

Review Article

The application of acupoints and meridians in the treatment of postoperative gastrointestinal dysfunction: a data mining-based literature review

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Abstract: Background: Postoperative gastrointestinal dysfunction (PGD) is a common complication after surgery. Acupuncture is considered a crucial complementary alternative therapy with a high efficiency in treating PGD. The selection of the acupoints is critical to acupuncture treatment, but the fundamental rules of acupoint selection and combination have not yet been reported. Objective: The present study aimed to delve into the mechanisms of acupoint selection and combination to treat PGD based on data mining technology. Methods: PubMed, the China National Knowledge Infrastructure (CNKI), and the Chinese Biomedical Database (CBM) were searched for works published from 2009 to 2019 by computer. The database of acupuncture prescriptions for treating PGD was built using Excel 2019. Subsequently, a descriptive analysis was conducted using SPSS 25.0. Next, with the use of SPSS modeler 18.0, the association and complex network analysis was conducted. Result: A total of 204 relevant articles were retrieved. The number of specific acupoints made up 71.43% of all acupoints, and the frequency of the specific acupoints reached 90.28% of the total frequency. According to the frequency and association analysis, *Zusanli* (ST-36), *Shangjuxu* (ST-37), *Neiguan* (PC-6), *Tianshu* (ST-25), *Zhongwan* (CV-12), *Xiajuxu* (ST-39), and *Sanyinjiao* (SP-6) were the most common acupoints with the most robust associations. Most core acupoints were taken from the Stomach Meridian of Foot *Yangming* and Conception Vessel. The acupoints were primarily located in the lower limbs, chest, and abdomen. Conclusion: Data mining is capable of effectively characterizing acupoint selection and combination. The acupoint selection and combination comply with the theory of traditional Chinese Medicine, and the results are expected to be employed in clinical practice.

Keywords: Postoperative gastrointestinal dysfunction, acupuncture, data mining, clinical research, traditional Chinese Medicine

Introduction

Postoperative gastrointestinal dysfunction (PGD) is a common gastrointestinal complication resulting from comprehensive factors (e.g., trauma, anesthesia, inflammatory reaction, and body temperature). It can cause several uncomfortable symptoms, including abdominal distention, constipation, nausea, vomiting, etc. [1]. Current research indicates that, with the occurrence of PGD, inpatients' prognosis will be affected, the use of medical resources and nursing costs will increase, and even more deaths will occur [2]. The early recovery of gastrointestinal function is critical to patients' po-

stoperative rehabilitation; it can have nutritional benefits, accelerate anastomotic stoma healing, and mitigate postoperative complications [3]. Acupuncture is considered a critical therapy in traditional Chinese Medicine (TCM), effectively intervening with gastrointestinal dysfunction [4-6]. In recent years, there has been an increasing number of patients seeking alternative therapies in clinical practice, so more relevant studies of acupuncture for treating PGD have been conducted in a wide range of databases [7, 8]. Nevertheless, no prescription of acupuncture for treating PGD has been internationally accepted, and there has not been any data mining of clinical studies reporting on acu-

puncture for treating PGD. In this study, data mining was adopted to explore the acupoint selection strategies and acupoint combination rules of acupuncture for treating PGD. The potential treatment strategies explored by data mining can provide clinicians TCM research ideas; these strategies can also help researchers establish specific databases of acupuncture prescriptions for treating PGD and use them in the clinic.

Materials and methods

Data sources

One English-language database: (PubMed) (<http://www.pubmed.com>), two Chinese databases: China National Knowledge Infrastructure (CNKI) (<http://www.cnki.net>), and China Biomedical Database (CBM) (<http://www.sinomed.ac.cn>) were searched; a time limit of 10 years was prescribed, from 2009 to 2019. The searching target was limited to the modern articles about acupuncture, moxibustion, or a combination of the two for treating PGD patients. Eligible studies were only searched in the electronic databases, and the languages were limited to English and Chinese.

Literature search strategy

In terms of the free search and subject search terms, “acupuncture, needle, electroacupuncture, hand-acupuncture, moxibustion, acupoint, [and] meridian” were used; these words were linked with “OR”. The English medical subject term was limited to “postoperative gastrointestinal dysfunction” in accordance with Medical Subject Headings [9]. The Chinese medical subject term was limited to (postoperative gastrointestinal dysfunction) consistent with the Chinese translation of the term used in Medical Subject Headings.

Types of studies

Inclusion criteria: Clinical trials that evaluated the effect of acupuncture for treating PGD, with or without the methods of randomization and/or control. The latest articles would be included if there were duplicate publications from the same author. The research objects were participants with PGD.

In terms of the exclusion criteria, reviews, animal trials, case reports, systematic reviews and meta-analyses were excluded.

Types of intervention

For the inclusion criteria, the following were covered: clinical trials that employed acupoints as the primary action points and adopted acupuncture therapies as the main treatment methods; acupuncture and moxibustion could be used alone or jointly with other interventions. Acupuncture therapies were defined as follows: needle insertion into acupoints or meridians; electric stimulation of needle insertion into acupoints or meridians; moxibustion; or the simultaneous intervention of hand-acupuncture/electroacupuncture and moxibustion.

