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A Literature Review Study: a Meta-Analysis and Investigation of the Frequency Pattern of Point Selection Based on Clinical Studies of Acupuncture for Postoperative Treatment of the Anterior Cruciate Ligament

Pengyi Zhang[1,2], Yongyuan Huang[1,2], Yushan Fan[1], Xuejie Yang[1*]

1.College of Acupuncture and Moxibustion of Guangxi University of Chinese Medicine, Nanning 530000, China.
2. Graduates School of Guangxi University of Chinese Medicine, Nanning 530000, China.

Abstract: Objective: Acupuncture is a common treatment for postoperative ACL reconstruction, however, there are still a large number of gaps in the literature related to acupuncture for postoperative ACL rehabilitation. This study was conducted by measuring the clinical observation indexes and meta-analyzing the efficacy of the literature related to acupuncture for postoperative ACL rehabilitation in the CNKI and PUBMED databases. Results: The top 5 acupoints were ST34 28 times (14.28%), ST36 27 times (13.77%), SP10 23 times (11.73%), SP 6 21 times (10.71%), and GB34 20 times (10.2%), and the combination of acupoints with the highest level of support was "ST34→ST36", followed by "ST34→SP10", both of which had a support degree of >50%.

Keywords: Meta-Analysis; ACLR; Acupuncture Treatment

Introduction

The anterior cruciate ligament (ACL) of the knee is an important structure for maintaining the stability of the knee joint [1]. And ACL injury is often accompanied by limitation of knee joint motor function [2]. Most of the patients with ACL injury are combined with medial collateral ligament and meniscus injury, and the patients suffer from knee pain and joint instability after injury, which greatly affects their daily life [3]. At present, the clinical treatment of ACL injury mainly adopts arthroscopic ACL reconstruction surgery (ACLR), which has achieved good therapeutic effect [4], and relevant studies have also shown that [5] traditional Chinese medicine (TCM) has excellent therapeutic efficacy in the treatment of postoperative rehabilitation of ACL injury.

Acupuncture is one of the commonly used therapies in traditional Chinese medicine, and several studies have proved [6, 7] that acupuncture has a positive significance in the recovery of proprioception after ACLR, and that acupuncture treatment has a significant analgesic inhibitory effect on pain that occurs in the process of postoperative rehabilitative functional exercise after ACLR [8]. Some researchers [9] found that analgesia and anti-inflammation were the two major therapeutic categories of acupuncture by analyzing the disease spectrum of acupuncture. Related studies also found that: 2 Hz low-frequency stimulation can cause the brain to generate and release enkephalins and endorphins, and 100 Hz high-frequency stimulation can cause the spinal cord to release dynorphins, which can play an analgesic role; the two can play a synergistic effect when used alternately to achieve analgesia [10].

However, reviewing the literature related to acupuncture for ACL postoperative rehabilitation, there is still a large gap in the literature related to acupuncture in regulating proprioception and pain after ACLR. Based on this premise, the present study aims to discover the current status of research and its future trend in the field of acupuncture in ACL reconstruction and rehabilitation, and to provide research ideas for related scholars through meta-analysis of the clinical observation indexes and the therapeutic efficacies of acupuncture in postoperative rehabilitation of the ACL in the CNKI and PUBMED databases. The purpose of this study is to investigate the current status and future development of acupuncture and moxibustion in the field of postoperative rehabilitation of ACL reconstruction, and to provide research ideas for related scholars.

1. Information and methods

1.1 Search strategy

The Chinese database CNKI and the English database PUBMED were searched for all relevant literature related to acupuncture for postoperative ACL treatment from the beginning of the database construction to April 01, 2023. The terms “Acupuncture”, “needling”, “Moxibustion”, “Electroacupuncture”, “Fire”, and “Fire” were used respectively. Electroacupuncture” “Fire needle” as a category of subject terms, and “AND” to connect “ACL “AND” to “ACL” or “Anterior Cruciate Ligament”.

1.2 Inclusion criteria

CNKI language was limited to Chinese, and PUBMED included English literature by default, with no restriction on the type of study and complete, authentic and reliable information. All studies with titles, abstracts, and keywords related to the search subject terms were included.

