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Review Article

Acupoints Compatibility Rules of Acupuncture for Functional Gastrointestinal Disorders Based on Data Mining Technology: A Systematic Review

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Abstract

Background: We aimed to comprehensively summarise and classify the rules for selecting acupoints for acupuncture for functional gastrointestinal disorders (FGIDs).

Methods: We searched relevant literature in PubMed, Embase, Web of Science, the Cochrane Library, China Biology Medicine, China National Knowledge Infrastructure, Wanfang Data, and Chinese Scientific Journal Database from the inception of the database to 18 Aug 2023. Following literature screening, data extraction, standardised processing, frequency analysis, association rules analysis, and correlation analyses were conducted using Microsoft Excel, IBM SPSS Modeller, Cytoscape, and R software.

Results: Zusanli (ST36), Tianshu (ST25), and Shangjuxu (ST37) were the most used acupoints. The stomach meridian, conception vessel, and bladder meridian were the more commonly used. The Five-shu points were the most used acupoints. The Shangjuxu-Tianshu (ST37-ST25) combination was the most common acupuncture combination in clinical settings. Furthermore, the acupoints ST36, ST25, Zhongwan (CV12), and Guanyuan (CV4) constituted the core groups of acupoints.

Conclusion: We summarized the current characteristics of acupuncture treatment for FGIDs, including the selection of acupoints, meridians, and specific acupoints. The stomach meridian of foot-yangming is frequently utilised, as it aligns with the core meridian theory of "Where the meridian passes through, that's the key point of healing" and "The relationship between meridians and internal Zangfu (脏腑)". The treatment of FGIDs focuses on specific acupoints, with the most effective option being the combination of the Front Mu and Lower-he(sea) points. These findings provide novel insights for the clinical management of FGIDs.

Keywords: Acupuncture; Data mining; Acupoints compatibility rules

Introduction

Functional gastrointestinal disorders (FGIDs), commonly referred to as disorders of the gut-brain interaction, are digestive disorders that arise from the interplay of physiological, psychosomat-

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ic, and social factors (1). Primary clinical manifestations include symptoms related to the digestive system, such as abdominal distension, abdominal pain, diarrhea, and constipation. These symptoms are categorized and named according to the characteristics of symptoms, including irritable bowel syndrome, functional dyspepsia, and functional constipation, among others (2, 3). Globally, FGIDs affect approximately 40% of the population (4), resulting in significant healthcare costs (5, 6) and reducing overall health-related quality of life (7).

Currently, the available therapeutic choices include lifestyle adjustments, dietary modifications, and therapies that manipulate the gut microbiota, such as faecal microbiota transplantation. Additionally, prokinetics, antispasmodics, laxatives, and neuromodulators that act on both the central and peripheral nervous systems are also viable options (8). Existing pharmacological interventions for functional dyspepsia have limited efficacy and may cause undesirable side effects (9). For example, 5-hydroxytryptamine 3 antagonists, which are neuromodulators, can induce ischemic colitis (10).

Acupuncture, an important component of traditional Chinese medicine, is an effective and safe with few sides effects treatment method of complementary and alternative medicine (11, 12). Globally, including in Western countries, acupuncture is increasingly accepted as an alternative treatment for FGIDs (13). Notably, acupuncture is effective in the treatment of FGIDs, including diarrhea and constipation irritable bowel syndrome (14), functional dyspepsia(15), functional constipation (16), functional anorectal pain (17), functional diarrhoea (18), and functional defaecation disorder (19). Furthermore, medical evidence suggests that acupuncture is feasible and safe for FGIDs (20-23). Currently, research on acupoint selection for FGIDs has only analysed the frequency of acupoint use, and there are issues such as the limited scope of the search database and limited involvement in functional gastrointestinal diseases (24).

Therefore, we aimed to provide a comprehensive summary of the prescription of acupuncture treatment for FGIDs and to ascertain the features of acupoint compatibility using data mining techniques, such as association rule mining, network analysis, and correlation analysis.

Materials and Methods

Data Collection

Research articles on the treatment of FGIDs using acupuncture published from the inception of the database to 18 Aug 2023 were retrieved from the four Chinese and four English databases (China Biology Medicine, China National Knowledge Infrastructure, Wanfang Data, and Chinese Scientific Journal Database, PubMed, Embase, Web of Science, and Cochrane Library). Medical Subject Headings terms and free words were used in the search: Acupuncture, Electroacupuncture, Electro-acupuncture, Acupuncture Treatment, Acupuncture Treatments, Functional heartburn, Functional dysphagia, Functional abdominal pain syndrome, Functional dyspepsia, Globus sensation, Functional belching disorder, Functional nausea and vomiting, rumination syndrome, Irritable bowel syndrome, Functional bloating, Functional constipation, Functional diarrhoea, sphincter of Oddi dysfunction, Functional faecal incontinence, Functional anorectal pain, and Functional defaecation disorder. The full search strategy is shown in Appendix 1.

Inclusion Criteria

The inclusion criteria were based on the Cochrane Handbook (25) and previous data mining (26). 1) Type of study: Randomised controlled trials (RCTs) with acupuncture or electroacupuncture. 2) Participants: patients with FGIDs, with no restrictions based on age, sex, and disease duration. 3) There are clear acupoint prescriptions and Rome diagnostic criteria in the literature.

Exclusion Criteria

The exclusion criteria were based on the Cochrane Handbook(25) and previous data mining (26): 1) newspapers, academic conference pa-

pers, theses and dissertations, animal experiments, literature reviews, case reports, and the experiences of famous doctors; 2) duplicate publications, of which only one earlier publication was retained; 3) personal experience points, Dong's extraordinary points, other non-fourteen meridians acupoints and non-traditional forms of acupuncture; and 4) trials comparing the efficacies of different acupuncture therapies or acupuncture point extraction protocols.