For the exclusion criteria, the following were excluded: trials only covering stimulating *Ashi* acupoints; trials of dry needling or trigger point therapy based on anatomy and physiology; trials of laser acupuncture and non-invasive electrical stimulation as transcutaneous acupoint electrical stimulation; acupoint massage (finger-pressing acupoint); studies evaluating micro-acupuncture with body parts (e.g., head, ear, nose) considered as the whole human body's micro-system [10]. This study primarily focused on traditional acupuncture and acupoint selection by screening out other treatment methods.

Types of outcome measurements

The inclusion criteria are presented below. Studies were included if they reported at least one clinical outcome related to PGD (e.g., abdominal distention, nausea, vomiting, difficult defecation, abdominal pain, as well as the use of prokinetic agents); acupoint selection without statistical enhancement in symptoms could be covered into prescriptions in the case of controlled trials; the therapeutic effects of several acupoint prescriptions might be compared in some studies, but only the acupuncture prescriptions with the best efficacy would satisfy the inclusion criteria.

In terms of the exclusion criteria, the following were excluded: trials reporting only physiological or laboratory parameters; if one study compared the effects of different acupoint prescriptions, the prescriptions would be excluded, except for the most effective acupoint prescriptions.

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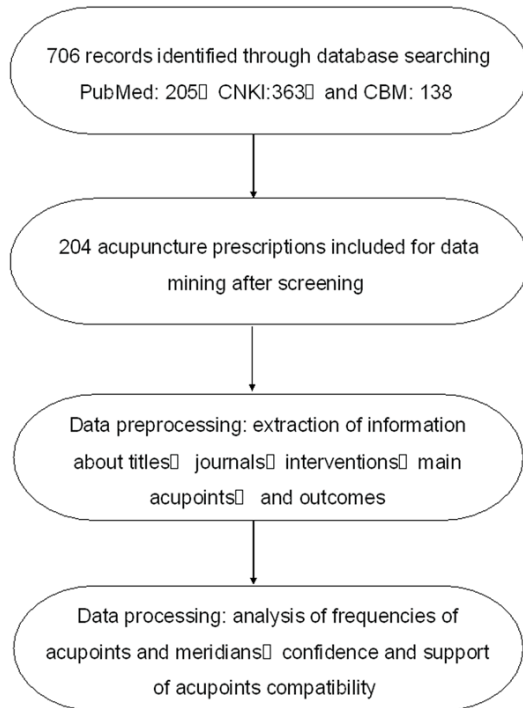


Figure 1. Flow of information through the different phases of data mining.

Data collection

All the titles and abstracts of each record retrieved from the literature searching conducted by Lisha Liu, who also excluded those distinctly unrelated abstracts (e.g., studies focusing on case reports reviews, experiments, and animals), who reviewed the full text of all potentially relevant articles, and subsequently re-screened these articles to exclude unrelated papers. Afterwards, Yu Wang formally checked the eligibility of all other articles following the mentioned screening criteria. If there was any divergence between them, the two researchers would decide whether to include the studies based on a discussion or after a third researcher's review of the information.

Data preprocess

Researchers standardized the article information before doing the data processing, including the title, author, journal name, intervention measures and results (e.g., number of acupoints, location of acupoints, meridians of acupoints, as well as specific acupoints). Due to historical evolution and usage habits, an acupoint may have multiple names. The names of

the acupoints were standardized in accordance with the basic principles of *Fundamentals of Acupuncture* [11].

Data processing

① Establishment of the database: Microsoft Excel 2019 was adopted to build the acupoint prescription database. ② Descriptive analysis: Frequency method was employed to calculate the frequencies of the acupoints and meridians. ③ Association analysis: The association rule analysis was conducted for acupoints with frequencies equal to or more than 3 times; its relevance was measured by support and confidence. The minimal support level of the project association was set at 10%, the minimal confidence level at 50%, and the maximum number of preceding items at 5. ④ Complex network analysis: A complex network analysis was conducted to verify the correlation analysis and to search for the core acupoints of new prescriptions. ⑤ Data mining tools: SPSS 25.0 was applied in the descriptive and cluster analyses, while the association rule and complex network analyses were conducted using IBM SPSS modeler 18.0.

Results

Overall profile of the acupuncture prescriptions

The database searching identified 205 records in PubMed, 363 in CNKI, and 138 in CBM. A total of 204 acupuncture prescriptions were covered here after the screening process was completed (**Figure 1**). 195 studies are controlled clinical trials of the whole 204 clinical trials, and the other 9 studies refer to clinical trials without control measures. **Figure 2** gives an outline of the study quality of the 195 controlled clinical trials.

Application of acupoints

Statistics suggested that the acupuncture prescriptions for treating PGD cover 49 acupoints, and the total frequency of the acupoints reaches 689 times. The most frequently used acupoints for treating PGD in descending order are *Zusanli* (ST-36), *Shangjuxu* (ST-37), *Neiguan* (PC-6), *Tianshu* (ST-25), *Zhongwan* (CV-12), *Xiajuxu* (ST-39), *Sanyinjiao* (SP-6), and *Hegu* (LI-4) (**Table 1** and **Figure 3**).

