



Irritable Bowel Syndrome—a Neurological Spine Problem

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Authors' contributions

This work was carried out in collaboration between all authors. Author BCB provided the hypothesis, designed and set up the study, controlled the data collection, analysis and interpretation and shared the writing process. Author AH managed the inclusion process and author MS managed the literature searches. Authors AH and MS contributed equally in the physical examination and writing process. All authors read and approved the final manuscript.

Original Research Article

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ABSTRACT

Aim: To investigate if patients with Irritable bowel syndrome (IBS) have more findings in the physical examination indicating nerve involvement from spine segments Th7-L1 than people without gastrointestinal disorder.

Study Design: Clinical randomized blinded case-control diagnostic study.

Place and Duration of Study: Torvalla back and sports medical clinic and CeFAM at Karolinska Institutet, Stockholm, Sweden, Mars-May 2012.

Methodology: Ten patients with IBS and six age-matched controls were randomly scheduled to a physical examination by two independent examiners who were blinded to the status of the person they examined. The physical examination followed a pre-determined protocol focused on neurological examination and palpation of the abdomen and the spine. Fischer's exact test and Cohen's kappa (K) test were used to analyze prevalence respectively inter-examiner reliability of examination findings.

Results: Disturbed sensibility to pain in one or more of dermatomes T7-L1 was more prevalent in patients with IBS than controls ($p=0.007$ for both examiners). Tenderness on palpation of one or more of spinal processes T7-L1 was more prevalent in patients with

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IBS than controls ($p=0.001$ for examiner 1, $p=0.008$ for examiner 2). Inter-examiner reliability in the physical examination test for sensibility to pain and palpation of the abdomen was 100% ($K=1.0$).

Conclusion: Patients with IBS have significantly more findings in the physical examination indicating nerve involvement from spine segments Th7-L1 than people without gastrointestinal disorder. Further work in larger cohorts and with added diagnostic methods is required to confirm our findings and if confirmed may open up for new treatment strategies of IBS.

Keywords: Irritable bowel syndrome; neurologic examination; physical examination; spine.

1. INTRODUCTION

Irritable bowel syndrome (IBS) is a common gastrointestinal disorder of unknown pathogenesis, which significantly reduces the quality of life [1]. In our clinical work we have observed that IBS is often correlated to nerve dysfunction of the lower thoracic spine and if proven so this may open new ways to treat IBS.

IBS affects 10-20% of the general population [2] and might account for 30% of referrals to gastroenterologists [3]. The symptoms include abdominal pain, altered stool consistency and frequency, which all result in impaired quality of life and a serious economical burden to society [4-6] and yet the pathogenesis of IBS remains unclear [1].

Hypotheses of the pathogenesis of IBS include; stress, anxiety, emotion, depression, and other psychological factors as well as infection or inflammation of the intestine [2,7] and/or food allergies [8]. A recent hypothesis has attributed the IBS pathogenesis to neural and immunological networks within the gut and the central nervous system (CNS), the so called "brain-gut axis" [9].

Our hypothesis is that patients with IBS, in the physical examination, have more prevalent findings indicating nerve involvement from the spine than people without IBS. This hypothesis is based on more than 15 years of clinical observations where we have found that almost all patients with IBS have neurological findings that indicate nerve involvement with possible spinal origin at one or more of the spinal segments Th7-L1 from which the gastrointestinal tract is innervated [10]. Treatment through steroid injection and/or manual traction of this part of the spine has in our clinical work rendered positive results in numerous patients with IBS symptoms (unpublished observations). In support of our clinical observations, Rana et al. and Xing and Qu, respectively reported a similar treatment effect in a patient treated with spinal cord stimulation [11] on 105 patients treated with spinal orthopedic manipulation [12].

In this clinical case-control diagnostic pilot study we investigated our hypothesis and found that patients with IBS had significantly more prevalent findings in the physical examination indicating nerve involvement from the lower thoracic spine than people without IBS. Further work in larger cohorts is required to confirm our findings and if so open up for new treatment strategies of IBS.

