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Minimally Invasive Interventions on Ganglion Impar in Treatment of Patients with Coccygodynia

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Chronic pelvic pain (CPP) is usually treated conservatively, but in patients who do not respond to treatment, ganglion impar (GI) interventions are used as an alternative way to reduce pain.

Objective – to study the course of pain syndrome and functional status in patients with coccygodynia (CD) and CPP during the application of minimally invasive interventions on GI.

Materials and methods. The analysis of the results of 56 interventions on GI in 50 patients was performed. Inclusion criteria were patients with coccyx pain for ≥ 3 months aged 23 to 71 years (mean age 47.9 ± 14.8 years) who did not respond to conservative treatment methods. 15 (35.7%) of the study participants were male and 27 (64.3%) were female. Interventions were performed on the patients according to five different methods, which were divided into two groups: the first group ($n=34$) – GI block (GIB) with a local anesthetic and a steroid (patients with CD in whom medical conservative methods of treatment were not effective). The second group ($n=14$) consisted of persons with recurrent pain syndrome, resistant forms of CD and CPP, including after previously performed steroid injections: $n=2$ – neurolysis of GI with ethyl alcohol; $n=2$ – neurolysis of GI by phenol; $n=3$ – radio frequency modulation of GI; $n=7$ – radiofrequency ablation of GI.

Results. 14.0% of all study participants had post-traumatic CD (history of falling on the coccyx), the vast majority of 86.0% – idiopathic CD. Pain intensity was significantly lower post-intervention compared to baseline VAS mean of 7.6 ± 1.5 cm: 2.5 ± 0.9 cm one-week post-procedure, 1.5 ± 1.9 cm one month, 1.3 ± 1.5 cm three months, 2.1 ± 1.2 cm six months. The average score according to the Karnovsky Scale (KS) before and after the procedure was $73.3 \pm 6.3\%$ and $83.9 \pm 4.9\%$, respectively.

Conclusions. Interventions on ganglion impar are an effective method of treating patients with coccygodynia of various etiology, which significantly reduce pain according to the VAS scale ($p < 0.001$) and improve the quality of life according to the KS ($p < 0.001$) in dynamics after 1, 3, 6 months. Minimally invasive interventions on ganglion impar make it possible to reduce tissue trauma, to quickly recover for patients after the procedure, and to minimize any complications. In the first and second groups of the study, there was a decrease in the pain on the VAS from 8.0 cm to 2.0 cm ($p < 0.0001$) and from 7.0 cm to 2,7 cm ($p < 0.001$) before and after the procedure, respectively. In the first and second groups of the study, there was an improvement in the indicator of functional status according to the KS from 70% (95% confidence interval (CI) 60–90%) to 90% (95% CI 70–100%, $p < 0.0001$) and from 70% (95% CI 70–90%) to 90% (95% CI 80–100%, $p = 0.001$) before and after the procedure, respectively.

Key words: ganglion impar; ganglion of Walther; coccygodynia; pelvic pain; ganglion impar block

Introduction

Chronic pelvic pain (CPP), perineal and coccyx pain is a complex issue for both patients and health professionals, who have limited options for its effective treatment. The diagnosis of CPP is made when pain lasts for more than 3 months, is localized in the pelvic area, the anterior abdominal wall at or below the level of the umbilicus, as well as in the lumbosacral or sciatic area. The pain is quite intense, resulting in disruption

of vital activities. In about 38 out of 1,000 women aged 15 to 73, the reason for seeking primary care is CPP. The number of such referrals is comparable to the number of referrals for bronchial asthma [1]. CPP is the most frequent reason for referring female patients to gynecological clinics (20%) [2]. In almost half of the cases, the source of pain cannot be determined [3]. The most common causes of CPP include postoperative adhesions in the pelvis, endometriosis, pelvic venous

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congestion syndrome, leiomyoma (fibroid), malignant tumors of the pelvic organs, interstitial cystitis, chronic prostatitis, irritable bowel syndrome, reflected pain in the pelvis (occurs with pathology of the chest and lumbar spine). It should be remembered that a patient may have not one, but several conditions causing pelvic pain. Endometriosis and interstitial cystitis often coexist. In the most severe cases, the diagnosis of CPP cannot be determined. If the diagnosis of the underlying condition causing CPP is made, identifying the source of the pain is straightforward. However, if the diagnosis is unclear, it is essential to first determine the nature of the pain (visceral, somatic, neuropathic, or mixed).