Data Extraction

Two researchers independently screened the eligible articles based on the inclusion and exclusion criteria. To resolve possible disagreements, the article was screened by a third researcher. First, NoteExpress (Version: 3.2.0.7705; Country: China; Developer: Aegean Software Corporation; Website: http://www.inoteexpress.com/aegean/) was used to deduplicate the retrieved literature. After reading the titles and summaries, irrelevant articles were excluded. The full text was then carefully read for the final screening of the articles. Finally, an Excel dataset of acupuncture treatments for FGIDs was established, which included the following information: title of the article, author, date of publication, type of disease, diagnostic criteria, interventions, main acupoints, and additional acupoints.

Standardized Processing

Following to the World Health Organization's Standard Acupuncture Point Location in the Western Pacific Region (27), the China National Standard 'Naming and Positioning of Acupoints' (GB/T 12346-2021) (28), and International Classification of Diseases 11th Revision (29), the names of the diseases and acupuncture points in the Excel data were standardized.

Data Analysis

Descriptive Analysis The frequency of acupoints, meridians, and specific points in the established database were analysed by using Excel (Version:2019; Country: USA; Developer: Microsoft Corporation; Website: https://www.microsoftstore.com.cn/).

Association Rule Analysis Apriori algorithm is a collection of items that occur more than or equal to the minimum support threshold in a dataset to identify interesting associations or patterns between the variables in the dataset (30). Using the Apriori algorithm of IBM SPSS Modeler (Version: 18.0; Country: USA; Developer: International Business Machines Corporation; Website: https://www.ibm.com/docs/zh/spss-modeler), the included acupoint prescriptions were ranked and combined. The minimum support degree was set to 15% and the minimum confidence degree to 70% to obtain a combination of acupoints with higher association law. The specific acupoint-meridian relationships, acupoint-acupoint associations, and disease-acupoint co-occurrence networks were visualised using Cytoscape (Version: 3.9.0; Country: USA; Developer: The Cytoscape Consortium; Website: https://cytoscape.org/).

Correlation Analysis The correlation coefficient is mainly used to examine the correlation between two or more variables (31). In the study of compatibility rules, acupoints are sometimes used as variables to calculate the correlation between two acupoints to show or prove the connection between the core acupoints(32). To calculate of the correlation between two categorical variables, a better choice in theory is the phi coefficient (33). Correlation analysis and acupoint visualisation were performed using R Studio (Version: 4.3.1; Country: Austria; Developer: R Foundation for Statistical Computing; Website: https://www.r-project.org/).

Results

Retrieval Results of Literature

We identified 8,897 articles and excluded 3,796 duplicate studies. After reading the titles and abstracts of the articles, 2,837 studies were extracted. Finally, 984 RCTs were included after examining the full texts according to the inclusion and exclusion criteria (Fig. 1). Eleven functional gastrointestinal diseases were included: irritable bowel syndrome, functional dyspepsia, functional

constipation, functional diarrhoea, functional anorectal pain, functional defaecation disorder, functional faecal incontinence, sphincter of Oddi dysfunction, functional abdominal pain, functional heartburn, and globus sensation. The top five functional gastrointestinal diseases were irritable bowel syndrome, functional dyspepsia, functional constipation, functional diarrhoea and functional anorectal pain, with a total of 969 articles (Fig. 2). Therefore, this study began with data analysis of these five diseases. We classified 969 articles into low-, moderate-, and high-quality based on the journals in which they were published. We included Science Citation Index and A Guide to the Core Journal of China as high-quality studies, The Key Magazine of China Technology, Chinese Science Citation Database, and Emerging Sources Citation Index as moderate-quality studies, and other general journals as low-quality studies (Fig. 3).