2. MATERIALS AND METHODS

2.1 Cohort and Recruitment

Participants consisted of patients with IBS and controls. Patients were recruited through the gastroenterology section of the Ersta Hospital's IBS education program. The inclusion consisted of having attended the education program sometime during a period of 6 months (fall 2011), the ability to understand Swedish and being 18 to 57 years old. Participants attending Ersta Hospital's IBS education program were admitted after being screened for IBS by a simplified Rome II questionnaire and by exclusion of organic diseases through blood and stool samples and when necessary by colonoscopy screening. Patients with IBS were asked to recruit a friend of matched age (± 5 years of age), without gastrointestinal disorders, to use as a control in the study.

All 124 patients from the Ersta hospital's IBS program fulfilling the inclusion criteria were invited to participate in our study. However, the Ersta hospital's IBS clinic had to close abruptly at the beginning of the predetermined study period (March 2012) and the study was moved to another clinic (25 kilometers outside the city center). As a consequence of these events, 12 patients with IBS finally consented for the study and 10 showed up for examination. Six controls were also included. Patients and controls were included on a continuous basis. Ersta hospital's ethical board as well as the Stockholm ethical board approved the study (dnr 2011/2018-31).

Examiners (medical students) were taught the physical examination procedure by the first author who has performed similar examinations on thousands of patients. The training was performed in two brief sessions before the study was executed.

2.2 Procedure

A secretary randomly scheduled the participants for examination at the Torvalla back and sports medical clinic. The secretary also informed the participants not to reveal their status to the examiners. At the clinic on the day of the examination the participants were again reminded not to reveal their status to the examiners. The participants signed a consent form and filled in two history forms; an IBS-questionnaire (Appendix I) and a discomfort drawing (Appendix II), which were not seen by the examiners. Each examiner then examined each participant without asking any questions other than for a response to the specific physical examination test and also without knowledge of the other examiner's examination findings. After the second examiner had made his examination and sealed the physical examination protocol, questions about the history forms were allowed.

Randomization of the patients was secured in one or two alternative ways. Two examination rooms were used and there were two examiners. An examiner was randomly selected to be the first to examine the participant. After the first examination, the second examiner examined the participant. If two participants were present at the same time, the randomization was accomplished by whichever participant chose a room first. The other examiner and participant used the other room simultaneously. When finished the examiners switched rooms and performed the second examination on the respective participant.

Documentation of findings was consistently done on participant coded examination protocols. The examination protocol also contained guidelines for abdominal palpation zones

and innervation zones for each dermatome (Appendix III) [13]. After the second examiner was finished, all protocols were put in an envelope that was sealed until all participants were examined.

2.3 Protocols

2.3.1 History forms

Two standardized history forms were used; an IBS-questionnaire and a discomfort drawing. The IBS-questionnaire (Appendix I) was a simplified version of the Rome II questionnaire and included five main questions about IBS, four with a visual analogue scale, and one with a numerical analogue scale between 0 and 500. A Swedish version of the questionnaire has been evaluated in previous studies and was used in our study [14]. An IBS-score above 300 was classified as severe IBS, 175-<300 were classified as moderate IBS, 75-<175 were classified as mild IBS and below 75 were classified as in remission. Ten additional questions about comorbidity were included to evaluate progression of IBS-related symptoms [15]. We used the questionnaire to subgroup patients with IBS with different clinical findings and to screen the controls for gastrointestinal-related symptoms.

The discomfort drawing (Appendix II) was a simplified version of a pain drawing. The drawing consists of a chart with a front and a back view of a human body in which the participant is instructed to indicate with a pencil any discomfort experienced and the character of the discomfort, date of onset and progression. The drawing may be used to distinguish nociceptive from neuropathic discomfort. Neuropathic discomfort tends to make patients draw charts consistent with known innervation zones while nociceptive discomfort may lead to unspecific charts [16]. The sensibility, sensitivity and reliability of the discomfort drawing to indicate nerve involvement has been previously evaluated [17]. The drawing was analyzed in three steps; does the discomfort drawing indicate: 1) any discomfort? 2) nerve involvement? 3) nerve involvement with possible spinal origin in segments Th7-L1?