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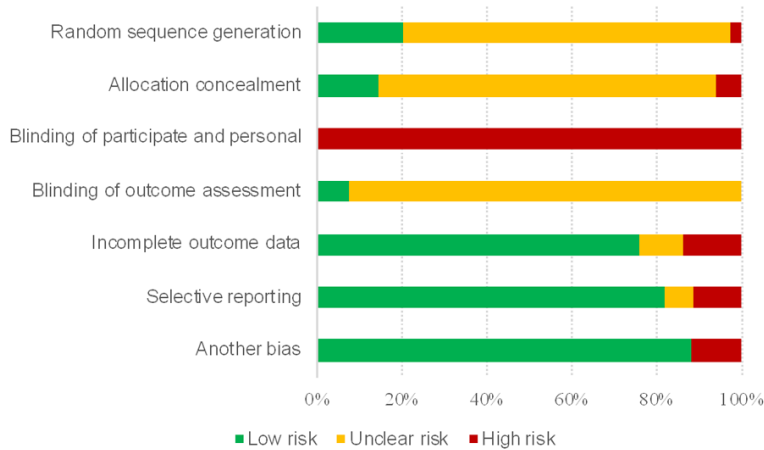


Figure 2. Overall view on the study quality of the 195 controlled clinical trials.

Application of meridians

The taken acupoints are distributed among 13 meridians, covering 11 regular meridians, Conception Vessel, and Governor Vessel. Stomach Meridian of Foot *Yangming* is the most frequently used meridian. Furthermore, Conception Vessel and Pericardium Meridian of Hand *Jueyin* have been frequently used; no extraordinary acupoint has been applied in the prescriptions. The frequencies for each meridian and acupoint are listed in **Table 2**.

Application of special acupoints

The number of specific acupoints takes up 35 (71.43%) of the whole 49 acupoints; these acupoints show a high frequency of 622 times, reaching up to 90.28% of the total frequencies of all acupoints. Lower *he-sea* point is the most frequently used specific acupoint, with a frequency of 289 times used in the 5 acupoints. Five-*shu* point and Crossing point have also been frequently used (**Figure 4A** and **4B**).

Application of acupoints on different body parts

Given the analysis and statistics of the acupoint locations, acupoints of the lower limbs were found to be the most frequently used, with 19 acupoints that were used 392 times, followed by acupoints of the chest and abdomen (used 169 times), the upper limbs (used 115 times), and acupoints of the head, face, and neck (used 8 times), acupoints of the back and

lumbar (used 5 times) (**Figure 4C** and **4D**).

Association of acupoints

26 records were achieved using an association rule analysis; the result revealed that *Zusanli* (ST-36)-*Shangjuxu* (ST-6) exhibits the maximum support degree, 35.468%, *Zusanli* (ST-36)-*Sanyinjiao* (SP-6), and *Shangjuxu* (ST-6) display the maximum confidence level, 100%. The support and confidence of the 26 most common acupoint combinations are listed in **Table 3**, and

the result of the complex network analysis in accordance with the association result is presented in **Figure 5**.

Common acupoint combinations

The frequency of the acupoint combinations was calculated based on the percentage of the rule support presented by the association analysis. The common acupoint combinations for the acupuncture treatment for PGD are listed in **Table 4**. There are 5 pairs of acupoint combinations with a frequency ≥ 40 times: *Zusanli* (ST-36) and *Shangjuxu* (ST-37), *Zusanli* (ST-36) and *Neiguan* (PC-6), *Zusanli* (ST-36) and *Xiajuxu* (ST-39), *Xiajuxu* (ST-39) and *Shangjuxu* (ST-37). The total frequency of the mentioned combinations reaches 226 times, and the combination of *Zusanli* (ST-36) and *Shangjuxu* (ST-37) appears 69 times, making up 33.82% of all acupuncture prescriptions. The mentioned results comply with the cooccurrence matrix heatmap of acupoint combinations (**Figure 6**).

Discussion

The application characteristics of acupoints for treating PGD

According to the statistical results of the acupoint location analysis, the acupoint selection for treating PGD emphasizes the meridians where the disease is located. PGD pertains to the category of “vomiting” and “epigastric fullness” in TCM theory; it is located in the stomach [12]. The acupoint sites are concentrated in the lower limbs, chest, and abdomen, name-

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Table 1. Top 28 acupoints of acupuncture for PGD

Number	Acupoint	Frequency	Support (%)	Number	Acupoint	Frequency	Support (%)
1	Zusanli (ST-36)	162	79.80%	15	Yinlingquan (SP-9)	12	5.91%
2	Shangjuxu (ST-37)	72	35.47%	16	Gongsun (SP-4)	7	3.45%
3	Neiguan (PC-6)	61	30.05%	17	Quchi (LI-11)	7	3.45%
4	Tianshu (ST-25)	44	21.67%	18	Liangqiu (ST-34)	6	2.96%
5	Zhongwan (CV-12)	43	21.18%	19	Neiting (ST-44)	6	2.96%
6	Xiajuxu (ST-39)	38	18.72%	20	Xiawan (CV-10)	5	2.46%
7	Sanyinjiao (SP-6)	36	17.73%	21	Xuehai (SP-10)	4	1.97%
8	Hegu (LI-4)	27	13.30%	22	Baihui (GV-20)	4	1.97%
9	Shenque (CV-8)	25	12.32%	23	Qichong (ST-30)	4	1.97%
10	Taichong (LR-3)	19	9.36%	24	Daheng (SP-15)	4	1.97%
11	Yanglingquan (GB-34)	16	7.88%	25	Liangmen (ST-21)	4	1.97%
12	Guanyuan (CV-4)	15	7.39%	26	Qiuxu (GB-40)	3	1.48%
13	Qihai (CV-6)	15	7.39%	27	Waiguan (TE-5)	3	1.48%
14	Zhigou (TE-6)	13	6.40%	28	Taixi (KI-3)	3	1.48%

