STUDY PROTOCOL

Analysis of Acupoint Selection and Combinations in Acupuncture Treatment of Piriformis Syndrome: A Protocol for Data Mining

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Background: Piriformis syndrome (PS) is a neuromuscular condition characterized by discomfort in the gluteal region. The efficacy of acupuncture as a treatment modality for PS has been substantiated through a multitude of clinical trials. However, certain queries persist, such as the optimal approach for identifying the most efficacious acupoints. The objective of this study is to perform an initial data mining analysis aimed at identifying the optimal acupoint selection and combinations for the treatment of PS.

Methods: We will search 7 electronic bibliographic databases (PubMed, Embase, Cochrane Library, China National Knowledge Infrastructure, Wanfang Database, Chinese Biomedical Literature Database and Chongqing VIP Database) from inception to June 2023. We will select clinical trials that evaluate the efficacy of acupuncture therapy in the management of PS. Exclusions will be made for reviews, protocols, animal trials, case reports, systematic reviews, and meta-analyses. The primary outcome measure will be clinical outcomes associated with PS. Descriptive statistics will be performed in Excel 2019. Association rule analysis will be performed in SPSS Modeler 18.0. Exploratory factor analysis and cluster analysis will be performed in SPSS Statistics 26.0.

Results: This study will investigate the most effective acupoint selection and combinations for patients with PS.

Conclusion: Our findings will provide evidence for the effectiveness and potential treatment prescriptions of acupoint application for patients with PS, helping clinicians and patients make a more informed decision together.

Keywords: piriformis syndrome, acupuncture, data mining

Introduction

Piriformis syndrome (PS) is a medical condition that is distinguished by sensations of tingling, numbness, and discomfort in the gluteal region, which often extend to the back of the thigh. This is caused by the entrapment of the sciatic nerve at the greater sciatic notch.[1] The piriformis muscle exhibits a close association with the sciatic nerve, given that the sciatic nerve traverses beneath or within the piriformis muscle.[2] PS is a condition characterized by persistent contraction of the piriformis muscle in the posterior region, resulting in restricted hip movement. This condition is often caused by repetitive trauma or ischemia, which can lead to the entrapment of the sciatic nerve.[3] The symptoms of PS include pain, numbness, or tingling in the hip, which may be intensified by compression and deep palpation.[4] The prevalence of PS ranged from 12.2% to 27%, and it typically affects women and middle-aged people.[5,6] PS is believed to be responsible for low back pain and sciatica in a range of 0.3% to 6% of individuals, resulting in an estimated annual incidence of roughly 2.4 million cases.[7] It not only severely affects the patients' work and daily activities, but also imposes a significant financial burden on society and families.[8]

PS is commonly managed in clinical settings through the administration of anti-inflammatory, antipyretic, and analgesic medications, such as diclofenac sodium or ibuprofen. However, the effectiveness of these treatments is often suboptimal and they may be associated with undesirable side effects and gastrointestinal complications.[9] Hence, there exists a pressing necessity to explore alternative therapeutic modalities, particularly those rooted in traditional Chinese medicine.

The practice of acupuncture therapy is experiencing a growing trend of popularity on a global scale.[10] As a complementary and alternative therapy, it has been utilized to alleviate various painful conditions, including PS.[11,12] Numerous clinical trials conducted in China have reported the efficacy of various acupuncture techniques, including manual acupuncture, electroacupuncture, and warm acupuncture, in the treatment of PS.[13] The selection of acupoints may differ based on varying perspectives and clinical expertise among medical practitioners. The acupuncture treatment system is widely recognized to place significant emphasis on the selection and combinations of acupoints as its fundamental component.[14] The practice of combining multiple acupoints is a prevalent technique among acupuncturists in clinical settings. This approach aims to optimize the therapeutic efficacy of acupuncture by promoting synergistic effects between the selected acupoints. The growing prevalence of effective acupuncture treatments for PS conditions has relied significantly on the application of various acupoint protocols. The correlation between meridians and acupoints plays a crucial role in determining the efficacy of medical prescriptions. This relationship is characterized by its multifaceted, paradoxical, and ambiguous nature. Consequently, it is imperative to utilize pre-existing data to scrutinize the principles of acupoint selection and combinations, with the aim of enhancing the therapeutic efficacy of acupuncture. The utilization of data mining technology can facilitate the identification of potentially valuable information and knowledge within a vast corpus of documents.[15] Prior research has examined the selection and combinations of acupoints in the application of acupuncture for the treatment of various medical conditions, including carpal tunnel syndrome,[16] dry eye disease,[17] vascular dementia,[18] primary osteoporosis,[19] Alzheimer's disease,[20] diabetic gastroparesis,[21] and so on. The results of this study will provide evidence for the existence of specificity among the acupoints of different meridians and the relationship between the effectiveness of acupuncture and the specificity of the acupoints. Hence, it holds immense importance to ascertain the traits and principles governing the selection and combinations of PS acupoints for subsequent scholarly investigations and practical medical applications. The objective of this investigation is to examine the correlation principles of acupoints through data mining techniques, and to provide a moderately standardized treatment protocol for the utilization of PS acupuncture points.