1.3 Exclusion criteria

(i)The type of disease studied excludes “rehabilitation treatment after ACLR”□(ii)Only “anterior cruciate ligament reconstruction” is involved, not “acupuncture and moxibustion” related content□(iii) The main subject of the article is “acupuncture therapy”, and the disease type is not related to “rehabilitation after ACL reconstruction”; (iv) reviews, animal experiments, and non-RCT related studies; (v) conference papers and news reports.

1.4 Literature Screening and Data Extraction

Two researchers reviewed the literature according to the inclusion and exclusion criteria, screened the titles and abstracts, and further evaluated the full text, and excluded the dissenting literature by third-party negotiation. The literature was downloaded in PDF or CAJ format, and then integrated and categorized into EXCEL for classification and statistical processing.

1.5 Results of the literature search

By searching the CNKI literature database with ACLR as the search term, the following search terms were logically connected by AND, respectively, and the following search results were obtained: Acupuncture 16, Needling 23, Electroacupuncture 20, Fire Acupuncture 0, Moxibustion 6; by searching the PUBMED database with ACL, Anterior Cruciate Ligament as the search terms, respectively, the following search terms were logically connected by AND The following search results were obtained: “Acupuncture” 25; “Needling” 110; “Moxibustion” 7; “Electroacupuncture” 8; “Needle warming moxibustion” 0. After de-emphasis and exclusion, a total of 41 papers were included.

2. Frequency of acupoints and attribution analysis

Among the 41 papers included, 37 acupuncture prescriptions were extracted, and these acupuncture prescriptions were imported into EXCEL for data statistics to obtain the following results:

2.1 Frequency of use of acupuncture points

From the 41 articles included in the literature, a total of 37 prescriptions for acupoints and 4 prescriptions for single acupoints (including 2 prescriptions for the Ah Yes point) were extracted, and the statistical results involved a total of 38 acupoints, with a total frequency of use of 248 times. The top 5 frequently used acupoints were ST34 28 times (14.28%), ST36 27 times (13.77%), SP10 23 times (11.73%), SP 6 21 times (10.71%), and GB34 20 times (10.2%). See Table 1 (only those with a frequency >5 are shown):

Name	Frequency	Percentage	Main and collateral channels
ST34	28	11.29%	ST
ST36	27	10.89%	ST
SP10	23	9.27%	SP
SP6	21	8.47%	SP
GB34	20	8.06%	GB
ST35	19	7.66%	ST
ST32	15	6.05%	ST
SP9	13	5.24%	SP
EX-LE5	11	4.44%	EX-LE
EX-LE2	8	3.23%	EX-LE
ST40	6	2.42%	ST
BL57	5	2.02%	BL

Table 1 Acupoints with a frequency of use >5 for ACLR in acupuncture treatment

2.2 Frequency of acupoint attribution to meridians

The included acupoints were categorized into meridians. The categorization results showed that the Foot Yangming Stomach Meridian was used 103 times (41.53%), followed by the Foot Taiyin Spleen Meridian 63 times (25.40%) and the Foot Shaoyang Gallbladder Meridian 33 times (13.31%). In terms of the number of acupoints, the Foot Yangming Stomach Meridian was dominated by 11 points (35.00%), the Foot Shaoyang Gallbladder Meridian by 6 points (15.79%), and the Foot Taiyin Spleen Meridian by 5 points (13.16%). See Table 2:

Main and collateral channels	Numbers of acupoints		Types of acupoints		Acupoint (Frequency)
	Frequency	Percentage	Frequency	Percentage	
ST	103	41.53%	11	28.95%	st32 (15) st36 (27) st34 (28) st31 (3) st40 (6) st35 (19) st37 (1) st38 (1) st21 (1) st44 (1) st39 (1)
SP	63	25.40%	5	13.16%	sp10 (23) sp9 (13) sp6 (21) sp8 (4) sp11 (2)
GB	33	13.31%	6	15.79%	GB39 (3) GB34 (20) GB33 (4) GB30 (1) GB31 (3) GB33 (2)
EX-LE	25	10.08%	4	10.53%	EX-LE5 (11) EX-LE2 (8) Siqiang acupoint (2) Ashi acupoint (4)
BL	13	5.24%	6	15.79%	BL23 (1) BL18 (1) BL40 (4) BL57 (5) BL37 (1) BL55 (1)
KI	6	2.42%	4	10.53%	ki10 (2) ki3 (2) ki6 (1) ki4 (1)
LI	3	1.21%	1	2.63%	LI4 (3)
DU	2	0.81%	1	2.63%	DU20 (2)