2.3.2 Physical examination

The physical examination protocol (Appendix III) was predetermined and non-invasive and focused on neurological examination and palpation of the abdomen and the spine. Inter-examiner reliability of the examination method used in this study was previously evaluated in a study with patients with neck and shoulder problems [18].

Visual inspection was performed with the participants standing up straight. The examiners performed anterior and posterior visual body inspection and performed bilateral palpation of spina iliaca posterior superior. Participants were then instructed to lie supine on a stretcher with their legs flexed. The abdominal palpation was performed starting under the left arcus costae and moving counterclockwise. Reported tenderness was noted in the examination protocol.

The neurological examination included skin sensibility testing for touch, pain, and cold in dermatomes Th7-L1 of the trunk. Participants were examined in supine position and were told to report any disturbed sensibility such as numbness, hypo sensibility, hyper sensibility and whether the sensation appeared to be symmetrical or not. Touch was tested with fingertips of the index finger pulling them gently from body midline towards the anterior axillar line in each dermatome area. Thereafter touch was tested at the mid clavicle line by moving the fingertips in a superior-inferior direction from Th7 down to L1. Sensibility tests for

pain and cold were then performed in the same manner. Pain was examined with Wartenberg wheels and cold with metal rolls. All motions during examination of sensibility were performed with a speed of about 5cm/s.

Palpation of the spine was made with the patient in a prone position. Each spinal process from Th7-L1 was palpated with some pressure with the right thumb. If any tenderness was reported then the same vertebrae were palpated paravertebral bilaterally.

2.4 Data Analysis and Statistics

A pre-study power calculation to estimate the number of needed participants was made based on a sample test on 12 persons without IBS and the experience of the first author that at least 85% of patients with IBS have findings indicating nerve involvement from spinal segments Th7-L1. Two of the participants in the pre-study had findings indicating nerve involvement from spinal segments Th7-L1. The calculation rendered a difference of 70% between controls and patients with IBS. With this hypothetical difference, the estimated number of patients and controls needed would be 17 of each group to reach 90% power at 5% significance level.

Findings in the physical examination and the discomfort drawing were dichotomized and documented as either positive or negative. Patient data was analyzed using STATA version 10. Fischer's exact test was used to analyze data from the sensibility tests, abdominal, and spine palpation and for the discomfort drawing. Cohen's kappa was used to analyze the inter-examiner reliability of the physical examination findings. Findings were interpreted as agreed upon when noted in the same or next to the same dermatome or vertebral process. A $P=.05$ was considered significant.

3. RESULTS

3.1 Participant Characteristics

Female gender dominated with 9(90%) among the patients and 4(67%) among the controls. Mean IBS-score was 319(266-455) among the patients and 28(0-100) among the controls. Mean age was 46 years (34-56) among the patients and 48 years (37-57) among the controls.

3.2 Skin Sensibility Findings Indicating Nerve Involvement from the Spine

Both examiners observed skin sensibility findings indicating nerve involvement from the spine in 8 of the patients with IBS (80%) and one examiner observed it in 1 of the control participants (17%) (Table 1). The difference in prevalence of skin sensibility findings was highly significant for both examiners ($P=.007$).

All skin sensibility findings were unilateral and of the same character whether it concerned touch, pain, or cold. They were observed on the right side in 6 patients and on the left side in 2 patients. Skin sensibility was classified as hypo sensibility in 4 patients and as hyper sensibility in the other 4 patients. All examined dermatomes (Th7-L1) were affected in 3 of the patients. In the other 5 patients, 2-3 dermatomes next to each other were affected and always in the thoracic dermatomes Th7-Th12.