Methods and Analysis
Search Methods
We will conduct a comprehensive search of electronic libraries in both Chinese and English languages, covering the period from their inception to June 2023. The databases to be searched include PubMed, Embase, Cochrane Library, China National Knowledge Infrastructure (CNKI), Wanfang Database, Chinese Biomedical Literature Database (CBM), and Chongqing VIP Database (VIP). The linguistic repertoire is constrained to the utilization of solely Chinese and English. The review will employ a combination of medical subject headings terms and free-text terms as search criteria. Table 1 illustrates the application of search strategies, as demonstrated by PubMed. The search methodology shall be customized to the particular limitations of individual databases, duly considering their distinctive attributes.

Table 1 Search Strategy for PubMed Database

No.	Search Terms
#1	MeSH terms: "piriform syndrome"
#2	Title/Abstract: "piriform syndrome" OR "piriformis injury syndrome" OR "piriformis syndrome" OR "pyriformis syndrome" OR "musculi piriformis syndrome" OR "PS"
#3	#1 OR #2
#4	MeSH terms: "acupuncture therapy" OR "acupuncture" OR "cupping therapy" OR "bloodletting"
#5	Title/Abstract: "needling" OR "needles" OR "needle" OR "pricking blood" OR "blood-letting" OR "bloodletting" OR "cupping" OR "fire acupuncture" OR "warm needling" OR "warm acupuncture" OR "electro-acupuncture" OR "body acupuncture" OR "electroacupuncture" OR "manual acupuncture" OR "acupuncture" OR "acupuncture therapy" OR "cupping therapy"
#6	#4 OR #5
#7	#3 AND #6

Review Process

Literature Screening

Types of Studies

The inclusion criteria encompass studies that document the utilization of acupuncture therapy as a principal intervention, either with or without randomized and/or controlled methodologies. It is imperative that the sample size for each group or trial surpasses ten individuals.

The exclusion criteria comprised of various types of publications such as animal trials, case reports, meta-analyses, protocols, reviews, and systematic reviews.

Types of Participants

Inclusion criteria comprised of clinical trials that encompassed individuals who have been diagnosed with PS based on the established diagnostic criteria.

Exclusion criteria comprised the use of acupuncture for postoperative rehabilitation of PS. This decision is based on the belief that there exists a notable distinction between the pathophysiology of PS and PS postoperative rehabilitation. Furthermore, surgery is deemed the primary treatment for PS in this scenario, and not acupuncture.

Intervention Types

These requirements shall be implemented towards the inclusion criteria. The selection of acupoints for needle insertion and/or moxibustion may involve either specialized acupoints or conventional meridian acupoints. Acupuncture and/or moxibustion were utilized either in isolation or in conjunction with other interventions, with the former being the primary modality. Studies comparing various acupuncture techniques for PS will also be included.

Exclusion criteria included trials of ear needle, head needle, wrist and ankle needle and other non-body needle, due to their lack of theoretical relevance to conventional acupoints.

Types of Outcome Measurements

The inclusion criteria shall be established in the following manner. Inclusion of studies in the analysis will be contingent upon their provision of at least one clinical outcome related to PS, such as pain intensity, response rate, or electro-physiological status of the sciatic nerve. This study will encompass research that has exhibited superior outcomes for patients who underwent acupuncture therapy, either as a standalone treatment or in conjunction with other therapies, compared to patients who did not receive acupuncture therapy and were part of the control group.

