing and analyzing data from relevant studies to determine whether Agnikarma provides significant improvements in pain relief, functional outcomes, and overall quality of life for patients with musculoskeletal disorders.

2. Methodology

This review adheres to the checklist recommended by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).

2.1. Search Strategy and Data Sources

The search strategy for this systematic review and meta-analysis involved a comprehensive search of electronic databases including PubMed, Springer, Taylor and Google Scholar. Keywords used were related to “Agnikarma,” “musculoskeletal pain,” and “pain management.” Specific search terms such as “thermal cauterization,” “localized heat applications,” “Ayurvedic therapy” and “Vata dosha imbalance” were also employed. Studies were included if they assessed the clinical efficacy of Agnikarma in managing musculoskeletal pain, reported on relevant outcomes such as pain relief and functional improvement and were published in English in peer-reviewed journals between 2015 and 2024. Exclusion criteria included studies lacking sufficient detail on treatment protocols or outcomes, non-peer-reviewed articles, conference abstracts, and those published before 2015. A manual screening of references and consultation with libraries ensured a thorough inclusion of relevant literature. A total of 10 relevant studies were selected, providing valuable insights into the effectiveness of Agnikarma for musculoskeletal pain management.

Table 1: Search Strategies (Source: Author)

S. No.	Search Strategy
1.	(“Agnikarma Therapy”) OR (“Thermal Cauterization”) OR (“Therapeutic Burn Therapy”) AND (“Musculoskeletal Pain”) OR (“Musculoskeletal Disorders (MSDs)”) AND (“Pain Management”)
2.	(“Non-pharmacological Treatments”) OR (“Local Heat Application”) AND (“Vata Dosha”) OR (“Doshas Balance”) AND (“Nonsteroidal Anti-inflammatory Drugs (NSAIDs)”) AND (“Pharmacological Approaches”) AND (“Ayurveda”) OR (“Ayurvedic Principles”) OR (“Ayurvedic Treatments”)
3.	(“Osteoarthritis”) AND (“Frozen Shoulder”) AND (“Lower Back Pain”) AND (“Sciatica”) AND (“Tennis Elbow”) AND (“Cervical Spondylosis”)
4.	(“Panchaloha Shalaka”) AND (“Marma Therapy”) AND (“Raktamokshana (Cupping)”) AND (“Snigdha Agnikarma”) OR (“Thermal Cauterization”) AND (“Dasamuladi Yog”) OR

2.2. Inclusion and Exclusion Criteria

Table 2: Inclusion and Exclusion Criteria (Source: Author)

Inclusion Criteria	Exclusion Criteria
Studies that were published in journals with peer-reviewing policies provided by the publishers were included.	Studies that were published in journals with peer-reviewing policies not provided by the publishers were excluded.

The studies included in the review were selected based on having the keywords “Agnikarma”, “musculoskeletal pain” and “pain management”.	The studies not having the specific keyword “Agnikarma”, “musculoskeletal pain” and “pain management” were excluded from the review.
The studies published in the last 10 years from 2015 to 2024 were included in this review.	The studies performed or papers published prior to 2015 were excluded in order to gather data from the most relevant researches.
Only studies that were accessible in full-text format for the public view were included.	Studies not accessible in open access format in any authorized database were excluded.

2.3. Data Collection Process

All the articles found from the database searches were retrieved and entered into the reference manager EndNote database using the imported option, excluding duplicates and any titles in foreign languages. Finally, in the EndNote file, the article records were uploaded to Rayyan, a web-based software that filters articles based on title and abstracts. The process was then divided into three stages:

1. Screening of identified articles through title and abstract to identify those studies that should be included in the review.
2. Evaluation of the qualified articles based on the goal of the review under consideration.
3. Selective identification with the help of well-defined exclusion and inclusion criteria, with data abstraction, is used to obtain information regarding the type of interventions employed in the respective studies, the number of participants, and the methodological nature of the works.