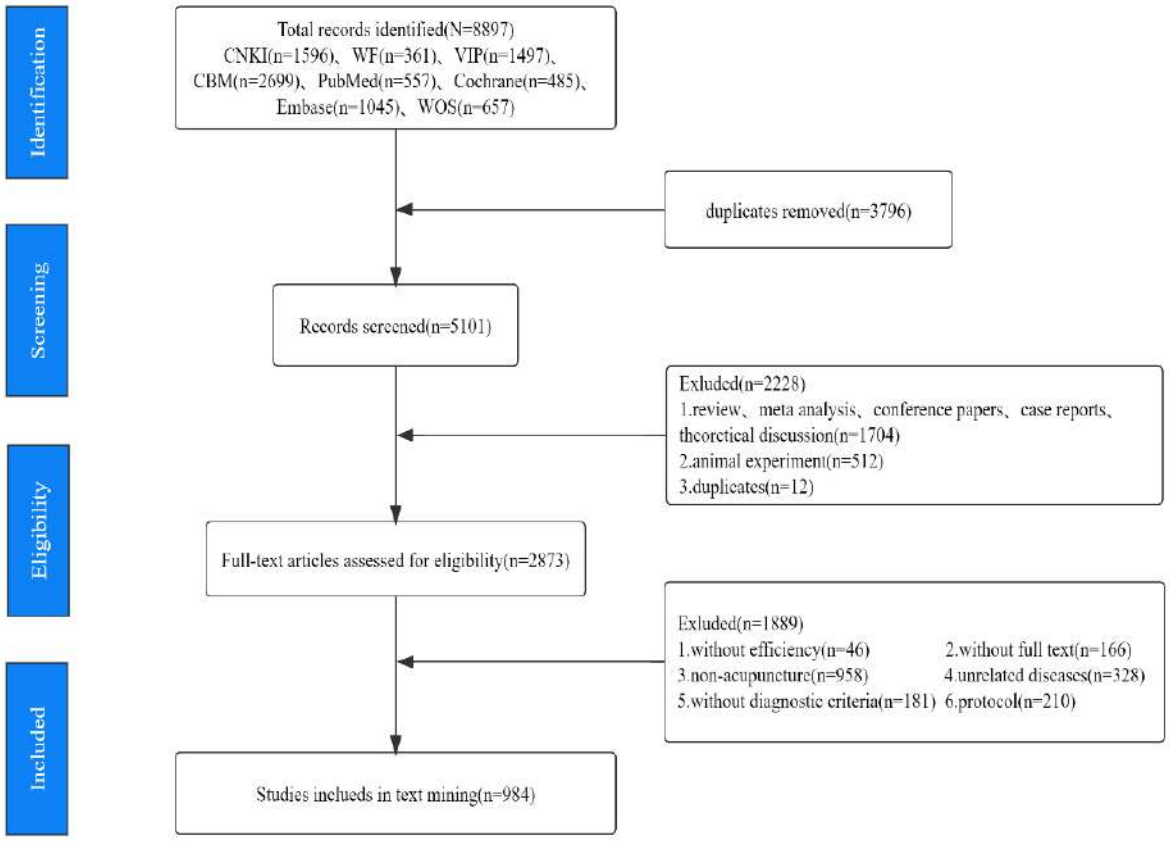

Fig. 1: Flowchart for the selection of RCTs. CNKI, China National Knowledge Infrastructure; WF, Wanfang Data; VIP, Chinese Scientific Journal Database; CBM, China Biology Medicine; WOS, Web of Science