The exclusion criteria shall be delineated as follows. Studies that exclusively presented physiological or laboratory data will be excluded. In the event that acupuncture therapy, either as a standalone treatment or in conjunction with other therapies, yields inferior outcomes for patients relative to the control group, the studies in question will be deemed ineligible for inclusion in controlled trials. Studies included incomplete or missing acupoint prescriptions will also be excluded (Table 2).
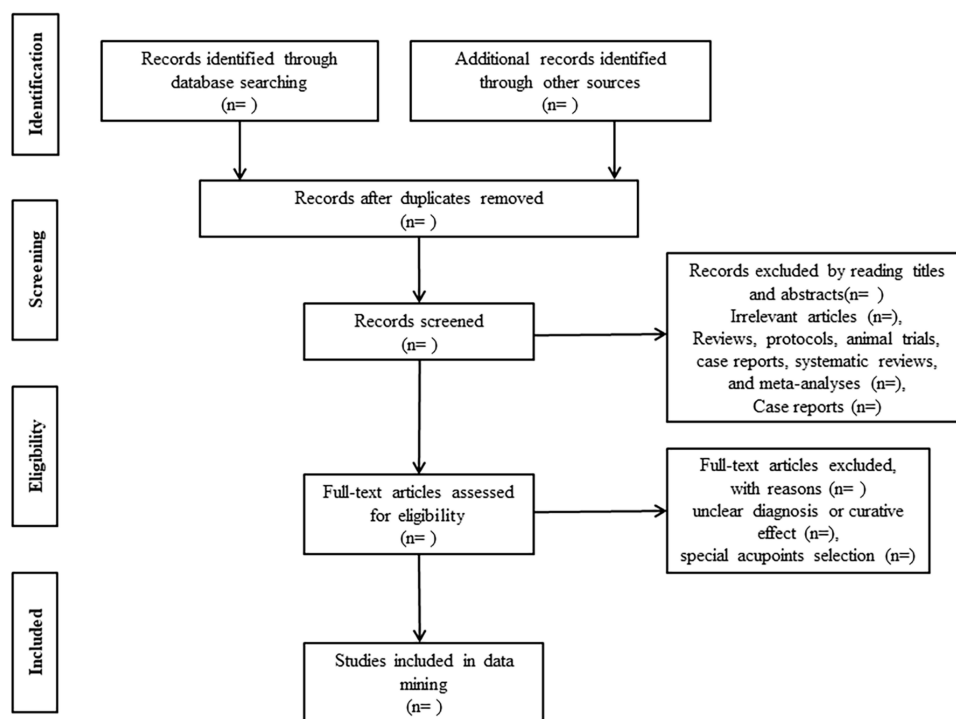
Study Selection

All researchers will receive complete system evaluation training. Zibin Wang and Jiujie He shall undertake the task of scrutinizing all the titles and abstracts that have been retrieved through the literature search and eliminate those that are evidently irrelevant, such as those that concentrate on reviews, animal trials, case reports, and so on. The complete texts of the remaining references will be gathered and subjected to further scrutiny to eliminate any publications that are deemed irrelevant. This task will be completed independently by them and disagreement will be resolved by discussion or consensus with a third author (Yushan Fan). Subsequently, Yu Wu and Yiping Zhao will independently conduct a systematic evaluation to determine the suitability of the remaining papers, based on the aforementioned inclusion criteria. If there is disagreement regarding inclusion or exclusion, they will be resolved through discussion or consensus with the third author (Pu Yang).

Table 2 Criteria for Eligible Studies to Be Included in the Study

Items	Criteria
Types of Studies	1. Document the utilization of acupuncture therapy as a principal intervention, either with or without randomized and/or controlled methodologies. 2. Sample size for each group or trial surpasses ten individuals.
Types of Participants	Individuals who have been diagnosed with PS based on the established diagnostic criteria.
Intervention Types	1. The selection of acupoints for needle insertion and/or moxibustion may involve either specialized acupoints or conventional meridian acupoints. 2. Acupuncture and/or moxibustion were utilized either in isolation or in conjunction with other interventions, with the former being the primary modality. 3. Studies comparing various acupuncture techniques for PS.
Types of Outcome Measurements	1. Inclusion of studies in the analysis will be contingent upon their provision of at least one clinical outcome related to PS, such as pain intensity, response rate, or electrophysiological status of the sciatic nerve. 2. Research that has exhibited superior outcomes for patients who underwent acupuncture therapy, either as a standalone treatment or in conjunction with other therapies, compared to patients who did not receive acupuncture therapy and were part of the control group.