2.4. Flow Diagram

The study design follows the PRISMA flow diagram and protocol, a systematic process for identifying relevant publications and selecting those that meet eligibility requirements for further analysis, as shown in Figure 1.

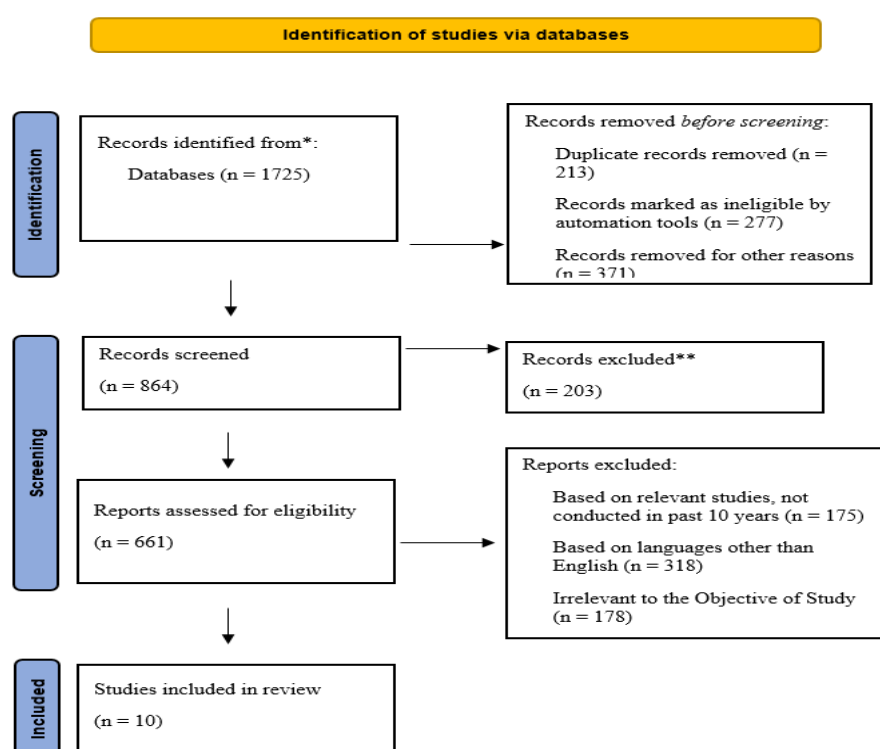


Figure 1: PRISMA Flow Diagram

5.5. Assessment of Methodological Quality

The review included articles that underwent rigorous evaluation using QUADAS-2 software to ensure alignment with the research design. QUADAS is a frequently used and highly reliable tool for systematically evaluating the quality and risk of bias in diagnostic accuracy studies. The QUADAS tool enables the assessment of the risk of bias and concerns about the applicability of the findings at one or more of the key domains integral to diagnostic accuracy investigations, qualifying it as a coherent and comprehensive approach to quality assessment. Differences in opinions were resolved through discussions or different assessors. The Joanna Briggs Institute's critical evaluation methods assessed various study designs, including observational studies, systematic reviews, and randomized controlled trials.

5.6. Study Protocol

This systematic review and meta-analysis protocol has not been formally registered. The primary reason for not registering the protocol is the specific approach taken in manually selecting studies, conducting risk of bias assessments, and generating plots using publicly accessible online tools. While registration in databases such as PROSPERO offers benefits in transparency and reducing duplication, the nature of this meta-analysis focused on real-time analysis and a dynamic refinement process based on ongoing study selection and risk assessments, led to a more flexible approach. Given the narrow scope of included studies (from the past four years) and the emphasis on minimizing bias through manual evaluation, the lack of formal registration does not compromise the integrity or value of the findings. This meta-analysis followed rigorous scientific standards, ensuring robustness without the formal registration process.