Visceral pelvic pain originates from internal organs (bladder, rectum, uterus, ovaries or fallopian tubes). The pain worsens with stretching, compression, or torsion of the organ. This pain is often described by patients as poorly localized, dull and aching. The reason for this nature of pain is a small number of afferent nerve fibers over a large area. A relatively large area, such as urinary bladder, is supplied with few afferent fibers, making it impossible to localise the pain accurately.

Somatic pelvic pain arises from the structures that support the pelvic organs (fascia, pelvic floor muscles, and diaphragm). The localization of this pain is easy to determine, it is usually described as sharp pain in small areas.

Neuropathic pelvic pain occurs because sensory stimuli travel along nerves to the brain, where they are interpreted. Under normal circumstances, impulses are transmitted steadily, but in pathological conditions, the control of the passage of sensory signals is disrupted, and they begin to reach the brain chaotically. The damaged nerve not only responds to high-threshold stimuli, but also exhibits pathological activity by intensifying responses to normal chemical, temperature, and mechanical stimuli. The brain interprets abnormal nerve stimulation as pain. Nerve damage can occur due to mechanical, infectious, metabolic, toxic, radiation, idiopathic and other causes. Patients describe neuropathic pain as acute, shooting, burning. During the interview of the patient, it is necessary to inquire the details of the medical history, qualitative and quantitative characteristics of pain.

Sympathetically mediated pain is felt as dull, burning, may be combined with a sense of urgency during urination or defecation, its localization is often indistinct [4]. Acute, shooting and stabbing nature of the pain indicates a somatic etiology. Thus, to differentiate the nature of pain, it is usually enough to take a thorough medical history, determine its qualitative and quantitative characteristics, and perform a physical examination of the patient.

In 1859, J.Y. Simpson introduced the term "coccygodynia" (CD) to describe pain and hypersensitivity around the sacrococcygeal area [5]. Mostly, CD is associated with abnormal mobility of the coccyx, which causes chronic inflammation [4, 6]. The pain is usually aggravated by prolonged sitting on hard, narrow or uncomfortable surfaces, abnormal sitting posture, such

as leaning backwards while sitting, as well as sudden rising from a sitting position. It has a multifactorial origin, but can be idiopathic. The most common cause is a traumatic etiology, such as coccyx injury caused by falling backwards onto a hard surface, coccyx dislocation or trauma during childbirth, hypermobility, or spicules (osteophytes) of the coccyx. Infection or tumors of the coccyx are rarer causes [7, 8].

Nontraumatic CD result from degenerative joint or disc disease, hypermobility or hypomobility of the sacrococcygeal joint, obesity, infection, pelvic and anorectal cancer, a variant of the morphology of the coccyx. It is also important to rule out non-organic causes, such as somatization disorder and other psychological disorders in patients with chronic persistent CD [4, 9, 10].

The exact frequency of CD is unknown, but it occurs more often in women. The average age of the disease is 40 years, although CD can occur at any age [9]. Women are five times more likely to have the disease than men [11]. Adults and adolescents suffer from this disease more often. Obesity is also associated with an increased risk of developing CD [8, 11].

Most cases of CD (about 90%) can be treated with conservative therapy (non-steroidal anti-inflammatory drugs (NSAIDs), modification of the way of sitting, use of special coccyx cushions, pelvic floor rehabilitation and exercises, heat and cold compresses, transcutaneous electrical nerve stimulation, shock wave therapy, physiotherapy) [9]. In case of ineffectiveness of conservative treatment, direct injections around the coccyx (paracoccygeal blockades), caudal epidural steroid injections or ganglion impar (GI) interventions can be used [6–9]. In some cases, a coccygectomy is performed. Considering the high frequency of complications, surgical intervention is considered only when other analgesic measures fail [8].