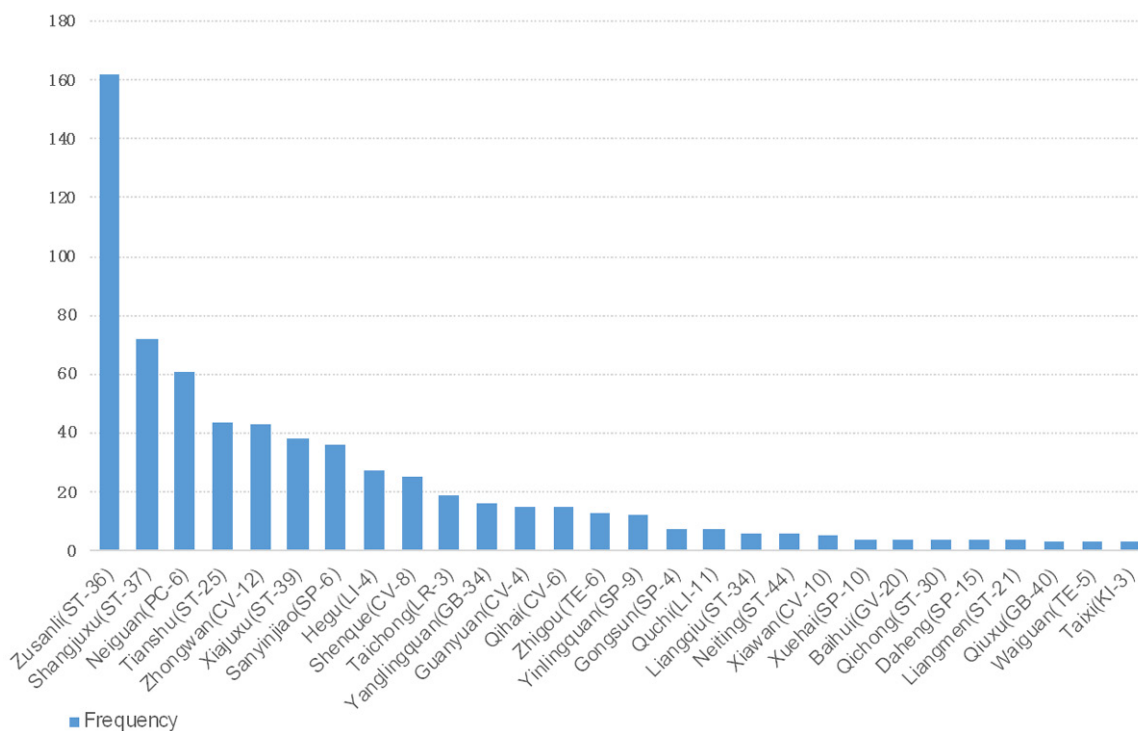


Figure 3. The frequencies of the 28 most frequent acupoints.

ly, the range of the meridians ST and meridian CV. "Acupoint selection based on the disease location" in TCM theory has two implications. First, acupoints are capable of treating the diseases in the nearby area. For instance, the acupuncture at *Tianshu* (ST-25) and *Zhongwan* (CV-12) are suitable for treating abdominal disease [13], the one at *Baihui* (GV-20) can treat head

diseases [14], and the one at *Zusanli* (ST36) can treat knee joint disease [15]. Second, acupoints can feasibly treat the diseases in the distribution range of the meridian. As reported in the study of acupuncture for migraine and functional dyspepsia [16], acupuncture at Meridian ST outperforms the one at Meridian GB in patients with functional dyspepsia, but acu-

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Table 2. Meridians and acupoints used in acupuncture for PGD