6. Results

3.1. Included Studies

The literature search yielded 10 potentially relevant articles from PubMed, Springer, Taylor and Google Scholar databases, with a few additional articles identified from the reference lists of relevant articles. After removing duplicate studies and non-English publications, 531 records were selected for further analysis. Upon review of keywords and abstracts, 178 publications were deemed outside the scope of this review. Subsequently, a thorough assessment based on relevance, study design, and quality assessment identified the 10 most relevant studies for inclusion in this review.

3.2. Studies Characteristics

This review included a total of 10 studies, comprising a collective analysis of 10 cases. The included studies originated from the India, Europe and Asia and explored the efficacy of Agnikarma in musculoskeletal pain management. Specifically, the studies focused on various musculoskeletal conditions such as osteoarthritis, lower back pain, frozen shoulder and cervical spondylosis. Furthermore, the studies explored different treatment protocols, such as the number of sessions and follow-up durations, contributing to a comprehensive analysis of Agnikarma's potential in pain relief and improved functionality in musculoskeletal disorders.

3.3. Risk of Bias Assessment and Publication Bias

The assessment of bias in the selected studies was conducted across four important domains: patient selection (D1), index test (D2), reference standard (D3), and flow and timing (D4). As detailed in Figure 2 and 3, the majority of studies demonstrated a low risk of bias in patient selection, with six out of ten studies exhibiting low risk across all domains. However, there were some concerns noted, particularly regarding the reference standard and flow and timing, where a few studies raised issues that could potentially affect the reliability of their findings. Overall, while most studies revealed low bias, the presence of some concerns in specific areas suggests that caution is warranted in interpreting the results. This variability highlights the need for careful consideration of the methodologies

employed in these studies, as biases may influence the conclusions drawn about the efficacy of Agnikarma in managing musculoskeletal pain (McGuinness & Higgins, 2020).