The most promising of the minimally invasive injection techniques is GI intervention. Ganglion impar (ganglion of Walther) is a single sympathetic ganglion formed by the convergence of the distal ends of the lumbosacral division of sympathetic chains. It is the lowest of the ganglia of the sympathetic nervous system. It is the only sympathetic ganglion that is single and medial (rather than paired like the paravertebral sympathetic ganglia). Located in the retroperitoneum, anterior to the sacrum at the level of the sacrococcygeal symphysis and posterior to the rectum. It provides sympathetic efferent fibers and receives afferent sensory information from many pelvic structures and supplies sympathetic and nociceptive innervation of the perineum, coccyx, anus, distal rectum, vulva, urethra, and vagina. Intervention on the GI causes disruption of afferent sympathetic and nociceptive pathways from the pelvis, perineum, and anal region.

GIB is used to treat CD, CPP syndrome, pain in perineal cancer (rectum, vulva, prostate), etc.

Interventions on GI is performed with the help of fluoroscopy, computer tomography or sonography. In 2016, a cadaver study was conducted to investigate

This article contains some figures that are displayed in color online but in black and white in the print edition.

the feasibility of using magnetic resonance imaging to perform GIB. It was found to be technically feasible, but has not become widespread in clinical practice [12].

Interventions on GI can be performed using various agents and techniques (local anesthetics, corticosteroids, ethyl alcohol, phenol, botulinum toxin, radiofrequency ablation (RFA) or modulation (RFM), cryoablation [9–11].

The transsacrococcygeal technique is more commonly used. There are many technical variations,

but the goal is to successfully guide the needle to the anterior surface of the coccyx or sacrococcygeal symphysis to allow for local anesthetic, steroid, or neurolytic administration while avoiding injury to pelvic bones or organs. A radiopaque contrast agent is injected to reveal the correct retroperitoneal distribution of the agent along the anterior surface of the coccyx ("coma sign" or "reverse coma") (**Fig. 1**).