Number	Meridian	Frequencies	PCT (%)	Acupoint number	PCT (%)	Selected acupoints and their frequencies
1	Stomach Meridian of Foot <i>Yangming</i> (ST)	341	49.42	11	22.45	<i>Zusanli</i> (ST-36) 162, <i>Shangjuxu</i> (ST-37) 72, <i>Tianshu</i> (ST-25) 44, <i>Xiajuxu</i> (ST-39) 38, <i>Liangqiu</i> (ST-34) 6, <i>Neiting</i> (ST-44) 6, <i>Qichong</i> (ST-30) 4, <i>Liangmen</i> (ST-21) 4, <i>Huaroumen</i> (ST-36) 2, <i>Fenglong</i> (ST-40) 2, <i>Burong</i> (ST-19) 1
2	Conception Vessel (CV)	112	16.23	10	20.41	<i>Zhongwan</i> (CV-12) 43, <i>Shenque</i> (CV-8) 25, <i>Guanyuan</i> (CV-4) 15, <i>Qihai</i> (CV-6) 15, <i>Xiawan</i> (CV-10) 5, <i>Renzhong</i> (CV-26) 2, <i>Shangwan</i> (CV-12) 2, <i>Shuifen</i> (CV-9) 2, <i>Zhongji</i> (CV-3) 2, <i>Chengjiang</i> (CV-24) 1
3	Spleen Meridian of Foot <i>Taiyin</i> (SP)	63	9.13	5	10.20	<i>Sanyinjiao</i> (SP-6) 36, <i>Yinlingquan</i> (SP-9) 12, <i>Gongsun</i> (SP-4) 7, <i>Xuehai</i> (SP-10) 4, <i>Daheng</i> (SP-15) 4
4	Pericardium Meridian of Hand <i>Jueyin</i> (PC)	61	8.84	1	2.04	<i>Neiguan</i> (PC-6) 61
5	Large Intestine Meridian of Hand <i>Yangming</i> (LI)	35	5.07	3	6.12	<i>Hegu</i> (LI-4) 27, <i>Quchi</i> (LI-11) 7, <i>Yangxi</i> (LI-5) 1
6	Liver Meridian of Foot <i>Jueyin</i> (LR)	21	3.04	3	6.12	<i>Taichong</i> (LR-3) 19, <i>Zuwuli</i> (LR-10) 1, <i>Xiguan</i> (LR-7) 1
7	Gallbladder Meridian of Foot <i>Shaoyang</i> (GB)	20	2.90	3	6.12	<i>Yanglingquan</i> (GB-34) 16, <i>Qiuxu</i> (GB-40) 3, <i>Riyue</i> (GB-24) 1
8	Triple Energizer of Hand <i>Shaoyang</i> (TE)	16	2.32	2	4.08	<i>Zhigou</i> (TE-6) 13, <i>Waiguan</i> (TE-5) 3
9	Bladder Meridian of foot <i>Taiyang</i> (BL)	7	1.01	5	10.20	<i>Ganshu</i> (BL-18) 2, <i>Danshu</i> (BL-19) 2, <i>Dachangshu</i> (BL-25) 1, <i>Weizhong</i> (BL-40) 1, <i>Jinmen</i> (BL-63) 1
10	Kidney meridian of foot <i>shaoyin</i> (KI)	5	0.72	2	4.08	<i>Taixi</i> (KI-3) 3, <i>Yongquan</i> (KI-1) 2
11	Governor Meridian (GV)	5	0.72	2	4.08	<i>Baihui</i> (GV-20) 4, <i>Yintang</i> (GV-29) 1
12	Lung Meridian of Hand <i>Taiyin</i> (LU)	2	0.29	1	2.04	<i>Chize</i> (LU-5) 2
13	Heart Meridian of Hand <i>Shaoyin</i> (HT)	1	0.14	1	2.04	<i>Shenmen</i> (HT-7) 1
14	Total	689		49		

Note: PCT = percentage point.

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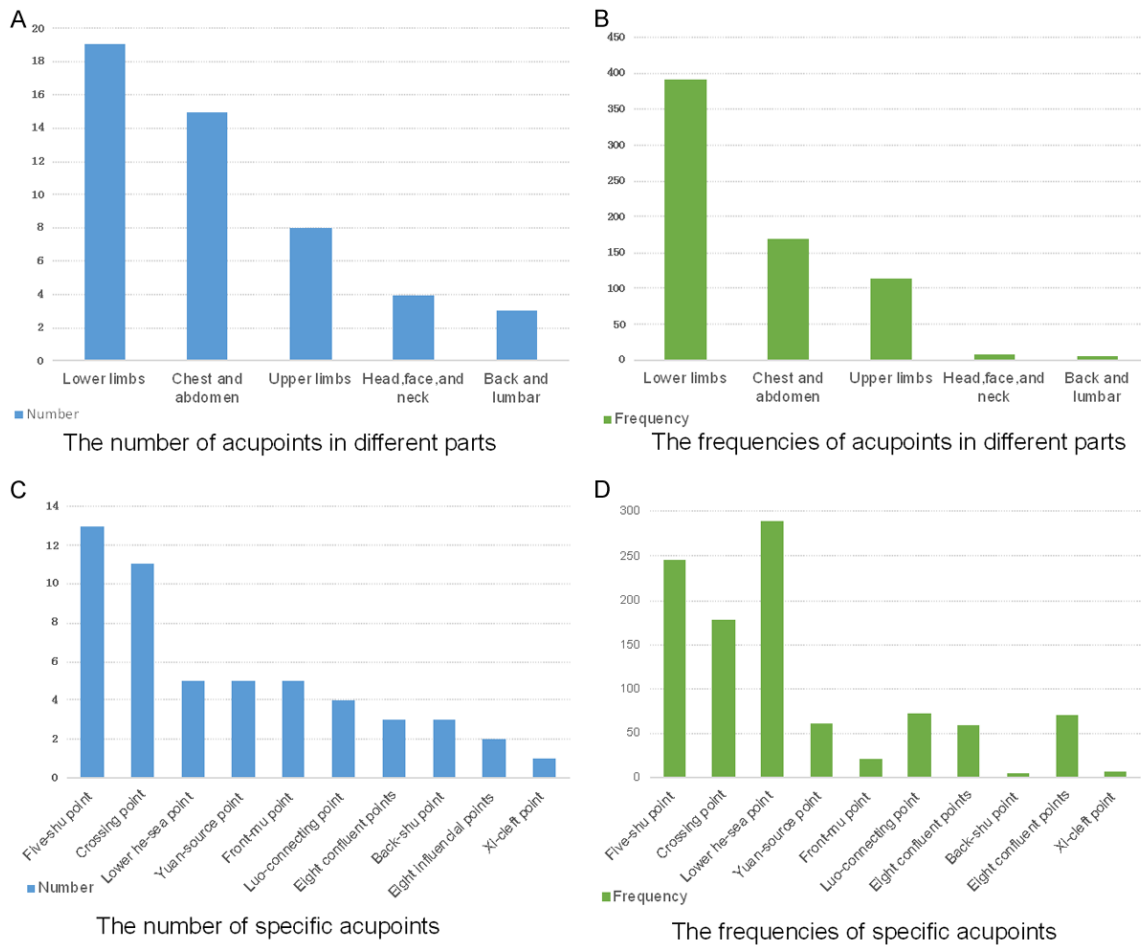