Table 1. Skin sensibility findings indicating nerve involvement from the spine made by examiner 1 respectively examiner 2 (1/2). P value shown for examiner 1/examiner 2

Skin sensibility finding	Positive findings by examiner 1/examiner 2 among IBS (n=10)	Positive findings by examiner 1/examiner 2 among Controls (n=6)	P value (examiner1/ examiner2)
Touch	4/5	0/0	.23/.09
Pain	8/8	0/0	.007/.007**/**
Cold	6/7	0/1	.034/.12 */
Any finding	8/8	0/1	.007/.007**/*

* =P<.05, ** =P<.001

3.3 Abdomen and Spine Palpation

Both examiners noted abdominal tenderness in 9 of the patients and in 1 of the controls (P=.008). Spine tenderness differed slightly between examiners; examiner 1 noted tenderness in 9 patients and none of the controls (P=.001) while examiner 2 found tenderness in 10 of the patients and 2 of the controls (P=.008). One of the controls with spine tenderness also reported abdomen tenderness, and the other control had an IBS score of 100.

3.4 Inter-examiner Reliability in the Physical Examination (N=16)

Inter-examiner reliability for the test of abdominal tenderness and disturbed sensibility to pain was 100%, (K=1.0; Table 2). Inter-examiner reliability for the other tests was fair to excellent.

Table 2. Inter-examiner reliability in the physical examination (n=16)

Test	Positive findings by examiner 1/examiner 2	Agreement (%)	Cohen's kappa
Abdominal tenderness	10/10	100	1.00
Disturbed sensibility (Th7-L1) to touch	4/5	94	0.85
Pain	8/8	100	1.00
Cold	5/8	75	0.50
Spine tenderness (Th7-L1)	9/12	81	0.60

4. DISCUSSION

In this clinical case-control diagnostic pilot study we found that patients with IBS had significantly more findings in the physical examination indicating nerve involvement from spine segments Th7-L1 than people without IBS. The inter-examiner reliability of our blinded and independent examiners in the testing procedure of skin sensibility to touch and pain was excellent.

Our findings of nerve involvement from spine segments Th7-L1 in patients with IBS are consistent with those of Jorgenssen and Fossgreen who described a correlation between

patients with chronic functional abdominal pain and spine pathology [19]. The patients with functional abdominal pain (n=39) reported back pain in 72% of the cases compared to 17% (p<0.001) of the healthy controls (n=28). Abdominal skin sensitivity was significantly decreased in patients with abdominal pain, specifically in segments Th10-Th12. There were no differences between patients with functional abdominal pain and IBS symptoms (n=20) and patients with functional abdominal pain as their only symptom (n=19) [19]. It would be interesting to compare findings indicating nerve involvement from spine segments Th7-L1 in patients with severe IBS versus moderate and mild IBS as well for patients with other gastrointestinal disorders.

The current knowledge of the pathogenesis of IBS is limited due to lack of objective pathological abnormalities and/or reliable biomarkers. Traditionally, IBS has been considered a functional disorder¹. However, more recent work based on specimens obtained at endoscopy and in serological cytokine studies considers IBS as a localized low grade inflammatory disorder with mast cells having an important role [2,7]. An alternative hypothesis points to food allergies as main cause of IBS⁸. Most recently, the relationship between the neural and immunological networks within the gut and the bi-directional communication between the gut and the CNS—often related to as the brain-gut axis (BGA)—has attracted most attention [1,9]. A relationship between overactive bladder and other pelvic disorders in patients with IBS has also raised the question of a common pathophysiology [20-25]. The innervation of the pelvic organs converge in the lower thoracic and upper lumbar segments and we believe that a discoligament injury causing chemical and/or mechanical inflammation of efferent (and afferent) nerves may well lead to dysfunction of the viscera. Back pain may also be present though patients and caregivers may not consider the possible connection.