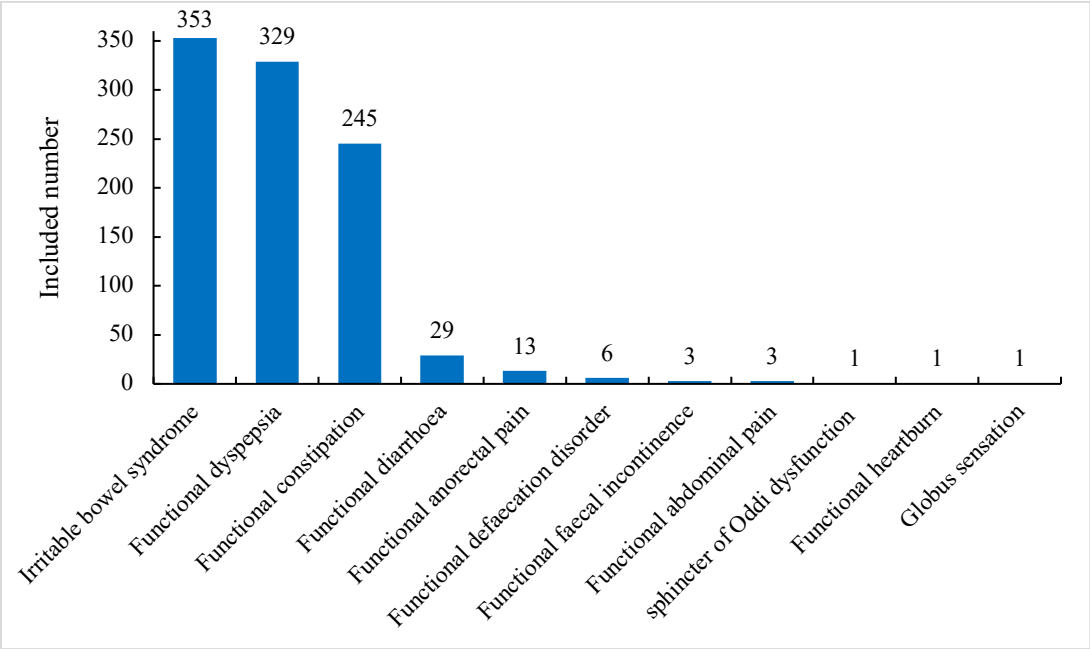

Fig. 2: Quantity of published articles of acupuncture for FGIDs

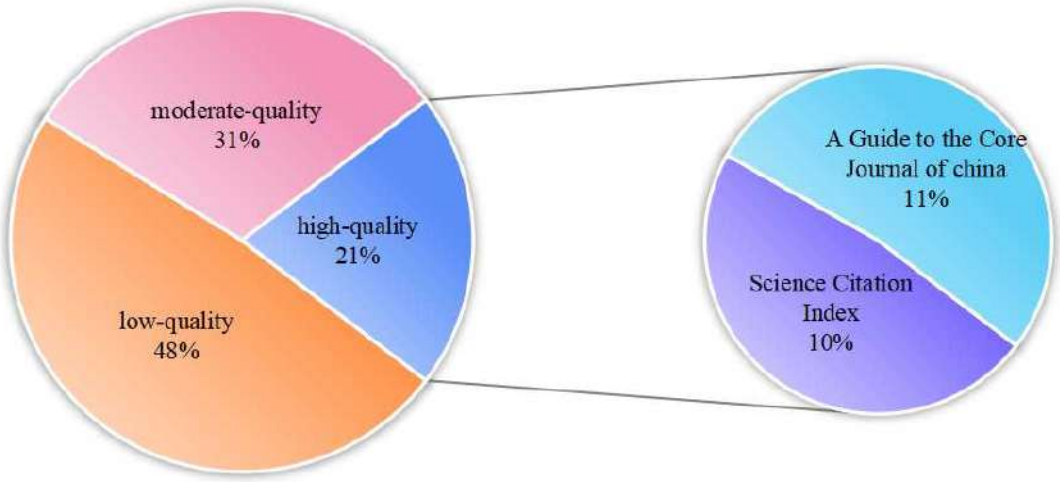

Fig. 3: The distribution of high-, moderate-, and low-quality studies

Frequency of Acupoint Analysis

The acupoint prescriptions in the literature of the previously mentioned five FGIDs were extracted and normalized to include 969 prescriptions involving 132 acupoints, with frequency of 5,431 uses of the acupoints. The top 10 acupoints used in acupuncture for the treatment of FGIDs were Zusanli (ST36), Tianshu (ST25), Shangjuxu (ST37), Zhongwan (CV12), Taichong (LR3), Neiguan (PC6), Sanyinjiao (SP6), Pishu (BL20), Dachangshu (BL25) and Qihai (CV6)with a total use frequency of 3,458 (63.67%) (Table 1).

Table 1: Frequent use of acupuncture points for the treatment of functional gastrointestinal diseases

No.	Acupoint	Frequency	Proportion	Meridian Distribution
1	ST36	706	72.86%	Stomach meridian of foot-yangming
2	ST25	632	65.22%	Stomach meridian of foot-yangming
3	ST37	409	42.21%	Stomach meridian of foot-yangming
4	CV12	401	41.38%	Conception Vessel
5	LR3	294	30.34%	Liver meridian of foot-jueyin
6	PC6	262	27.04%	Pericardium meridian of hand-jueyin
7	SP6	252	26.01%	Spleen meridian of foot-taiyin
8	BL20	174	17.96%	Bladder meridian of foot-taiyang
9	BL25	170	17.54%	Bladder meridian of foot-taiyang
10	CV6	158	16.31%	Conception Vessel

Includes 969 prescriptions, Proportion = (frequency of use of acupoint ÷ number of prescriptions included) × 100%.

Frequency of Meridian Analysis

By analysing the attribution of the mentioned 132 acupoints to the meridians, the acupoints used in acupuncture treatment for FGIDs were widely distributed in the twelve main meridians and the Ren and Du meridians. Among these meridians, the ones with the highest frequency were the Stomach meridian (23 acupoints), the Conception Vessel (7 acupoints), the Bladder meridian (26 acupoints), the Spleen meridian (11 acupoints), and the Liver meridian (7 acupoints) (Table 2).

Table 2: Frequent use of meridian application for the treatment of functional gastrointestinal diseases

Meridian	Frequency	Proportion	Acupoint
Stomach meridian of foot-yangming	1966	36.20%	ST36(706), ST25(632), ST37(409), ST40(40), ST44(38), ST34(37), ST39(31), ST42(25), ST21(20), ST29(10), ST28(10), ST23(9), ST24(6), ST26(4), ST27(3), ST35(3), ST38(3), ST33(3), ST32(2), ST43(2), ST20(1), ST9(1), ST2(1)
Conception Vessel	858	15.80%	CV12(401), CV6(158), CV4(153), CV10(61), CV13(23), CV17(16), CV8(15), CV11(14), CV9(12), CV14(2), CV5(2), CV21(1)
Bladder meridian of foot-taiyang	686	12.63%	BL20(174), BL25(170), BL21(99), BL18(68), BL23(48), BL33(23), BL34(20), BL32(18), BL57(12), BL31(12), BL15(8), BL19(5), BL17(5), BL27(5), BL22(3), BL62(3), BL30(2), BL13(2), BL60(2), BL38(1), BL26(1), BL8(1), BL24(1), BL66(1), BL40(1), BL54(1)
Spleen meridian of foot-taiyin	527	9.70%	SP6(252), SP4(87), SP9(84), SP14(46), SP15(39), SP3(9), SP8(3), SP10(3), SP7(2), SP13(1), SP5(1)
Liver meridian of foot-jueyin	391	7.20%	LR3(294), LR14(36), LR13(28), LR2(28), LR5(3), LR8(1), LR6(1)
Pericardium meridian of hand-jueyin	271	4.99%	PC6(262), PC7(4), PC3(4), PC8(1)

Table 2: Continued...

Governor Vessel	246	4.53%	GV20(112), GV24+(71), GV4(20), GV24(18), GV1(14), GV2(4), GV23(2), GV11(2), GV16(2), GV26(1)
Large intestine meridian of hand-yangming	165	3.04%	LI4(93), LI11(66), LI3(3), LI10(2), LI18(1)
Triple energizer meridian of hand-shaoyang	99	1.82%	TE6(95), TE5(2), TE4(1), TE3(1)
Gallbladder meridian of foot-shaoyang	64	1.18%	GB34(40), GB13(6), GB37(3), GB40(3), GB36(3), GB41(3), GB4(2), GB21(1), GB25(1), GB19(1), GB24(1)
Kidney meridian of foot-shaoyin	56	1.03%	KI6(26), KI3(22), KI7(3), KI18(3), KI4(1), KI16(1)
Heart meridian of hand-shaoyin	33	0.61%	HT7(31), HT3(2)
Extraordinary points	33	0.61%	EX-HN1(19), EX-UE10(6), EX-B2(4), EX-UE2(2), Anmian(1), EX-B3(1)
Lung meridian of hand-taiyin	5	0.09%	LU9(2), LU5(1), LU7(1), LU1(1)
Small intestine meridian of hand-taiyang	1	0.02%	SI14(1)

Total frequency of 5431 uses of the acupoints, Proportion = (frequency of use of meridian ÷ total frequency use of the acupoints) × 100%.