Figure 4. The numbers and frequencies of acupoints in different parts and specific acupoints.

puncture at Meridian GB outclasses the one at Meridian ST in patients with migraines. The results of the data mining revealed that the acupoints applied for dysmenorrhea are primarily distributed in meridian SP, meridian CV, and meridian KI; high frequency acupoints, covering *Sanyinjiao* (SP-6), *Guanyuan* (CV-4), and *Taixi* (KI-3), are considered the typical acupoints of the mentioned meridians [17]. The scope of acupuncture treatment is tightly related to the specificity of acupoints, and the former acts as the premise of the latter. 11 regular meridians, meridian CV and meridian GV are involved in this study. The frequency percentages of the primary acupoints originating from meridian ST and meridian CV are 49.42% and 16.23%, respectively. Meridian ST complies with the direction from head to foot and follows the stomach. Meridian CV starts in the small abdomen, from the perineum along the center of the body to the point of *Chengjiang* (CV-24).

According to the result, modern acupoints selection for treating PGD also complies with the theory of TCM.

The group and combination of acupoints for treating PGD

Association rules, namely, association mining, have been extensively employed to identify the correlation in the project sets of large databases [18]. The combination of herbs and acupoints refers to a feature of TCM. Modern and ancient TCM doctors usually make prescriptions by combining a range of herbs or acupoints. Accordingly, association rules are significantly suitable for delving into the prescriptions of TCM herbs and acupoint [19]. In the exploration of the relevance of prescriptions, the association rules should be considered by integrating support, confidence, and lift. In **Figure 5**, the thickness of the line suggests a

Table 3. Acupoint association analysis of acupoints

Number	Association of acupoints	Support (%)	Confidence (%)	Lift
1	ST-36→ ST-37	35.468	95.833	1.201
2	ST-36→ PC-6	30.049	67.213	0.842
3	ST-36→ ST-25	21.675	95.455	1.196
4	ST-36→ CV-12	21.182	81.395	1.020
5	ST-37→ ST-39	18.719	97.368	2.745
6	ST-36→ ST-39	18.719	94.737	1.187
7	ST-36→ ST-39, ST-37	18.227	94.595	1.185
8	ST-36→ SP-6	17.734	97.222	1.218
9	ST-37→ ST-39, ST-36	17.734	97.222	2.741
10	ST-37→ SP-6	17.734	63.889	1.801
11	ST-37→ SP-6, ST-36	17.241	65.714	1.853
12	ST-25→ CV-12, ST-36	17.241	65.714	3.032
13	ST-36→ LI-4	13.300	81.481	1.021
14	ST-36→ ST-25, ST-37	12.808	96.154	1.205
15	ST-39→ ST-25, ST-37	12.808	69.231	3.698
16	CV-12→ ST-25, ST-37	12.808	61.538	2.905
17	ST-36→ CV-12, ST-25	12.315	92.000	1.153
18	ST-39→ ST-25, ST-37, ST-36	12.315	68.000	3.633
19	ST-36→ CV-8	12.315	64.000	0.802
20	ST-37→ CV-12, ST-25	12.315	64.000	1.804
21	CV-12→ ST-25, ST-37, ST-36	12.315	60.000	2.833
22	ST-36→ SP-6, ST-37	11.330	100.000	1.253
23	ST-36→ PC-6, ST-37	11.330	95.652	1.199
24	ST-39→ SP-6, ST-37	11.330	65.217	3.484
25	ST-39→ SP-6, ST-37, ST-36	11.330	65.217	3.484
26	ST-37→ CV-12, ST-25, ST-36	11.330	65.217	1.839

higher the correlation between the acupoints will be. It can be directly recognized that *Zusanli* (ST-36), *Xiajuxu* (ST-39), *Tianshu* (ST-25), *Shangjuxu* (ST-37), *Neiguan* (PC-6), *Sanyinjiao* (SP-6), and *Zhongwan* (CV-12) are the core acupoints of this whole complex network. In the cooccurrence matrix heat map of acupoint clustering (**Figure 6**), the brighter the color block, the higher the frequency of acupoint combination will be; in contrast, the darker the color block, the lower the frequency of acupoint combination will be. Thus, the dominant acupoint combination noticeably tends to be accumulated to the high frequency acupoints, and there is a relatively slight combination of the low frequency acupoints. Numerous clinical and experimental studies on the mechanism of acupuncture for gastrointestinal diseases have been conducted. The mechanism of acupuncture has been partially interpreted. Yong [20] reported that electroacupuncture at *Zusanli* (ST-36) can noticeably increase the intragastric pressure and inhibit the

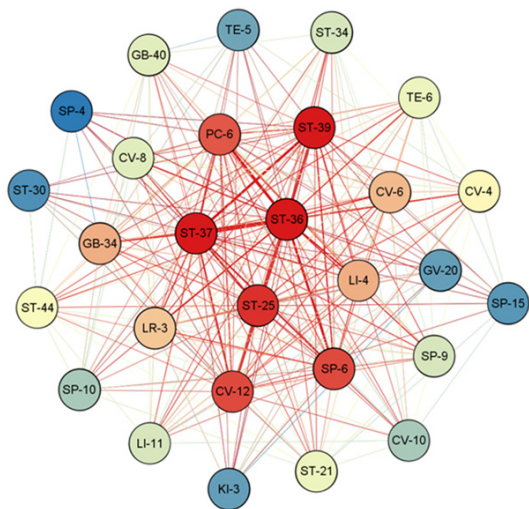


Figure 5. Complex network structure of acupoints for PGD.