Database Creation and Normalization Procedures

Endnote×9.2 will be utilized to import the literature obtained from the search. The included literature will undergo an independent review and rescreening process by two members of the research team, in adherence to the predetermined inclusion and exclusion criteria. Prior to this process, any duplicated literature will be eliminated through Endnote×9.2 software. After that, two researchers will independently remove similar or duplicate documents through manual screening (Fangzhi Zhang and Zibin Wang). Disagreement will be resolved by a third researcher (Furui Miao) through discussion and negotiation. The accuracy of the included literature will be assessed by two researchers (Fangzhi Zhang and Zibin Wang) separately through a thorough examination of the full-papers, and disagreement will also be resolved by a third researcher (Furui Miao) through discussion and negotiation. The research screening process will be visually represented through the utilization of a flow diagram, as depicted in Figure 1.

Figure 1 Flow diagram of the study selection process.

In order to summarize all the analyses conducted, we will incorporate a comprehensive table collect relevant information, such as acupuncture technique method, relevant variables or factors, and corresponding results (The sample table can be seen in the Supplementary Table 1).

The data that has been extracted will be utilized to create a prescription database for acupuncture treatment PS, which will be inputted into Excel 2019. The strategy of "a group of primary acupoints and a group of secondary acupoints constitute an acupoint prescription" will be utilized to extract valid prescriptions.[22] With regards to the "Study of Meridians and Collaterals" literature,[23] it is proposed that the nomenclature of acupoints be standardized. Additionally, site, meridian and specific acupoint attribution will be supplemented.

Missing Data Management

In order to perform an intention-to-treat analysis, communication will be initiated with the primary authors to acquire any deficient data. In the absence of comprehensive information, we shall solely assess the presently obtainable data.

Data Analysis
Literature Quality Evaluation

Using the The Cochrane Risk of Bias (ROB2) Tool,[24] Yujun He and Zibin Wang will independently analyze the risk of bias in the included studies. The tool in question consisted of six distinct components (randomization process, deviations from intended interventions, missing outcome data, measurement of the outcome, selection of the reported result, and overall bias) and the methodological quality will be assessed and categorized as either low risk, high risk, or some concerns. The final decision-making process will be aided by a third author (Pu Yang). The ROB 2 plot will be generated using the revised Cochrane ROB 2 tool for randomized trials. Disagreements will be resolved through discussion or negotiation with a third researcher (Yu Wu).

Descriptive Statistics

The supplied literature's acupoint prescriptions will all be imported into an Excel 2019 table. The PivotTable created from this table will then be used to execute descriptive statistical analysis on the frequency of acupoint usage, and site, meridian and specific acupoint attribution of individual acupoints (the sample table can be seen in the Supplementary Tables 2–5).

Association Rule Analysis

The SPSS Modeler 18.0 software will be employed to examine the association rules among high frequency acupoints through the implementation of the Apriori algorithm. The degree of support will represent the probability of both the anterior and posterior items occurring, while the probability of the posterior item occurring given the occurrence of the anterior item will be represented by the degree of confidence. After conducting several experiments, the most effective and minimal thresholds for support and confidence will be determined, with the upper limit for the former being established at 2 (The sample table can be seen in the Supplementary Table 6). Subsequently, a sophisticated network diagram will be generated to represent the interrelation between the acupoints.

Exploratory Factor Analysis

SPSS Statistics 26.0 will be utilized to carry out an exploratory factor analysis on the high frequency acupoints. Additionally, the prescription data will be subjected to KMO and Bartlett sphericity tests. Factor analysis will be conducted if the KMO measure is greater than 0.5 and the significance level of Bartlett's test of sphericity is less than 0.05. The principal factor components will be extracted using the maximum variance rotation method. Factor analysis is deemed unsuitable if the KMO measure is less than 0.5 or if the P value is greater than 0.05.

Cluster Analysis

The high frequency acupoints will undergo a cluster analysis using SPSS Statistics 26.0. Following this, a tree for cluster analysis will be produced in order to investigate the clustering correlation among the high frequency acupoints.