Table 2. Frequency of acupoint attribution to meridians

2.4 Association rule analysis

A total of 20 sets of eligible cave sets were analyzed according to the set conditions. According to the order of support, the top 5 combinations are: ① ST34→ST36; ② ST34→SP10; ③ SP10→SP6; ④ ST36→SP6; ⑤ ST34→SP6, see Table3, and the complex network diagram shows that the core acupuncture point group is “ST34-ST36”, see Table 3:

eventualities	antecedent (math.)	an actual example	Support/%	Confidence level/%
ST34	ST36	27	72.97	81.48
ST34	SP10	23	62.16	82.61
SP10	SP6	21	56.76	85.71

ST36	SP6	21	56.76	80.95
ST34	SP6	21	56.76	80.95
ST34	GB34	20	54.05	80
SP6	SP10, ST34	19	51.35	84.21
ST34	ST35	18	48.65	94.44
ST34	SP6, SP10	18	48.65	88.89
ST36	ST35	18	48.65	83.33

eventualities	antecedent (math.)	an actual example	Support/%	Confidence level/%
ST36	SP6, SP10	18	48.65	83.33
SP6	SP10, ST36	18	48.65	83.33
ST34	SP10, ST36	18	48.65	83.33
SP10	SP6, ST34	17	45.95	94.12
SP10	SP6, ST36	17	45.95	88.24
ST36	ST35, ST34	17	45.95	82.35
ST34	SP6, ST36	17	45.95	82.35
ST36	SP6, ST34	17	45.95	82.35
SP10	GB34, ST34	16	43.24	81.25
ST36	ST32	15	40.54	100

Table 3. Support and confidence level of association rule analysis

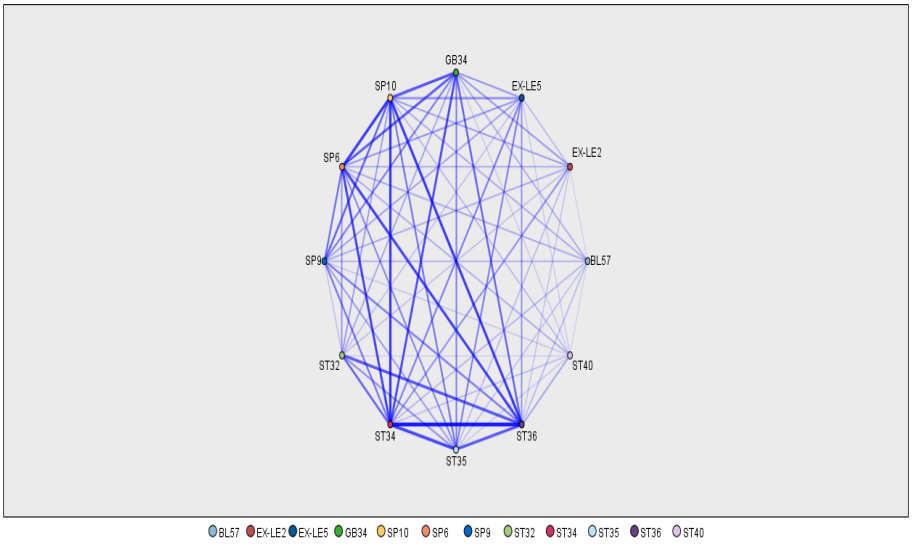


Figure 1. Network diagram of core acupuncture points

2.5 Cluster analysis

Using SPSS Statistic 25.0 to cluster the acupoints with frequency ≥5, as shown in Fig.2, the high-frequency selected acupoints for treating ACLR can be classified into five major categories when the scale is 15: ① SP10, SP9, SP6, GB34, BL57; ② ST35, EX-LE5, ST34; ③ EX-LE2; ④ ST36, ST32; ⑤ ST40.