correlation between the two drugs. The thicker the line, the greater the density will be, and the

expression of c-fos in the oxytocin neurons of the paraventricular nucleus in rats subject to upper cervical spinal cord injury, and electroacupuncture at *Zusanli* (ST-36) still exerted the mentioned effects even after a complete transection of the spinal cord. As demonstrated by Yuan [21], electroacupuncture is capable of enhancing the jejunal motor ability of rats and mice by stimulating the parasympathetic nerve pathway by stimulating *Shangjuxu* (ST-37) and *Zhongwan* (CV-12). Besides, the jejunal response is to a certain extent related to the intensity of the acupuncture stimulation. Chen [22] suggests that electroacupuncture at *Tianshu* (ST-25), *Zusanli* (ST-36), *Sanyinjiao* (SP-6), and *Taichong* (LR-3) can alleviate anxiety and mitigate the depression of irritable bowel syndrome rats by down-regulating the expressions of corticotropin-releasing factor receptor 1 (CRF-R1) and CRF in the hypothalamus, down-regulating the expression of CRF-R1 in the gastrointestinal mucosa, up-regulating

Table 4. Common acupoint groups of acupuncture for PGD

Number	Acupoint group	Frequency	PCT (%)	Number	Acupoint group	Frequency	PCT (%)
1	ST-36, ST-37	69	33.82	10	ST-36, ST-39	36	17.65
2	ST-37, ST-36	69	33.82	11	ST-36, SP-6	35	17.16
3	ST-36, ST-25	42	20.59	12	ST-36, ST-39, ST-37	35	17.16
4	ST-25, ST-36	42	20.59	13	ST-37, ST-39, ST-36	35	17.16
5	PC-6, ST-36	41	20.10	14	SP-6, ST-36	35	17.16
6	ST-36, PC-6	41	20.10	15	ST-36, CV-12	35	17.16
7	ST-37, ST-39	37	18.14	16	CV-12, ST-36	35	17.16
8	ST-39, ST-37	37	18.227	17	ST-39, ST-37, ST-36	35	17.16
9	ST-39, ST-36	36	17.734				

Note: PCT = percentage point.

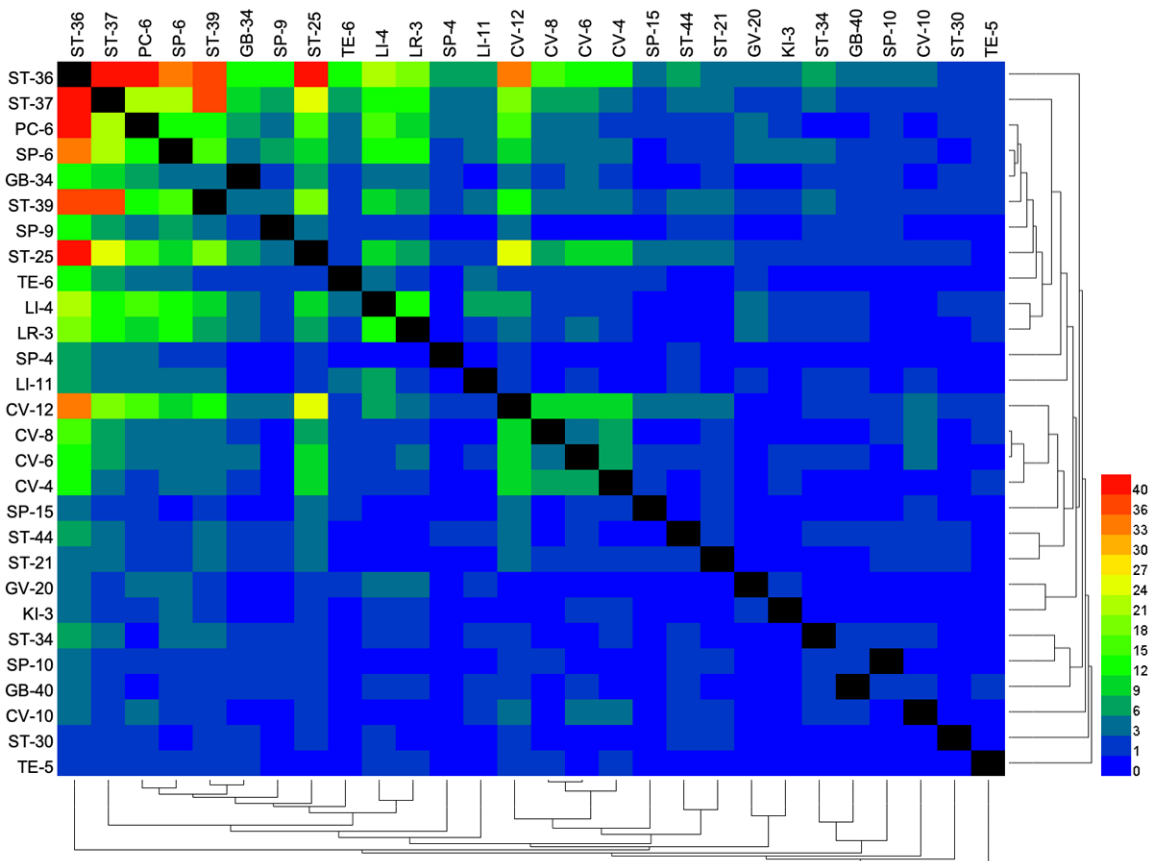


Figure 6. Cooccurrence matrix heat map of acupoints.