If our findings indicating nerve involvement from spine segments Th7-L1 in patients with IBS are confirmed, new treatment strategies may need to focus on the spine. This is in line with two recent Chinese publications [12,26]. Both compared treatment of patients with IBS with traditional Chinese spinal orthopedic manipulation (TCSOM) of the spine and the spasmolytic agent pinaverium bromide. The practitioner performed sensation and palpation tests and located the affected segment, which in all subjects in Qu's study [12], were somewhere at level T10-L2. The practitioner then performed two manipulation techniques to treat the affected segment. The TCSOM treatment group in both studies had excellent result based on a VAS-scale, a bowel symptom scale and a patient self-evaluation.

4.1 Strength and Limitations

A strength of this study was the homogeneity of the patient and the control groups as confirmed by the IBS questionnaire. This ensured that we measured the differences between patients with moderate to severe IBS and controls without IBS. However, one of the controls with tenderness on back palpation also had an IBS-score of 100, indicating mild IBS. This was not known until after the examination procedure; re-considering this control person as an IBS patient, further increased the difference in prevalence of findings indicating nerve involvement from the spine between patients and controls than what we now present.

Physical examination findings may be considered subjective and less reliable than blood or radiological findings. Previous studies have shown questionable inter-examiner reliability of findings in abdominal palpation by experienced physicians at emergency departments when asked to discern different abdominal findings [27]. However, the inter-examiner reliability in

our study was excellent for the abdominal palpation in which we used dichotomized answers.

The inter-examiner reliability of the bimanual skin sensibility test was also excellent and consistent with previous studies on other patient samples and may be due to the test simplicity [18]. Consequently, we consider our sensibility findings to be reliable. The reliability of spine palpation tenderness findings was considerably lower than the rest of the tests used in our study and consistent with previous studies showing difficulties for examiners to exactly indicate a tender segment in the spine [28].

The blinding of the examiners to the medical history of the participants may be considered a strength though the physical examination procedure by itself made the status of the participant highly probable due to the fact that most patients experienced abdominal tenderness, which is a cardinal sign of IBS. However, abdominal tenderness is not an obligate finding in an IBS patient [29] and our set-up with two independent examiners strengthens the possibility that the examination findings are reliable.

A major limitation of our study is the small sample size including that four of the patients did not recruit a friend as a control. The advantage of friend controls is that it may match socioeconomic status and education, which are known confounding factors [30]. A possible disadvantage of friends-controls is that friends may share personality traits with the patients and thereby cause an over-match [31]. However, if our IBS patients and their friends do over-match and personality traits would have been important in the pathogenesis of IBS we would not have found a significant difference in sensitivity and palpation examination findings in such a small study population.

Our hypothesis that patients with IBS, in the physical examination, have more prevalent findings indicating nerve involvement from the spine than people without IBS needs to be further validated and evaluated in future studies with larger patient samples and preferably compare with some other patient sample without abdominal dysfunction. One may also use quantitative sensory testing, magnetic resonance imaging (MRI) and other diagnostic methods to assess nerve involvement from the spine.

5. CONCLUSION

Our hypothesis that patients with IBS, in the physical examination, have more findings indicating nerve involvement from spine segments Th7-L1 than people without IBS was strongly confirmed in this pilot study. Our study invites the attention of further research on larger cohorts and with more elaborate diagnostic methods and if confirmed may open up for completely new treatment strategies of IBS. Our simple physical examination focusing on neurological findings, together with a discomfort drawing may be recommended as a complement to the Rome-III criteria for diagnosing IBS.

CONSENT

All authors declare that written informed consent was obtained from the patients prior to being included in the study.