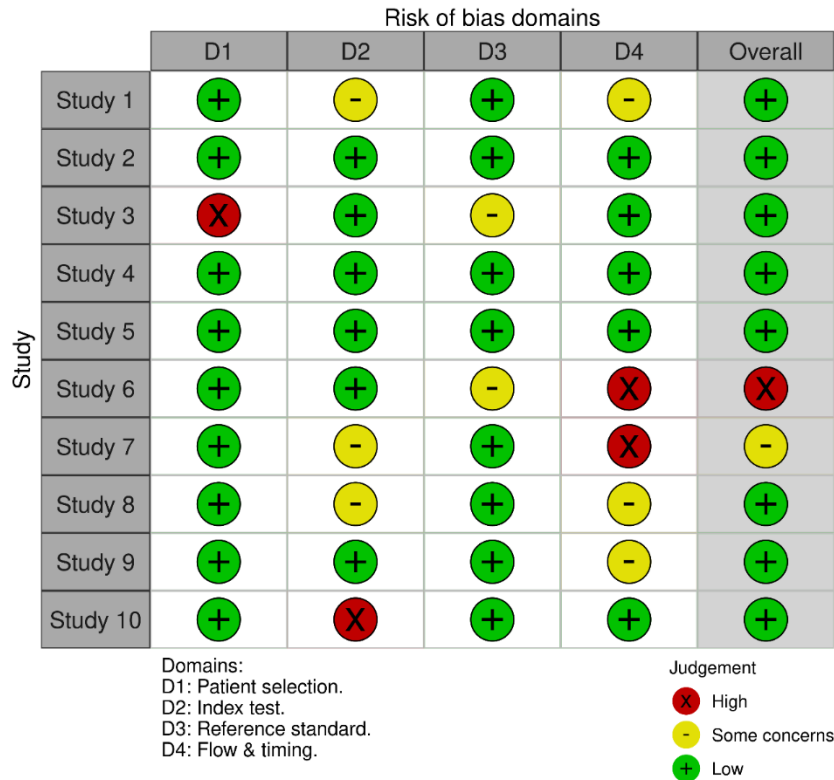


Figure 2: Risk of Biasness Domains

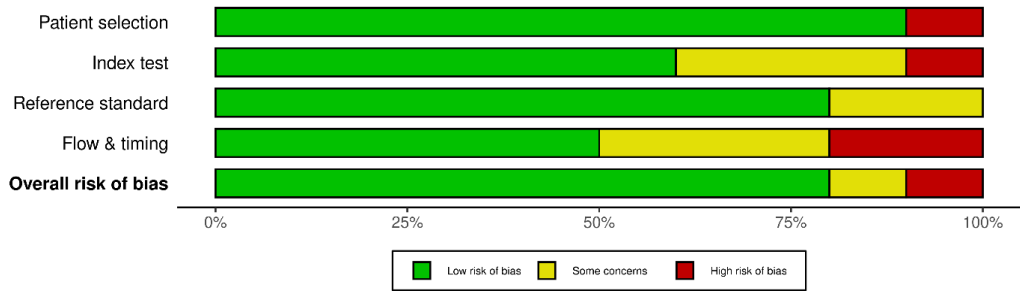


Figure 3: Graphical Representation of Overall Risk of Bias

3.4. Outcomes of Forest Plots and Meta-Analysis

Figure 4 exhibits forest plot evaluating the clinical efficacy of Agnikarma in managing musculoskeletal pain, revealing an overall mean effect of 0.69 (95% CI: [0.55, 0.83]), indicating a statistically significant outcome ($p < 0.01$). This suggests that Agnikarma therapy is associated with meaningful improvements in pain relief among patients with musculoskeletal disorders. However, the analysis also reveals significant heterogeneity, with a chi-square statistic of 310.86 ($df = 11$), indicating substantial variability in the results across different studies. The high I^2 value of 96% implies that most of the variation is due to differences between studies rather than chance. While the findings support the potential efficacy of Agnikarma, the considerable heterogeneity highlights the need for further research to understand the variability in treatment responses and to establish more standardized protocols for its application.

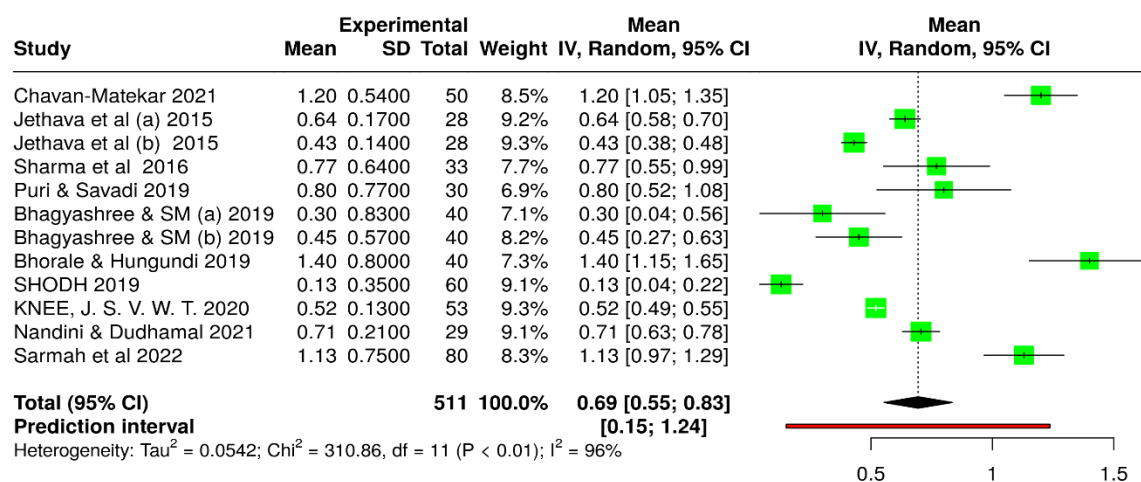


Figure 4: Forest Plot Results

Figure 5 exhibits funnel plot analysis for the clinical efficacy of Agnikarma in managing musculoskeletal pain reveals a symmetrical distribution of study results, indicating a low risk of publication bias. The studies are clustered around the mean effect, supporting the validity of the findings. However, while the overall effect is statistically significant ($p < 0.01$), the chi-square value of 310.86 ($df = 11$) suggests substantial heterogeneity among the studies. The high I^2 statistic of 96% confirms that most of the variability in results is attributed to differences in study designs and populations rather than chance. This variability emphasizes on the need for caution when interpreting the pooled results.