Specific Acupoints Analysis

The specific acupoints used for acupuncture treatment of FGIDs contained Five Shu points, Yuan-primary points, and Back Shu points, with a frequency of 6,194 times. Yanglingquan (GB34), Gongsun (SP4), and Lieque (LU7) belonged to various specific points. The total number of acupoints after removing duplicated acupoints was 70, with a frequency of 4,353 times. Five Shu points involve 27 acupoints such as Zusanli (ST36), Taichong (LR3), and Zhigou (TE6). Front Mu acupoints involve11 acupoints such as Tianshu (ST25), Zhongwan (CV12), and Juque (CV4). Lower-he (sea) points involve five acupoints such as Shangjuxu (ST37), Xiajuxu (ST39), and Weizhong (BL40) (Table 3). To further analyse the meridian distribution of high-frequency specific acupoints, specific acupoints with a frequency of more than 40 times were selected for meridian distribution analysis (Fig. 4). The meridian of clinically commonly used specific acupoints was in line with the results of the meridian distribution of acupoints.

Table 3: Frequent use of special acupoints application for the treatment of functional gastrointestinal diseases.

Special acupoints	Frequency	Proportion	Acupoints
Five Shu points	1344	30.86%	ST36(706), LR3(294), TE6(95), SP9(84), LI11(66), GB34(40), ST44(38), HT7(31), LR2(28), KI3(22), SP3(9), PC3(4), PC7(4), KI7(3), LI3(3), GB41(3), LU9(2), ST43(2), HT3(2), BL60(2), PC8(1), TE3(1), BL66(1), SP5(1), LR8(1), BL40(1), LU5(1)
Front Mu points	1273	29.24%	ST25(632), CV12(401), CV4(153), LR14(36), CV17(16), LR13(28), CV14(2), CV5(2), GB25(1), GB24(1), LU1(1)
Lower-he(sea) points	1187	27.27%	ST36(706), ST37(409), GB34(40), ST39(31), BL40(1)
Back Shu points	582	13.37%	BL20(174), BL25(170), BL21(99), BL18(68), BL23(48), BL15(8), BL19(5), BL27(5), BL22(3), BL13(2)
Eight influential points	492	11.30%	CV12(401), GB34(40), LR13(28), CV17(16), BL17(5), LU9(2)
Yuan-primary points	484	11.12%	LR3(294), LI4(93), HT7(31), ST42(25), KI3(22), SP3(9), PC7(4), GB40(3), LU9(2), TE4(1)
Luo-connecting points	413	9.49%	PC6(262), SP4(87), ST40(40), GV1(14), LR5(3), GB37(3), KI4(1), LU7(1), TE5(2)
Eight confluent points	384	8.82%	SP4(87), BL62(3), KI6(26), GB41(3), TE5(2), PC6(262), LU7(1)
Xi (Cleft) points	44	1.01%	ST34(37), GB36(3), SP8(3), LR6(1)

The total frequency of 4,353 uses of the special acupoints, Proportion = (frequency of use ÷ total frequency use of the special acupoints) × 100%.

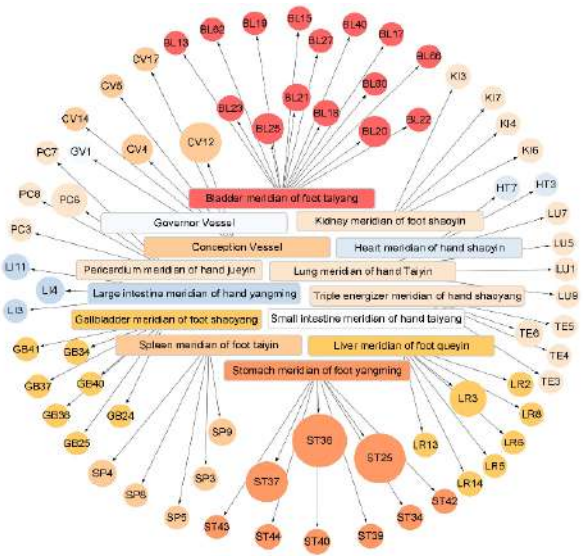

Fig. 4: The meridian distribution of special acupoints for FGIDs. The redder the color of the meridian node, the larger the area of the acupoint node, indicating that the higher the frequency.

Association Rule Mining Analysis

Acupoint-acupoint association rule mining analysis

Finally, 33 association rules were generated. The top 10 rules were ranked according to the confidence degree shown in Table 4. The association law of the acupoints was visualised and analysed in Fig. 5. Support is used to measure the frequency of acupoints in association rules. Confidence reflects the probability of two acupoints co-

occurrence. Lift reflects the correlation between the two points in the association rule, with lift > 1 and higher indicating higher positive correlation, lift < 1 and lower indicating higher negative correlation, and lift = 1 indicating no correlation. The combination of Tianshu (ST25)-Zusanli (ST36) had the highest frequency of simultaneous occurrence among the included acupoint prescriptions. There was a 71.84% probability of choosing ST36 among the acupoint prescriptions that selected ST25. However, the association lift in this group was 0.99. Shangjuxu (ST37)-Tianshu (ST25) had high support and lift.

Table 4: Association rules of acupoints for functional gastrointestinal diseases treatment.