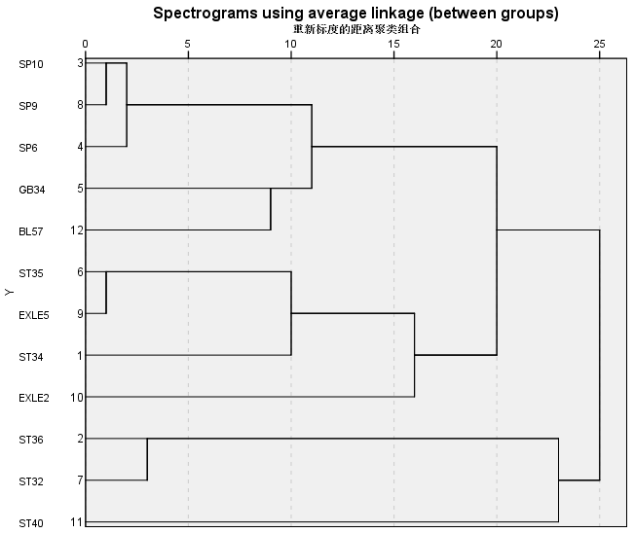


Figure 2. Dendrogram of cluster analysis of core acupoints

3. Meta-analysis

3.1 Search strategy and results

The search method and results were referred to the same as 1.1 above, and after excluding cohort studies and RCT trials in which non-acupuncture was used as a variable, a total of 28 papers with 1,747 subjects were included, and the quality of the literature was evaluated according to the Cochrane Handbook of Systematic Evaluation 5.3 of the Risk of Bias Assessment Tool for Treatment Evaluation. Data acquisition included the name of the first author, time of publication, intervention, and outcome indicators. Studies with incomplete data were supplemented by contacting the original authors.

3.2 Statistical analysis

Review Manager 5.3 software was used to analyze the data, and the heterogeneity of the included studies was first judged; if there was homogeneity among the included studies ($P > 0.1$, $I2 < 50\%$), a fixed-effects model was used, and if the heterogeneity among the included studies was obvious ($P < 0.1$, $I2 > 50\%$), a random-effects model was used, and at the same time, sensitivity analyses were performed to exclude the studies that could cause heterogeneity, and then Meta-analysis was performed; when the included literature > 10, a funnel plot was used to test for publication bias. studies, and then Meta-analysis was performed; when the included literature was >10 then the funnel plot was used to test for publication bias. The test level was set at $\alpha=0.05$.

3.3 General characteristics of included studies

The literature was published between 2012 and 2022; 17 of them used Lysholm score as diagnostic criterion, 19 used VAS diagnostic criterion, 17 used ROM diagnostic criterion, and 7 used IKDC diagnostic criterion.

3.4 Evaluation of the quality of literature

Twenty-two RCTs discussed the method of randomization and were judged to be “low risk”; six RCTs only mentioned randomization in the text but did not describe it specifically and were judged to be “unclear”; none of the literature reported allocation concealment; none of the text mentioned blinding; and the risk of bias was assessed as shown in Figures 3 and 4. Blinding was not mentioned throughout the text; the risk of bias assessment is shown in Figures 3 and 4.

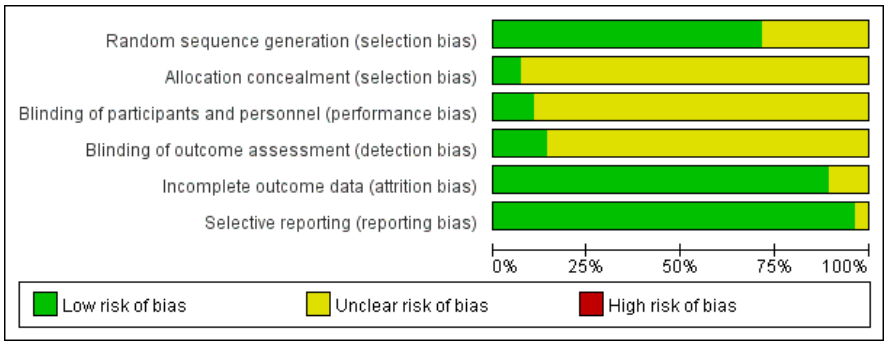


Figure 3. The risk of bias assessment(1)