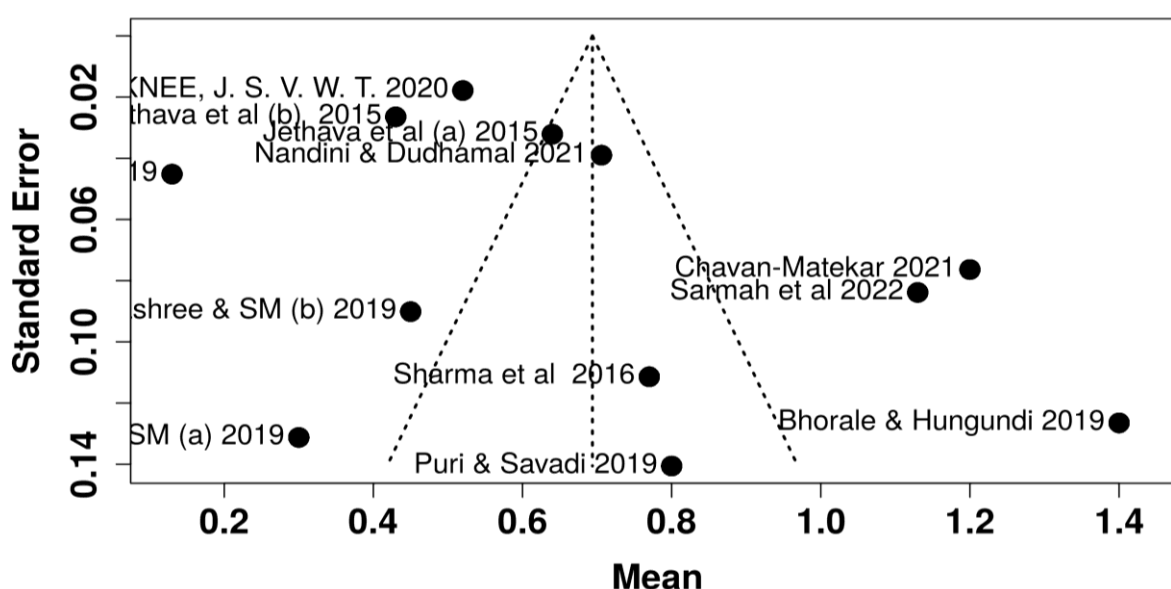


Figure 5: Comprehensive analysis by Funnel Plot

7. Discussion

A thorough literature searches on the efficacy of Agnikarma for managing musculoskeletal pain identified 10 relevant studies, with diverse musculoskeletal conditions such as osteoarthritis, lower

back pain and cervical spondylosis being explored. The overall effect size of 0.69 (95% CI: [0.55, 0.83], $p < 0.01$) suggests significant pain relief and functional improvement associated with Agnikarma therapy. However, substantial heterogeneity across studies, reflected by an I^2 value of 96%, points to variability in treatment protocols and outcomes. Despite low risk of publication bias, the presence of some methodological concerns, particularly regarding reference standards, suggests cautious interpretation of these findings.

Dr. Manjula Chavan-Matekar's study assessed the effectiveness of Agnikarma for osteoarthritis pain management. The study involved 50 patients who underwent daily treatment with a copper rod applied to tender areas of the knee for 7 days. The results demonstrated significant improvements in key symptoms such as pain (Shula), swelling (Shotha) and restricted movement (Prasaran-Ankunchan Vedana), with sustained effects even after the treatment ended. Statistical analysis revealed a P-value of <0.05 , confirming the therapeutic benefit of Agnikarma though crepitus revealed no significant change due to the short treatment duration. Agnikarma was revealed to be an effective, economical treatment with minimal side effects (Chavan-Matekar; Kumar et al.).