the expression of zonula occludens-1, and regulating tight junction to mitigate the intestinal mucosal barrier. A study by Lu [23] revealed that the promotion of electroacupuncture at *Neiguan* (PC-6) for gastric motility was primarily achieved by suppressing gamma-amino butyric acid transmission to the dorsal motor nucleus of the vagus, thereby mitigating the inhibition of

motor nerve fibers of the vagus nerve and enhancing the neural activity of the vagus nerve. These studies experimentally evidenced the core acupoints and dominant acupoints combination for treating PGD. Nevertheless, the effective mechanism of acupuncture has not been fully defined, and more in-depth studies will be required.



Figure 7. Main interventions of acupuncture for PGD.

Some interesting discoveries

In the present study, note that moxibustion played a major role in the acupuncture for treating PGD, particularly in the literature from mainland China. 127 articles mentioned the application of moxibustion alone, or moxibustion integrated with other treatment methods (e.g., hand-acupuncture, electroacupuncture, and acupoint massage), making up 62.25% of the total number of articles (**Figure 7**). Nevertheless, moxibustion has been rarely described in the English-language literature retrieved in PubMed, and the research method is primarily hand-acupuncture or electroacupuncture, which is probably associated with the requirements of rigorous clinical design ideas. The results also suggested that moxibustion is not as popular as acupuncture globally. Moxibustion is a type of therapy that ignites the natural wormwood to bake around the acupoints. According to the theory of TCM, patients postoperatively presented a state of cold, weakness, stagnation of *Qi*, and blood stasis as affected by the metal mechanical stimulation, intraoperative blood loss, and tension [24]. Moxibustion is capable of nourishing *Yang Qi*, supplementing the weak state, and facilitating the movement of *Qi* and the blood, which exhibits a higher effectiveness than acupuncture for treating diseases exhibiting the symptoms of cold, weakness and stagnation [25]. The effects of moxibustion on various gastrointestinal diseases have been observed in human and animal experiments. Several studies [26, 27] reported that moxibustion is capable of improving gastrointestinal peristalsis, protecting the gastric mucosa, and mitigating

visceral hyperalgesia. *Qi* [28] suggested that moxibustion has the ability to repair the intestinal mucosa and stimulate the rise in intestinal microbial diversity by down-regulating the inflammatory cytokines and up-regulating the inflammatory cytokines. Several meta-analyses [29, 30] and randomized controlled trials [31, 32] suggested that avoiding hypothermia in complex abdominal operations can lower the incidence of wound infections and heart complications, down-regulate the bleeding rate and blood transfusion demand, improve immune function, and shorten the recovery time after anesthesia. As also mentioned in the enhanced recovery after surgery (ERAS) [33], the patient's temperature should be regularly monitored during the operation, and the patient's central temperature should be kept at 36°C or higher using a heating pad, an air conditioner, a surgical warming blanket, a blood transfusion, and an infusion heating device. Accordingly, besides maintaining the patient's body temperature after surgery, hot compresses or moxibustion at a specific place to raise the local temperature are also feasible, and can probably achieve a better recovery from PGD.

Limitations

Data mining refers to a novel comprehensive discipline; it is conducive to analyzing and mining valuable information and knowledge from massive data files to guide the practice of researchers. As fueled by the advancement of data mining, the internal relationship in the prescriptions of Chinese herbs and acupoints can be explored. Though data mining was employed to analyze the acupoint selection rules for treating PGD, some limitations might remain. First, the results of data mining might show some deviations for the uneven quality of the research. Second, 204 prescriptions were collected here, yet these documents remain inadequate for big data collection, suggesting that the observable data might be incomplete. Third, due to limited space, there is considerable information in the published literature which was not mined or analyzed here (e.g., TCM syndrome differentiation, treatment time, intervention time). Fourth, the case reports of some scholars or experts should be covered in real-world research, but it was not mentioned here to facilitate the data management. According to the mentioned conclusions, an-

cient alternative medicine can be integrated with the novel technology of data mining. In the future, the results of data mining should be explored in depth and elucidated, data mining results should be fully exploited, data mining methods should be closely combined with clinical practice, and the conventional mining methods should be optimized.

Conclusions

In the present study, data mining was employed to find the combinations and frequencies of the acupoints for treating PGD. The most common acupoints include *Zusanli* (ST-36), *Shangjuxu* (ST-37), and *Neiguan* (PC-6), and the meridians used most frequently are meridian ST, meridian CV, and meridian SP. On the whole, specific acupoints make up the majority of acupoints (71.43%), and the acupoints of the lower limbs have been adopted most frequently. According to the findings here, *Zusanli* (ST-36), *Shangjuxu* (ST-37), *Tianshu* (ST-25), and *Neiguan* (PC-6) require more in-depth studies in the clinical practice of acupuncture for treating PGD. According to the results of the data mining and the evidence from the existing experimental studies, the mechanism of superior single acupoints or combinations for treating PGD may be a vital research path in the future.

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Disclosure of conflict of interest

None.

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