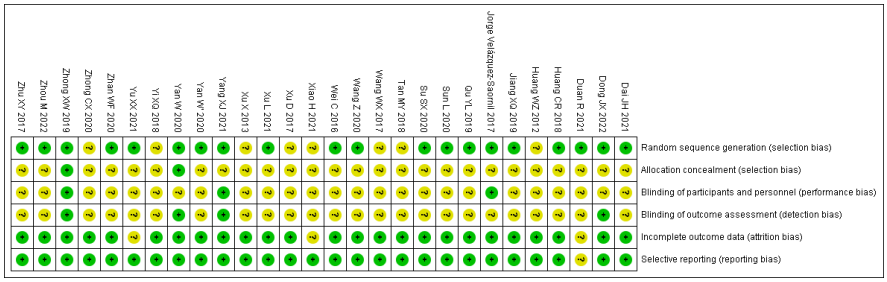
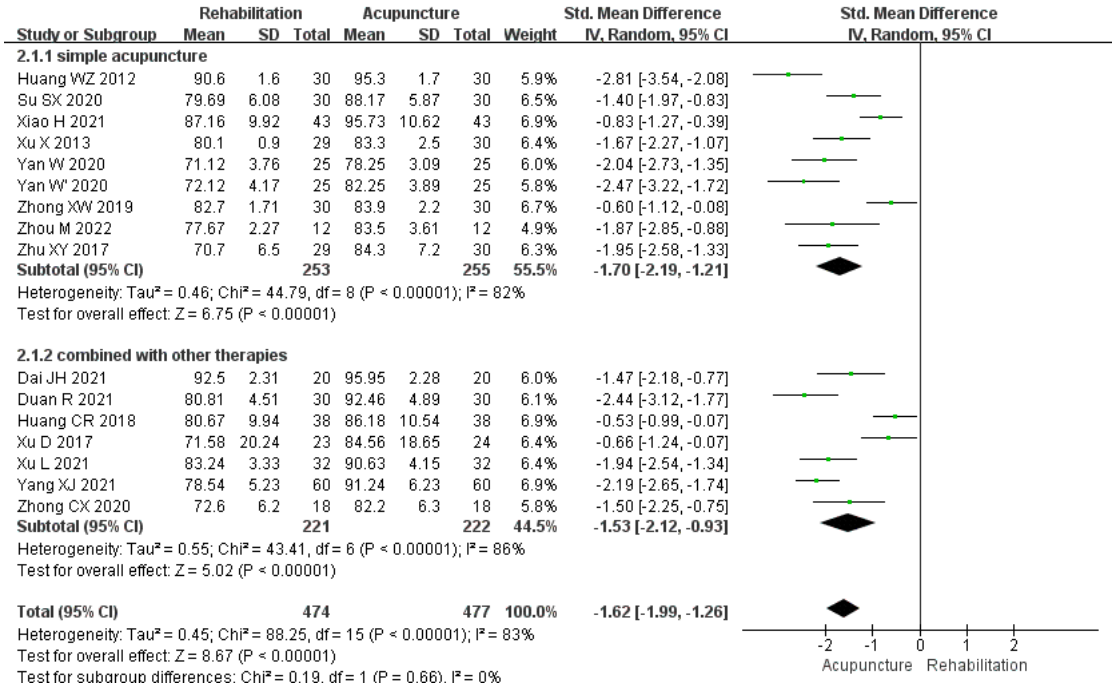


Figure 4. The risk of bias assessment(2)