Discussion

PS is a condition characterized by the enlargement of the piriformis muscle, leading to the compression of the sciatic nerve. This results in the manifestation of sciatica symptoms that are exacerbated by physical activity, prolonged periods of sitting, or ambulation.[25] It is a widespread and intricate medical condition that exerts a substantial influence on individuals' well-being.[26] The management of PS often involves the implementation of brief periods of rest, administration of muscle relaxants, nonsteroidal anti-inflammatory drugs, and physical therapy. Nevertheless, owing to their inadequate pain relief and substantial adverse effects, these therapies are not commonly preferred by individuals with PS. Intramuscular injection therapy has been the subject of numerous publications in recent years regarding its application in the management of PS.[27,28] In instances of severe cases, surgical intervention may be deemed necessary, although there is debate on its effectiveness and safety.[29]

Acupuncture is a significant component of traditional Chinese medicine and is extensively employed in the management of pain associated with musculoskeletal disorders.[30] Acupuncture has been suggested as a potentially efficacious therapeutic intervention for PS. Several clinical studies have demonstrated the efficacy of acupuncture in the treatment of PS, and it is known to have enduring therapeutic benefits.[31,32] Acupuncturists typically employ needle manipulation techniques to elicit the sensation of "deqi" in patients. This sensation is characterized by soreness, numbness, and heaviness at the acupoint site and has been found to be associated with discernible alterations in fMRI signals.[33] Nevertheless, acupuncturists select varying acupoints depending on their individual expertise and perspectives. Consensus regarding the standard acupoint selection and combinations for addressing PS remains elusive.

To explore the fundamental principles, the utilization of data mining technology will be employed, as it is a viable and effective methodology. The technology of data mining facilitates the identification of correlations between individual data points, quantifies the occurrence rate of each item within the database, and detects connections with other entities.[34] The utilization of data mining technology facilitates the identification of the most relevant factors. Through the application of descriptive statistical analysis, it is possible to identify the acupoints, meridians, specific points, and sites that are frequently utilized in the treatment of PS via acupuncture. Agrawal et al[35] introduced association rule mining as an unsupervised machine learning technique. The Apriori algorithm is classified as an association rule algorithm which is capable of modifying the frequent set's size based on its characteristics, ultimately producing a frequent item set. The Apriori algorithm possesses a type variable function, which enables it to derive diverse association outcomes based on varying conditions such as the support degree, confidence degree, and the preceding item's value. The degree of support denotes the extent to which a particular rule is universally applicable, while the degree of confidence pertains to the level of credibility associated with said rule. Both of these elements are crucial constituents of association rules. Our study will employ the concept of support degree to denote the likelihood of two acupoints being utilized simultaneously, whereas the confidence degree pertains to the probability of acupoint X being employed concurrently with acupoint Y.[36] In 1904, Charles Spearman introduced the concept of exploratory factor analysis.[37] The Varimax Rotation Major Components technique was employed in its creation. The fundamental tenet of this methodology suggests that through the utilization of dimensionality reduction in multivariate statistical analysis, it is feasible to consolidate numerous collections of observed variables that display significant correlation and semantic overlap into a restricted number of conceivably autonomous factors. The application of exploratory factor analysis confers benefits in determining the quantity of variables that comprise a particular construct.[38] The utilization of clustering analysis is prevalent in the field of knowledge discovery.[39] Clustering analysis is a multivariate analysis technique that involves the categorization of samples into distinct groups.[40] The utilization of cluster analysis is of paramount importance as it enables the identification of population structure, a key component in the analysis of multi-parameter data.[41] The representation of the internal structure of data and the classification of independent observations based on the degree of similarity of their internal structure may be feasible.[42] The objective of the proposed methodology is to ascertain the most favorable assortment and amalgamation of acupoints for PS. This endeavor is intended to augment the availability of evidence-based medicine for employment in clinical practice.

Conclusion

The results of our study will furnish substantiation for the efficacy and prospective therapeutic recommendations of acupoint application for individuals with PS, thereby facilitating collaborative decision-making between doctors and patients.

Author Contributions

Each of the authors has made noteworthy contributions to the work being reported, encompassing the areas of conceptualization, research design, execution, analysis, and interpretation, or a combination thereof. They have been involved in the drafting, revising, or reviewing of the article, have given their approval for the version to be published, and have consented to submitting the manuscript to the journal. Furthermore, they have agreed to take responsibility for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

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