Ex-item	Post-items	Support	Confidence	Lift
ST25	ST36	65.22	71.84	0.99
ST37	ST25	42.21	88.02	1.35
CV12	ST36	41.38	87.03	1.19
ST37 and ST25	ST36	37.15	71.94	0.99
LR3	ST25	30.34	75.85	1.16
LR3	ST36	30.34	91.50	1.26
LR3 and ST36	ST25	27.76	75.46	1.16
CV12 and ST25	ST36	27.14	84.03	1.15
PC6	ST36	27.04	93.89	1.29
SP6	ST25	26.01	80.16	1.23

Ex-item is defined as A, and Post-item is defined as B. Support=P(A&B): the frequency with itemset A and itemset B appearing in acupuncture prescriptions at the same time; Confidence=P(A&B)/P(A): itemset A appearing in the presence of itemset B; Lift=(P(A&B)/P(A))/P(B); A and B occurred simultaneously; this acupuncture prescription is valuable when the lift value is greater than 1.

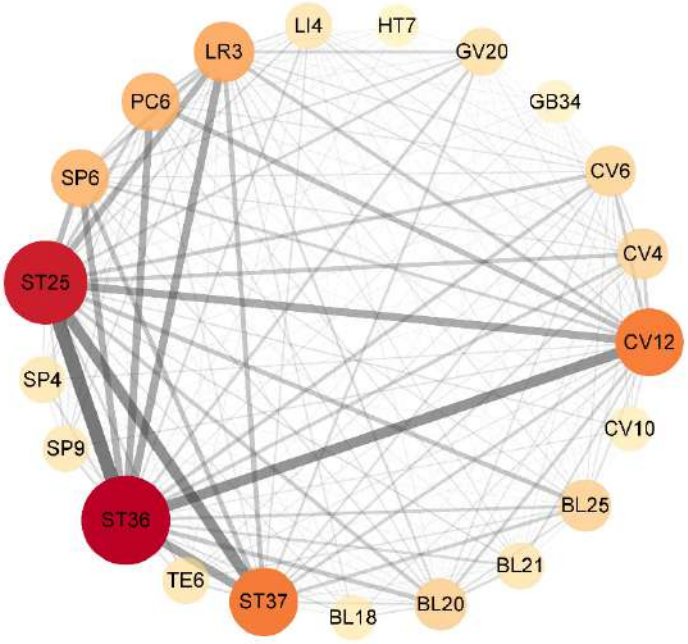

Fig. 5: Acupoints association network of acupuncture for FGIDs treatment. The higher the support, the thicker the connection, and the darker the color. The higher the frequency of acupoints, the deeper the color of the area.

Disease-acupoint association rule mining analysis

Acupoints that were used more frequently than the mean value in the treatment of each FGIDs were selected. Cytoscape software was used to construct the co-occurrence network of five common FGIDs (namely, irritable bowel syndrome, functional dyspepsia, functional constipation, functional diarrhoea and functional anorectal pain) with the co-occurrence network of these acupoints (Fig. 6). Zusanli (ST36), Tianshu (ST25), Zhongwan (CV12), and Guanyuan (CV4) were highly associated with the above-mentioned FGIDs; a group of acupoints with "ST36, ST25, CV12, CV4" as the core was formed to treat irritable bowel syndrome, functional constipation, functional diarrhoea, and functional dyspepsia. FGIDs with different clinical conditions have their own commonly used acupoint prescriptions. For example, functional anorectal pain is often paired with Shangliao (BL31), Ciliao (BL32), Zhongliao (BL33), and Xialiao (BL34).

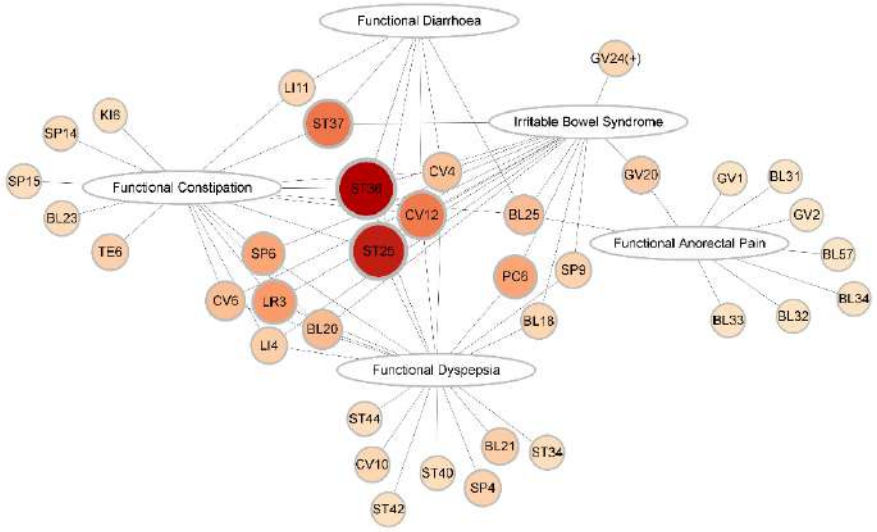

Fig. 6: Acupoints association network of acupuncture for FGIDs treatment. The higher the frequency of acupoints, the deeper the color of the area

Correlation analysis of high-frequency acupoints

We used R studio software to analyse phi correlations for acupoints with a frequency greater than 40 times. A heat map of the phi correlation coefficients is shown in Fig. 7. A total of 31 sets of cave pairs were statistically significant. When the phi coefficient is greater than 0.6, it indicates a moderate correlation(34, 35). Three pairs had cave pair correlation coefficients greater than 0.6: Fenglong (ST40) - Liangqiu (ST34) (Phi=0.69); Pishu (BL20)-Weishu (BL21) (Phi=0.61); and Baihui (GV20)-Yintang (GV24+) (Phi=0.67).