3.5 Meta-analysis

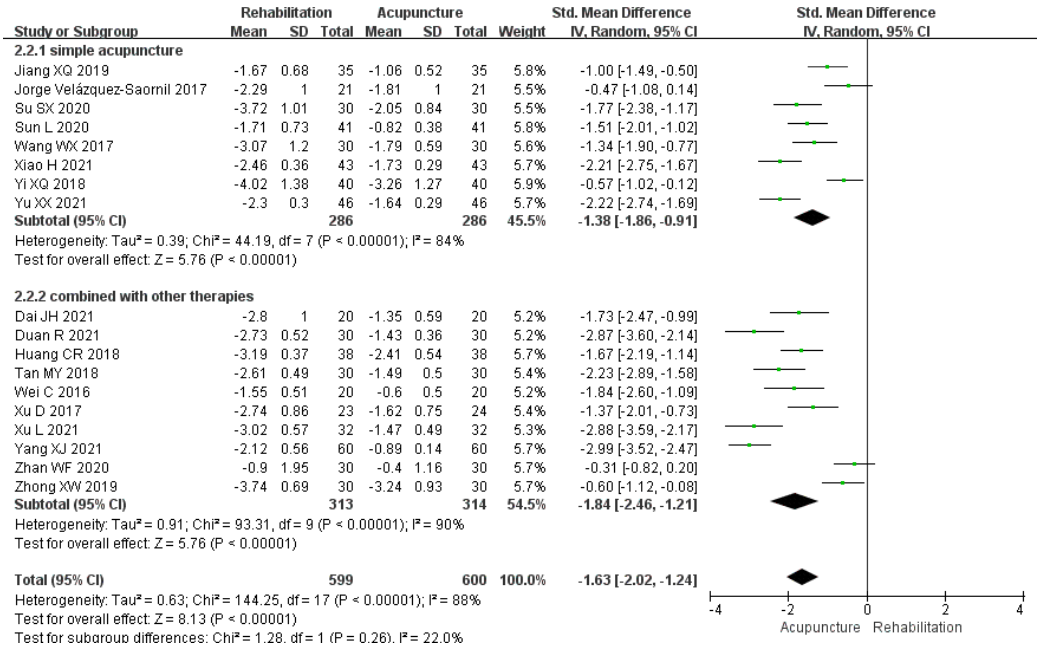
3.5.1 Lysholm score

A total of 16 papers reported the Lysholm score, of which 9 were acupuncture/ electroacupuncture therapy alone and 7 combined other therapies, after the test of heterogeneity, the results of subgroup 1, I2 = 82%, and the results of subgroup 2, I2 = 86%, with significant heterogeneity between groups, sensitivity analysis was performed, and the heterogeneity was >50% after excluding the papers one by one, and the results were more stable, and the random effect model was used. The results showed that the difference in Lysholm scores between the 2 groups was statistically significant [OR = -1.62, 95% CI (-1.99, -1.26), Z = 8.67, P < 0.00001].