ETHICAL APPROVAL

Ersta hospital's ethical board as well as the Stockholm ethical board approved the study (dnr 2011/2018-31).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Never All the time
10) Aches and pains in joints and muscles?
0 _____ 100
Never All the time

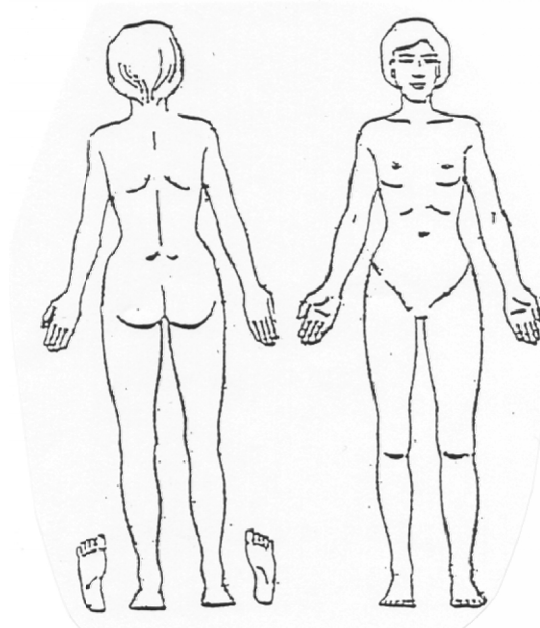
Appendix II. Discomfort drawing

Discomfort drawing

Where and what kind of discomfort have you experienced during the last 3 months?

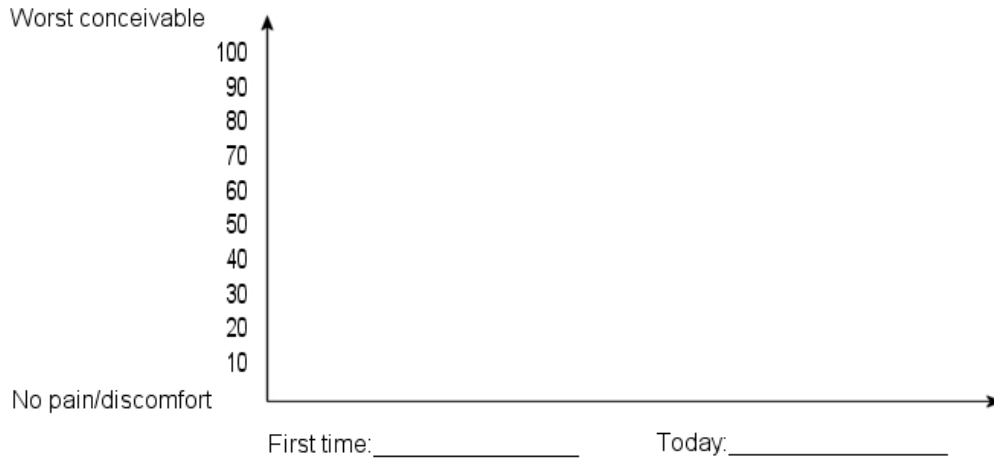
Shadow all pain/discomfort, shadow darker where there has been more discomfort.

Write by the figure what kind of discomfort: buzzing, tingling, pricking, aching, cramping, etc



When and how do you experience discomfort?

How has the pain/discomfort varied since the first time you experienced it?



Appendix III. Physical examination protocol

Examination protocol Nr: Examiner: Date:

ANTERIOR INSPECTION

YES

NO

Symmetrical body constitution?
 If no describe deviation _____
 Symmetrical muscles?
 If no, describe hypertrophy/atrophy of muscle/s _____

POSTERIOR INSPECTION

Symmetrical columnvertebralis with normal kyphosis/lordosis?
 If no, describe deviation to side and findings of kyphosis/lordosis

 Symmetrical muscles?
 If no, describe hypertrophy/atrophy of muscle/s _____
 SIPS at same level?
 If no, deviation to which side _____

PALPATION OF THE ABDOMEN

Soft and not tender?
 If no, what part of the abdomen and what type of discomfort?

SENSIBILITY TO TOUCH

Does the patient experience touch to be normal and alike right to left?
 If no, in what dermatome/is sensibility deranged

PAIN

Does the patient experience pin prick to be normal and alike right to left?
 If no, in what dermatome/is sensibility deranged

COLD

YES

NO

Does the patient experience cold to be normal and alike right to left?