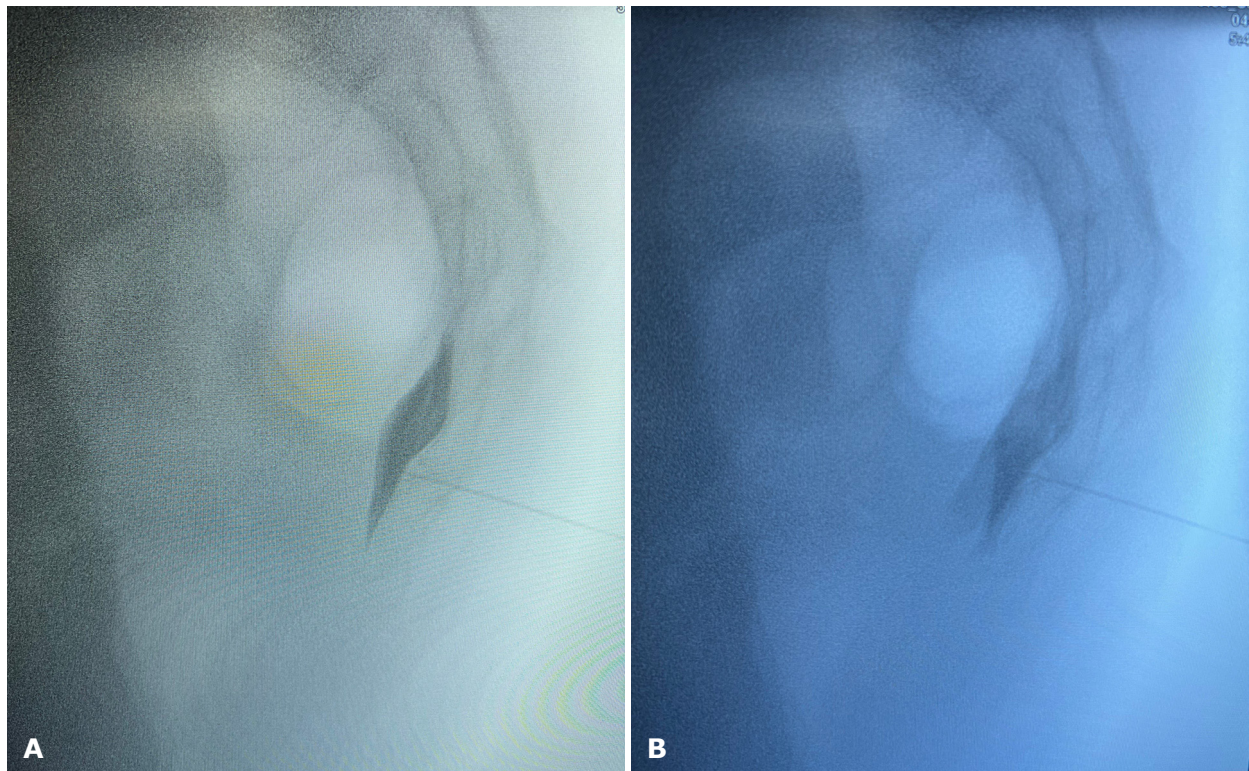


Fig. 1. Fluoroscopy of the GIB: transsacrococcygeal approach, lateral projection: A – visualization of the ganglion impar after dye injection, a "coma sign" in front of the sacrococcygeal joint, indicating the correct location of the needle; B - image after injection of a mixture of local anesthetic and steroid, confirmation of dye blurring - free diffusion (spreading) of contrast in the retroperitoneal pelvic space

Objective – to study the course of pain syndrome and functional status in patients with coccygodynia (CD) and CPP during the application of minimally invasive interventions on GI.

Materials and methods

Study design

A prospective interventional study was conducted on the basis of three medical institutions in Kyiv (Main Medical Center of the Ministry of Internal Affairs of Ukraine, Romodanov Neurosurgery Institute of the National Academy of Sciences of Ukraine and the medical center "Medclinic") in the period from 2017 to 2023. The results of 48 interventional procedures on GI in 42 patients were analyzed.

The study was approved by the committee on ethics and bioethics of the Institute of Neurosurgery named after Acad. A.P. Romodanov of the National Academy of Sciences of Ukraine (Minutes No. 3 dated December 16,

2020). Written informed consent was obtained from the patients after a detailed explanation of the procedure. The study was not associated with increased risk for the study subjects and was performed in compliance with bioethical norms and scientific standards for conducting clinical trials involving patients.

Inclusion criteria: presence of coccyx pain for ≥ 3 months, patients of both sexes, age from 23 to 71 years, no response to analgesics, anti-inflammatory drugs and other conservative treatment methods.

Exclusion criteria: age under 16 years, presence of local skin infection at the injection site or systemic infection, allergy to anesthetic or contrast dye, sacrococcygeal fusion due to any pathology, history of coccygectomy, coagulation of profile abnormality, pregnancy, mental disorders, psychiatric follow-up monitoring, inability to continue participating in the study during the follow-up period.

Characteristics of the group

There were 15 (35.7%) males and 27 (64.3%) females among the patients. The mean age of the patients is (47.9 ± 14.8) years.

Interventions were performed using five techniques. The patients were divided into two groups: the first group - 34 patients with CD, in whom medical conservative methods of treatment were ineffective. GIB was performed using local anesthetic and steroid; the second group comprised 14 individuals with recurrent pain syndrome and resistant forms of CD after previously administered steroid injections (neurolysis of GI with ethyl alcohol (n=2), phenol (n=2), RFM GI (n=3), RFA GI (n=7)).

Procedure technique

Patients were selected for empirical analysis of transsacrococcygeal injections under fluoroscopic control using the C-arm "Cios Select with FD" (Siemens, Germany), which was used at the Main Medical Center of the Ministry of Internal Affairs of Ukraine, or "Arcadis Varic" (Siemens, Germany) used at the Institute of Neurosurgery named after Acad. A.P. Romodanov of the National Academy of Sciences of Ukraine and the "Medclinic" medical center. In addition, the study performed radiography of the coccyx in lateral and anteroposterior projections in patients with a history of trauma to the coccyx. This was necessary in order to ensure the absence of deviations, bony anomalies, fusions of sacrococcygeal symphysis and the possibility of carrying out the procedure. All interventions on GI were performed on an outpatient basis. After the procedure, patients were sent home the same day, after being observed for one hour in the hospital to record possible complications after the procedure (local pain, marked numbness or anesthesia, pelvic organ disorders, hypotension, bradycardia, signs or symptoms of cardiotoxicity or neurotoxicity, etc.), and to assess the pain syndrome.