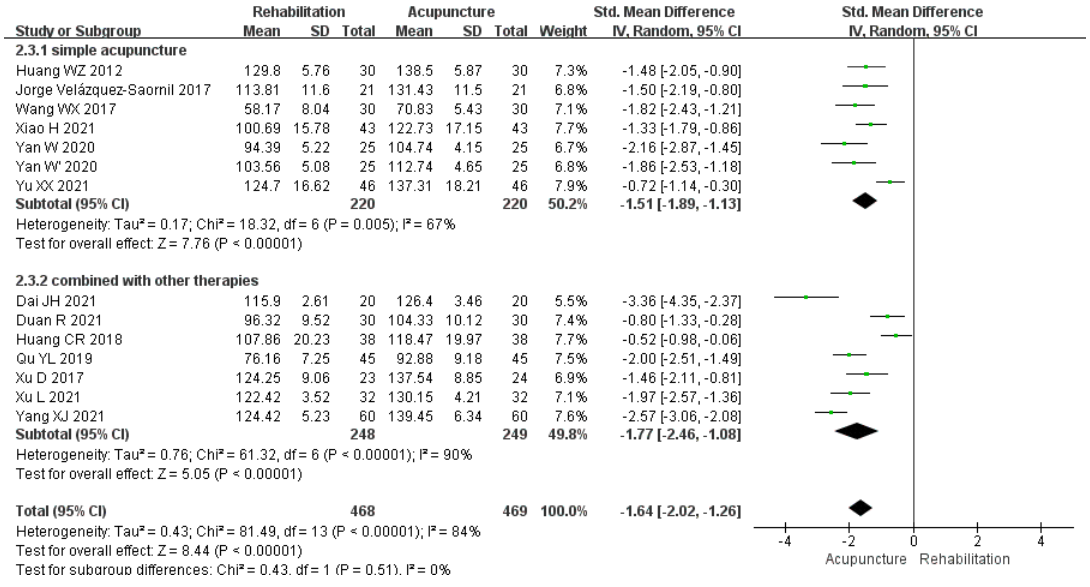
3.5.2 VAS score

A total of 18 papers reported the Lysholm score, of which 8 were pure acupuncture/electroacupuncture therapy and 10 combined other therapies, after the test of heterogeneity, the results of subgroup 1, I2 = 84%, and the results of subgroup 2, I2 = 90%, there was a significant heterogeneity between the groups, and sensitivity analysis was carried out, and the heterogeneity was all > 50% after excluding the papers one by one, and the result was more stable, using the random effects model. The results showed that the difference in VAS scores between the 2 groups was statistically significant [OR = -1.63, 95% CI (-2.02, -1.24), Z = 8.13, P < 0.00001].



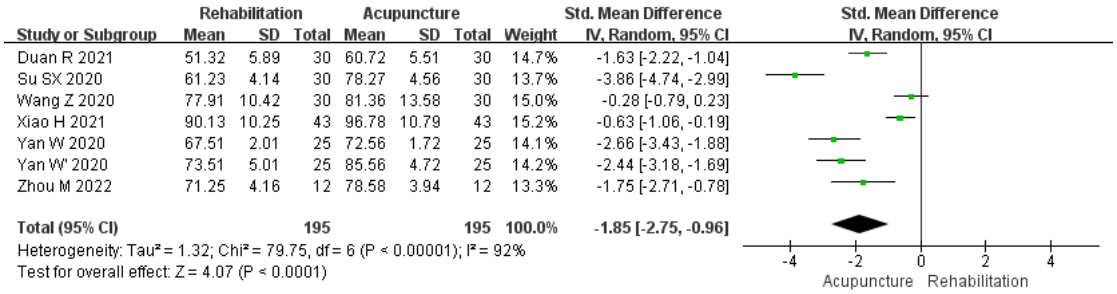
3.5.3 ROM score

A total of 14 papers reported the Lysholm score, of which 7 were acupuncture/electroacupuncture therapy alone, and 7 papers combined other therapies, after the test of heterogeneity, the results of subgroup 1, I2 = 67%, and the results of subgroup 2, I2 = 90%, there was a significant heterogeneity between the groups, and sensitivity analysis was carried out, and the heterogeneity was >50% after excluding the papers one by one, and the results were more stable, using the random effects model. The results showed that the difference in ROM scores between the 2 groups was statistically significant [OR = -1.64, 95% CI (-2.02, -1.26), Z = 8.44, P < 0.00001].



3.5.4 IKDC score

A total of 7 papers reported the Lysholm score, after the heterogeneity test, I2 = 92%, P < 0.00001, there is obvious heterogeneity between groups, sensitivity analysis, one by one after the exclusion of the literature, heterogeneity are > 50%, the results are more stable, the use of random effects model. The results showed that the difference in IKDC scores between the 2 groups was statistically significant [OR = -1.85, 95% CI (-2.75, -0.96) , Z = 4.07, P < 0.0001].



4. Discussion

4.1 Acupoint Frequency Mining

After data mining and analyzing the 41 articles included in this study, we found that the most frequently used acupoints for acupuncture-assisted postoperative rehabilitation of the anterior cruciate ligament were ST34, ST36, SP10, SP6, and GB34, and that ST34 Liangqiu is an acupoint of the foot-yangming gastric meridian, and is also a Xi point of the foot-yangming meridian, as mentioned in the book "Suwen-Impotence", which reads: "Treating myasthenia is only to take the Yangming "The ST36 Zusanli acupoint is a lower merging point of the stomach meridian, and both it and the ST34 Liangqiu point are rich in qi and blood of the foot yangming meridian, which has the effect of tonifying qi and blood of the yangming meridian and relieving qi and blood dysfunctions after ACLR surgery, and the depletion of blood and qi over a long period of time results in qi and blood deficiency and loss of nourishment of sinews, which leads to muscular atrophy and weakness, and limitation of flexion and extension [11]. The SP10 Sea of Blood acupoint is an acupoint of the foot Taiyin Spleen meridian acupoints, and ST34 and GB34 are ACL paraclinical acupuncture points, while SP10 specializes in the treatment of lower limb impotence, its location and ST34 relative to each other as a watchword [12] GB34 Yanglingquan acupuncture point is not only the joint point of the foot ShaoYang gallbladder meridian and gallbladder under the joint point, but also the eight will be points of the tendon will be ACL injuries in traditional Chinese medicine "tendon injuries" category, its take ACL injury is the category of Chinese medicine "tendon injury", and it takes the acupoint to take the meaning of relaxing tendons and activating collaterals. In addition, SP6 Sanyinjiao acupoint is the meeting place of the three meridians of the foot shaoyin, foot taiyin, and foot syncope, and the acupoint is taken to take the meaning of "the meridians and collaterals are passed, and the main treatment is reached", and at the same time, SP6 is also a commonly used empirical point for lower limb diseases.