If no, in what dermatome/is sensibility deranged _____

ABDOMEN REFLEXES

Are there abdominal reflexes?

If no, in what zone is it lacking _____

PALPATION OF THE SPINE

Is the patient not tender over spinous processes?

If no, which spinous process/es are involved and is the tenderness paravertebral, medial and/or deep?

OTHER

Has the examination gone well?

If no, describe what events that may have affected the exam

STOMACH ZONES AND DERMATOME CHART

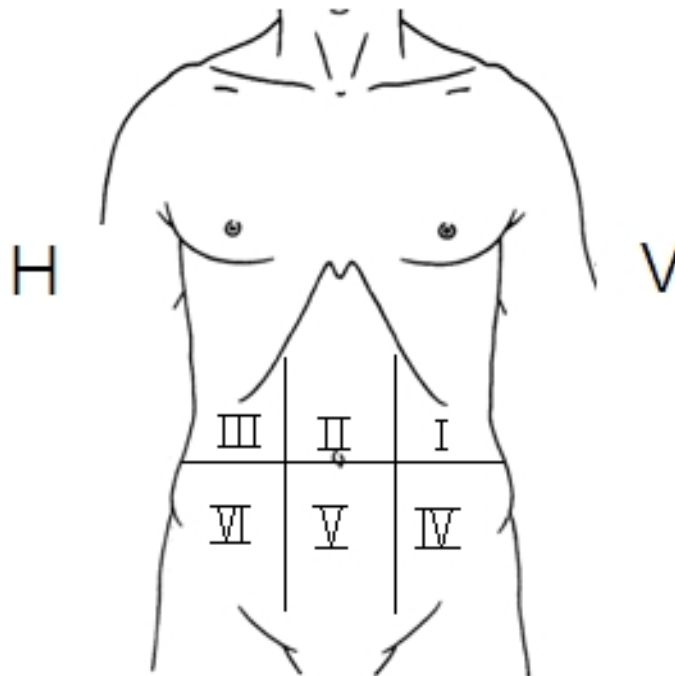


Fig. 1. STOMACH ZONES

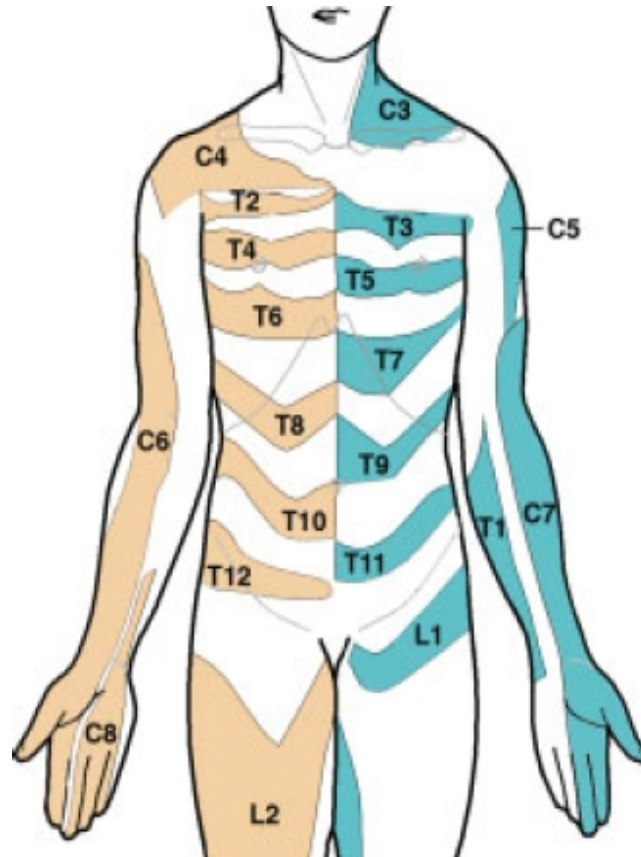


Fig. 2. DERMATOME CHART

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