Jethava et al. (2015) assessed the efficacy of Agnikarma in managing musculoskeletal pain, particularly in patients suffering from Sandhigata Vata (osteoarthritis of the knee joint). The study demonstrated a 76.31% reduction in pain and a marked improvement in joint function, particularly in knee flexion and extension. Agnikarma's heat application reduced joint stiffness and inflammation by improving blood circulation. Additionally, the study revealed no significant differences between the use of Rajata and Loha Shalaka in terms of pain relief, though Loha Shalaka provided slightly better results. Agnikarma is an effective, minimally invasive procedure for relieving musculoskeletal pain and managing osteoarthritis with minimal equipment (Jethava et al., 2015; Lobo et al., 2021).

Sharma et al. (2016) assessed Agnikarma's efficacy in managing knee osteoarthritis (OA) demonstrated that Agnikarma, both alone and combined with Panchatikta Guggulu, provided significant relief from knee joint pain, tenderness, swelling and improved range of motion. Agnikarma alone provided 86% pain relief, compared to 77.78% relief for the group also receiving Panchatikta Guggulu. Additionally, the study noted Agnikarma led to significant improvements in joint flexion and extension with better results in extension when combined with Panchatikta Guggulu. While Agnikarma is effective as a standalone intervention, its efficacy may be augmented when used in conjunction with other therapeutic modalities such as Panchatikta Guggulu. This highlights Agnikarma's effectiveness as a non-pharmacological treatment for OA, particularly when combined with other therapies (Patil & Rangnekar, 2022; Sharma et al., 2016).

Puri & Savadi (2019) evaluated Agnikarma's efficacy in managing Janu Sandhigata Vata, akin to knee osteoarthritis. Their study revealed Agnikarma, performed using Rajata Shalaka (silver rods), resulted in a 76% reduction in pain, significantly better than the 59% reduction observed with oral treatments. Agnikarma provided immediate relief and effectively balanced doshas, leading to improvements in pain, stiffness, range of motion and other objective parameters. Both Agnikarma and oral treatments revealed significant results, but Agnikarma provided more immediate and substantial relief. The results indicate Agnikarma as a promising, safe and effective therapy for musculoskeletal pain, suggesting further research to explore long-term clinical benefits (Puri & Savadi, 2019; Singh et al., 2021).

Bhagyashree VG et al. (2019) compared Asthapada Panchaloha Shalaka Agnikarma and Bindu Panchaloha Shalaka Agnikarma for pain management in Gridhrasi (sciatica). The study involved 40 patients, Group A (Asthapada Panchaloha) revealed an 87.29% improvement, while Group B (Bindu Panchaloha) revealed an 84.64% improvement. Group A demonstrating superior outcomes in reducing symptoms such as Ruk (continuous pain, 89.47% improvement), Toda (intermittent pain, 68.57%) and SLR (Straight Leg Raising test, 93.65%). The study concluded that Asthapada Panchaloha Agnikarma is more effective for pain management in Gridhrasi.S (Anandkumar & Thyagaraja, 2022; Bhagyashree & SM, 2019).

Bhorale et al. (2019) assessed Agnikarma for treating cervical spondylosis in 40 patients aged between 40-60 years. Post-treatment, pain scores improved by 31.7%, stiffness by 42.05%, and swelling by

56.92% (all $p < 0.05$). Follow-up assessments revealed further improvements: pain reduced by 69.26%, stiffness by 75.38% and swelling by 87.69% (all $p < 0.01$). The study concluded that Agnikarma, alongside oral medications, is a highly effective and safe treatment for cervical spondylosis, reinforcing its value in modern Ayurvedic practice (Bagali, 2018; Bhore & Hungundi, 2019; Dudhamal, 2023).