The analysis of the association rules of acupoints showed that the combination of acupoints with the highest degree of support was "ST34→ST36", followed by "ST34→SP10", and its degree of support was >50%. The combinations with a confidence level of up to 90% include "ST34-ST35", "SP10-SP6-ST34" and "ST36-ST32". These acupoint combinations are also commonly used in the treatment of postoperative ACLR, and the complex network relationship diagram more intuitively demonstrated that "ST34-ST36" can be regarded as the core acupoints for the treatment of ACLR.

The results of cluster analysis of acupoints showed five valid clusters: cluster 1 SP10, SP9, SP6, GB34, BL57, whose selected acupoints involved the above commonly used SP6, SP10, and GB34, which are all commonly used acupoints for regulating qi and blood loss of glory in the knee joints of the affected knee joints after ACLR surgery; the second group of ST35, EX-LE5, and ST34, in which EX-LE5 is located around the knee joint and It is a commonly selected acupoint for knee joint diseases; in the third group, EX-LE2 is a commonly used proximal treatment point after ACLR [13]; in the fourth group, ST36 is a high-frequency acupoint for the treatment of postoperative ACLR; ⑤ ST40 is a meridian acupoint of the foot yangming meridian, which is uniquely effective for the treatment of impotence and paralysis of the

lower limbs [14]. In this study, we analyzed the data mining of the selection pattern of acupuncture points for the treatment of postoperative ACLR, and compiled the patterns of commonly used acupoints, meridians, sites, and the pairing of acupoints. It was concluded that the selection of acupuncture points for the treatment of postoperative ACLR follows the therapeutic principles of promoting qi and blood circulation, and relieving tendons and activating collaterals, which provides a reference for the direction of clinical practice and scientific research.

4.2 Meta-analysis

Meta-analysis of the selection of outcome indicators, this study mainly included four outcome indicators, including Lysholom score, VAS score, ROM score, and IKDC score, and the differences were statistically significant.

There are some limitations in this study.1. In the included literature, some of the studies were unclear about the randomization method, allocation concealment and blinding implementation, and some of them had high-risk factors, which had a certain risk of bias.2. Literature on late follow-up, long-term efficacy was unclear.3. Literature on safety evaluation was not clear.4. Literature on small sample size. In future clinical studies, it is still necessary to further conduct more rigorous, high-quality randomized controlled trials under the guidance of evidence-based medicine to provide more reliable evidence for the clinical effectiveness and safety of acupuncture for postoperative ACLR.

5. Conclusion

For the treatment of ACLR, ST34, ST36, SP10 and SP6 were selected for acupuncture, and the meridians of foot yangming gastric meridian and foot taiyin spleen meridian were selected for acupuncture. The core point group is “ST34-ST36”, which follows the therapeutic principles of promoting qi, activating blood circulation, relaxing tendons and activating collaterals, and focuses on the circulation of the meridians, which can provide a reference basis for the clinic.

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Author:

Zhang Pengyi(1998-),male postgraduate of acupuncture and moxibustion and Massage, Guangxi University of Traditional Chinese Medicine.

Corresponding author:

Yang Xuejie (1980-), female, from Qinzhou, Guangxi, associate professor, Ph.D, research direction: mechanism of acupuncture and moxibustion.