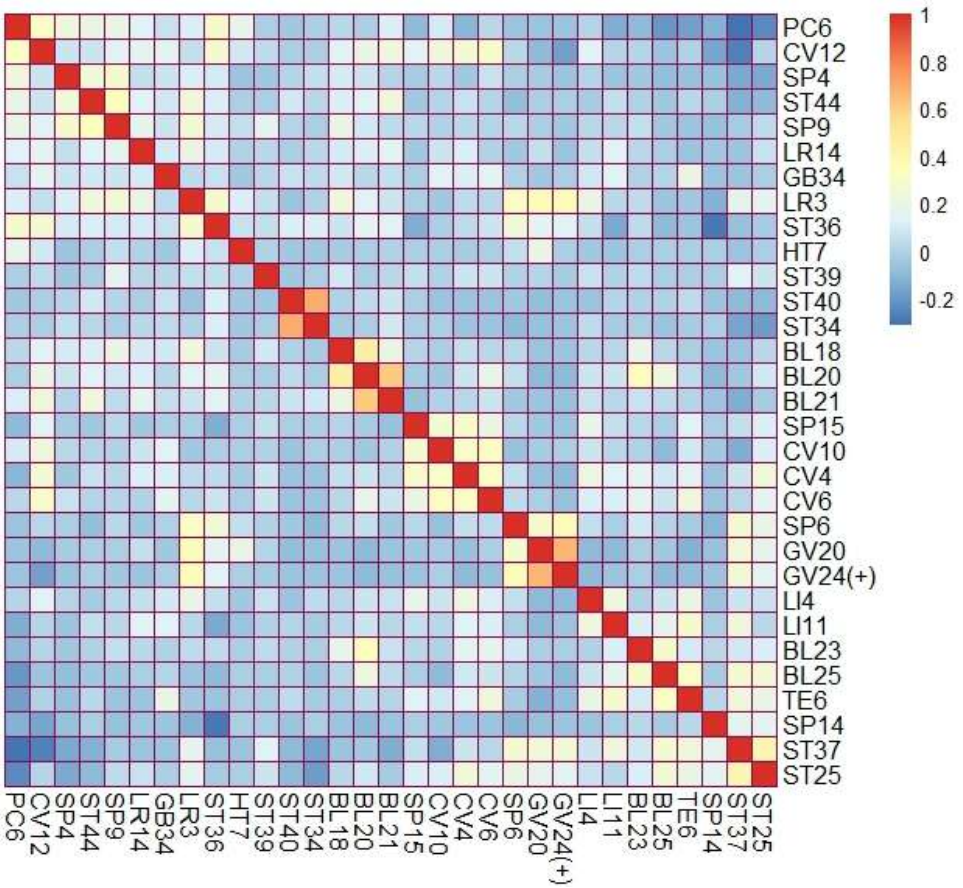

Fig. 7: Phi correlation analysis of high-frequency acupoints for FGIDs treatment. The redder the color, the greater the Phi coefficient

Discussion

Frequency analysis of the acupoints and meridians revealed that the acupoints associated with functional gastrointestinal disorders (FGIDs) encompassed 14 meridians and extra-meridian acupoints. The stomach meridian of foot-yangming, conception vessel, and bladder meridian of foot-taiyang had greater utilisation frequencies, with the top three acupoints (ST36, ST25, and ST37) being the stomach meridian of the foot-yangming acupoints. The stomach meridian of foot-yangming extends from the head and face, passes through the chest and abdomen, and descends to the tarsal region of the foot. This meridian is extensively dispersed throughout the body, linking many meridians and Zangfu (脏腑), and has the ability to regulate the Qi (气) of the spleen and stomach (36). The conception vessel originates from the perineum and ascends along the central line of the abdomen, terminating at the uppermost point where the abdominal circulation intersects the stomach and intestines (37). The bladder meridian of foot-taiyang conducts the follow of yang Qi (气) through the body, traversing the waist and back. Modern studies of acupoint structure have revealed that the Back-shu points of the bladder meridian of foot-taiyang are situated at the convergence point and branch site of the posterior branch of the spinal nerve, or are associated with the somatic and autonomic nerves(38-40). This provides contemporary anatomical evidence for the efficacy of treating Zangfu (脏腑) viscera diseases using the Back-shu points.

An analysis of specific acupoints use found that the most frequently used acupoints for the treatment of FGIDs are Five shu points, Front Mu points, and lower-he (sea) points. Specific acupuncture points are used more often than are non-specific ones. The location of mu points corresponds to internal organs, which is the concrete embodiment of the Qi (气) flow injection of the five zang organs and six fu organs. It can not only treat the visceral pathology but also treat the phase of superficial visceral disease and viscera-related tissue and organ diseases (41). The Lower-he(sea) point is the Qi (气) of the six fu viscera (gallbladder, stomach, large intestine, small intestine, bladder, sanjiao (三焦) that converge with the foot of the three-yang meridian. Ling shu (Miraculous Pivot):"employing he points to treat disorders of fu organs", the Lower-he (sea) point for regulating the function of the six fu viscera plays an important role (42). Modern research has found that acupuncture can stimulate the vagus nerve and sympathetic nerve, promote the release of neurotransmitters, thereby regulating gastrointestinal peristalsis and improving gastrointestinal dysfunction (43). Acupuncture also regulates the neuroendocrine network of the gastrointestinal tract, promotes the normal secretion of gastrointestinal hormones, modulates the function of the immune system, attenuates inflammatory responses, and facilitates the recovery of gastrointestinal function (44). In addition, acupuncture can regulate the states of insula, anterior cingulate cortex, orbitofrontal cortex, medial prefrontal cortex and hypothalamus in the homeostatic afferent processing network of the brain, and improve the state of gastrointestinal function by affecting the brain-gut axis (45, 46, 15).