Dr. Satyendra Kushwaha et al. (2019) studied Agnikarma and Marma Therapy for pain relief in conditions such as Sandhivata and Gridhrasi, involving 60 patients. Thirty patients received Agnikarma, while the other thirty underwent Marma Therapy. The results revealed significant pain reduction in both therapies, with Agnikarma proving more effective, reducing pain scores from 8.5 to 3.2 ($p < 0.01$), compared to Marma Therapy's reduction from 8.4 to 4.1 ($p < 0.05$). These findings support Agnikarma's superior efficacy in Ayurvedic pain management (Kushwaha et al.; Ninama et al., 2023).

Dr. Syed Mohammed Jalaludeen (2019) conducted a randomized controlled trial to assess the effectiveness of Agnikarma (therapeutic burn) with heated honey in treating knee osteoarthritis. Sixty patients were divided into two groups: Group A (control group) received traditional Ayurvedic treatment with Rasnasapthaka kwatha, Yogaraja Gulgulu internally, and Abhyanga, Nadi Swedana, and Dhara with Dhanwantharam oil for 15 days, while Group B (trial group) received the same treatments along with Agnikarma. The study revealed that Agnikarma with heated honey, combined with local Abhyanga, Nadi Swedana, and Dhara, offered greater relief compared to the control group (Anju et al., 2022; KNEE).

Nandini et al. (2021) compared Agnikarma and Raktamokshana (Cupping) for managing Gridhrasi (sciatica) in a clinical study of 32 patients, with 29 completing the trial. In the Agnikarma group, 26.67% achieved complete remission, while 20% had marked improvement and 40% experienced moderate improvement. Conversely, Raktamokshana group revealed no complete remissions but 42.85% marked improvement and 50% had moderate improvement. Agnikarma demonstrated superior outcomes in pain relief and functional improvement. This study highlights the effectiveness of Ayurvedic therapies in treating sciatica (De Silva et al., 2022; Nandini & Dudhamal, 2021).

Sarmah et al. (2022) conducted a clinical study on 80 patients to assess the effectiveness of Dasamuladi Yog and Snigdha Agnikarma in managing sciatica. The 30-day treatment revealed significant improvements in pain, numbness and disability scores, indicating enhanced functional capacity. The combination of Dasamuladi Yog's Vata and Kapha balancing properties with Snigdha Agnikarma's heat penetration and anti-inflammatory effects proved to be an effective therapeutic approach. The results suggest this Ayurvedic treatment could be a promising alternative for sciatica management, emphasizing the need for further research with larger sample sizes (Sarmah et al., 2022). In conclusion, the cumulative evidence from various studies indicates that Agnikarma is a highly effective therapy for managing musculoskeletal pain, particularly when used in conjunction with other treatment modalities. The significant pain relief, functional improvements, and minimal side effects observed across diverse musculoskeletal conditions, including osteoarthritis, sciatica, and cervical spondylosis, emphasizes on its therapeutic potential.

8. Conclusion

In conclusion, Agnikarma is an effective therapy for managing musculoskeletal pain, exhibiting significant improvements in pain relief and functional outcomes across various conditions such as osteoarthritis, sciatica and cervical spondylosis. The results emphasize on the Agnikarma's potential as a valuable non-pharmacological treatment option in musculoskeletal pain management. However, the variability in study methodologies and treatment protocols suggests the need for further research to refine its application and enhance clinical guidelines for practitioners.

9. Limitation and Future Implications

Despite the positive findings, this review has several limitations. The heterogeneity among the included studies, particularly in terms of sample sizes, treatment protocols and outcome measures,

poses challenges in drawing definitive conclusions. Additionally, some studies lacked strong methodological design, which may affect the reliability of the results. Future research should prioritize larger, well-structured randomized controlled trials to confirm the efficacy and safety of Agnikarma. Moreover, exploring standardized treatment protocols and long-term outcomes will be instrumental for establishing its therapeutic role in clinical practice.

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