The association rule analysis determined that the support for the ST25-ST36 connection was the strongest. However, an enhancement value of 0.99, which is close to 1, indicates that the ST25-ST36 association is invalid. This implies that the two elements, ST25 and ST36, may exist independently of each other. ST25 or ST36 is primarily used when a solitary acupoint is chosen for the treatment of FGIDs. ST37-ST25 has significant support and lift. ST37 corresponds to the Front Mu point of the large intestine of hand-yangming, while ST25 corresponds to the Lower-he(sea) point of the large intestine of hand-yangming. Both these points are part of the stomach meridian of foot-yangming. It is a well-known and successful combination of acupoints called "combining Front Mu and Lower-he(sea) points". This combination is commonly used to treat stomach pain, diarrhoea, and constipation (47-49). ST37-ST25 can hinder the activity of TRPV1, inhibiting the release of inflammatory factors and disrupting the NGF/TrkA signalling pathway(50, 51). ST37-ST25 can also regulate the hypothalamic-pituitary-adrenal axis and lead to a decrease in anxiety and depression symptoms in individuals with FGIDs(52, 53). Electroacupuncture involving ST37-ST25 can increase the expression of NLRP6 in the intestine, promote the secretion of antimicrobial peptides, participate in shaping the gut microbiota-host interaction interface, and regulate gut microbiota homeostasis (54).

To establish and evaluate the core network of connections between acupoints selected for the five FGIDs. The results showed that the core group of acupoints consisted of ST36, ST25, CV12, and CV4. ST36 and CV12 represent the Lower-he (sea) and Front Mu points of the stomach. The combination of these points, known as the combined Front Mu and Lower-he (sea) points, is said to have a more effective healing effect than that using a single acupoint for FGIDs (55). A recent study demonstrated the efficacy of this core prescription in the treatment of irritable bowel syndrome (56). However, the effectiveness of the core prescriptions in the treatment of other FGIDs needs to be verified through extensive clinical trials.

The correlation analysis of high-frequency acupoints showed that ST40-ST34, BL20-BL21, and GV20-GV24+ acupoints were strongly correlated. ST40 acupuncture attenuates pain behaviour, inhibits class C fiber reflex myoelectricity, and produces analgesic effects in rats with inflammatory pain models (57). Acupuncture at ST34 attenuates the activation of the thalamus, anterior

cingulate gyrus, insula, and other brain regions that manage pain (58). Therefore, in patients with pain, ST40 and ST34 can be selected. BL20 and BL21 are the Back Shu points of the Bladder that can regulate the expression of Cajal mesenchymal stromal cells and improve gastrointestinal motility (59). BL20 and BL21 can be used with the Qi (气) deficiency of the spleen and stomach. Acupuncture of GV20 can increase dopamine, norepinephrine, and 5-hydroxytryptamine levels in the brain, which can improve brain function and reduce mood symptoms (60, 61). GV24+ is in the frontal area between the two eyebrows, and this area is innervated by the trigeminal nerve. Stimulation of the trigeminal nerve can cause changes in cortical excitability, thereby affecting the central nervous system regulation and relieving depression and other symptoms of bad moods (62). In summary, GV20 and GV24+ can be used to treat patients with sleep disorders, depression, and anxiety. These acupoint combinations may provide a reference for research on new prescriptions for the clinical treatment of FGIDs. However, the validity of the analysed results remains to be clinically tested (63).

In this study, we incorporated a more comprehensive database, resulting in a broader coverage of the literature than that observed in previous research. Previous studies focused on a single disease, FGID includes a variety of diseases, and our analysis includes a wider range of these diseases. We also conducted a correlation analysis of HF acupoints, to further summarize in depth the rules of clinical point selection and optimize the treatment plan (24). Thus, our findings are more representative and generalisable. Furthermore, our research suggests that the selection of acupoints for treating FGIDs should prioritise the principle of "combining Front Mu and Lower-he (sea) points". This discovery provides new guidance for clinical acupuncture treatment and enriches the existing theories and practices.

This study has some limitations. We searched four Chinese and four English databases, indicating the variable quality of the included literature. Currently, data mining methods cannot not be used to evaluate the quality of literature. Our analysis focused on acupoint selection. For the same study, we only input effective acupuncture and moxibustion prescription information, which aims to ensure the unity and consistency of data analysis. Therefore, we exclude studies that compared different acupuncture and moxibustion prescriptions as well as studied that used the same acupuncture and moxibustion prescription but different acupuncture methods. However, this also means that our research may have overlooked some valuable prescription information and their relative efficacy, such as the relative advantages and effects of different moxibustion techniques in the treatment of FGIDs. In the future, a system suitable for evaluating the quality of data mining literature can be established by referring to the meta-analysis quality evaluation method to improve the quality of data mining results. In addition, the common criteria used to evaluate the efficacy of FGID treatment in research are mainly based on subjective rating scales. Therefore, more objective indicators are required to evaluate the efficacy of acupuncture.

Conclusion

The most used meridian for the treatment of FGIDs is the stomach meridian of foot-yangming. The most used acupoints (Zusanli and Tianshu) belong to foot-yangming, reflecting the meridian theory of "Where the meridian passes through, that's the key point of healing" and "The relationship between meridians and internal Zangfu (脏腑)". The treatment of FGIDs is based on specific acupoints, and the optimal choice is the combination of Front Mu and Lower-he(sea) points (Tianshu and Shangjuxu). According to the theory of meridian identification, appropriate host-guest point associations should be selected. This study provides a reference for the selection of acupuncture points for the treatment of FGIDs and a direction for optimising acupuncture point pairings for clinical acupuncture treatment of these diseases.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

Availability of supporting data

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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