The procedure is performed with the patient lying prone. Lumbar lordosis is reduced with the help of a cushion placed under the abdomen. The procedure is carried out under aseptic conditions. The intergluteal area is prepared with sterile aseptic technique and wrapped in sterile surgical linen. In the study, an aseptic metal pointer was used to localize the sacrococcygeal space, a lateral fluoroscopic projection was recorded, and the target area was marked. 2 ml of 2% lidocaine was injected into the subcutaneous tissue of the upper part of the intergluteal fold as a local anesthetic to anesthetize the area, followed by the introduction of a 23G needle (0.6×30 mm) into the sacrococcygeal disc (**Fig. 2**). The needle was moved towards the point of loss of resistance, indicating placement of the needle tip anterior to the ventral sacrococcygeal ligament. When the needle is in place, i.e. along the line of the sacrococcygeal disc, 1 ml of the radiopaque dye "Tomohexol 350" (Farmak, Ukraine) diluted in physiological solution in a ratio of 1:2–1:3 was injected. The needle location was confirmed by the "coma sign" in the retroperitoneal space in the lateral fluoroscopic projection (**see Fig. 1**). After a negative aspiration test, in the absence of blood or cerebrospinal fluid, 2–3 ml of 0.5% bupivacaine and 1 ml of "Depo-medrol®" (methylprednisolone, Pfizer, USA) were administered. Hemostasis was achieved by pressing on the injection site and applying a sterile dressing.

After the procedure, NSAIDs and ice compresses were prescribed to relieve local inflammation. Patients' vital signs were documented before the procedure, during the intervention, and after it in the ward.

In the case of neurolysis, 2–5 ml of 96% ethyl alcohol or an aqueous solution of 6.5% phenol was administered using a similar technique. Before removing the needle after the neurolysis procedure, it was washed with 1 mL of saline to prevent the neurolytic agent from entering the disc or superficial soft tissues of the patient.

Radiofrequency interventions on GI were performed using a radiofrequency generator "Radionics RFG-3C Plus" (USA). A 22G (0.7×98.6 mm) radiofrequency needle with a 10 mm exposed active tip was used. Before performing the procedure, tissue impedance, motor and sensory reactions (motor and sensory stimulation) were checked. Expected tissue impedance was <500 ohm. Sensory paresthesia sensation around the sacrococcygeal area <1 V at 50 Hz. Neuroablation was performed in two protocols of 90 s, temperature – 80 °C, neuromodulation – in two protocols of 90 s, temperature – 40–42 °C.

Data from patients after the observation period were used for analysis. Patients who were unable to visit the clinic were contacted by phone, and their responses were recorded. Patient examination data were also analyzed which were collected by means of a preliminary survey using a visual analog scale (VAS) of pain from 1 to 10 cm, where 0 cm is the absence of pain, 10 cm is unbearable pain. The patients' functional status was assessed before and after the procedure, according to the Karnovsky scale (KS) from 0 to 100%. The participants were followed up for 6 months, evaluations were carried out after 1 week, 1, 3 and 6 months, respectively.

Statistical analysis

The obtained data were processed using the statistical program package MedCalc V 22.016. Quantitative data (age, VAS and KS scores) are given in the form of arithmetic mean value and standard deviation. The Student's test for paired samples was used to detect differences after interventions, in the case of a normal distribution of data, the Wilcoxon rank sum test, if the data distribution differed from the normal distribution law. The critical significance level was 0.05.

Results and discussion

Most patients (86.0%) were diagnosed with idiopathic CD (**Table 1**).

Interventions were successfully performed for all patients on the first attempt. No issues occurred during the procedure. There were no cases of rectal or other pelvic structure perforations. No complications were recorded after the procedure.

In connection with the recurrent pain syndrome, interventions were repeated during the observation period for 2 (4.8%) men and 2 (4.8%) women. One (2.4%) man underwent three consecutive procedures performed due to persistent recurrent pain syndrome: neuromodulation, neuroablation, and GI phenolization. The patient was admitted to the clinic after performing the GIB, which did not contribute to long-term relief of the condition.

The VAS score data are given in the **Table. 2** and **Fig. 3**. It was found that this score was significantly

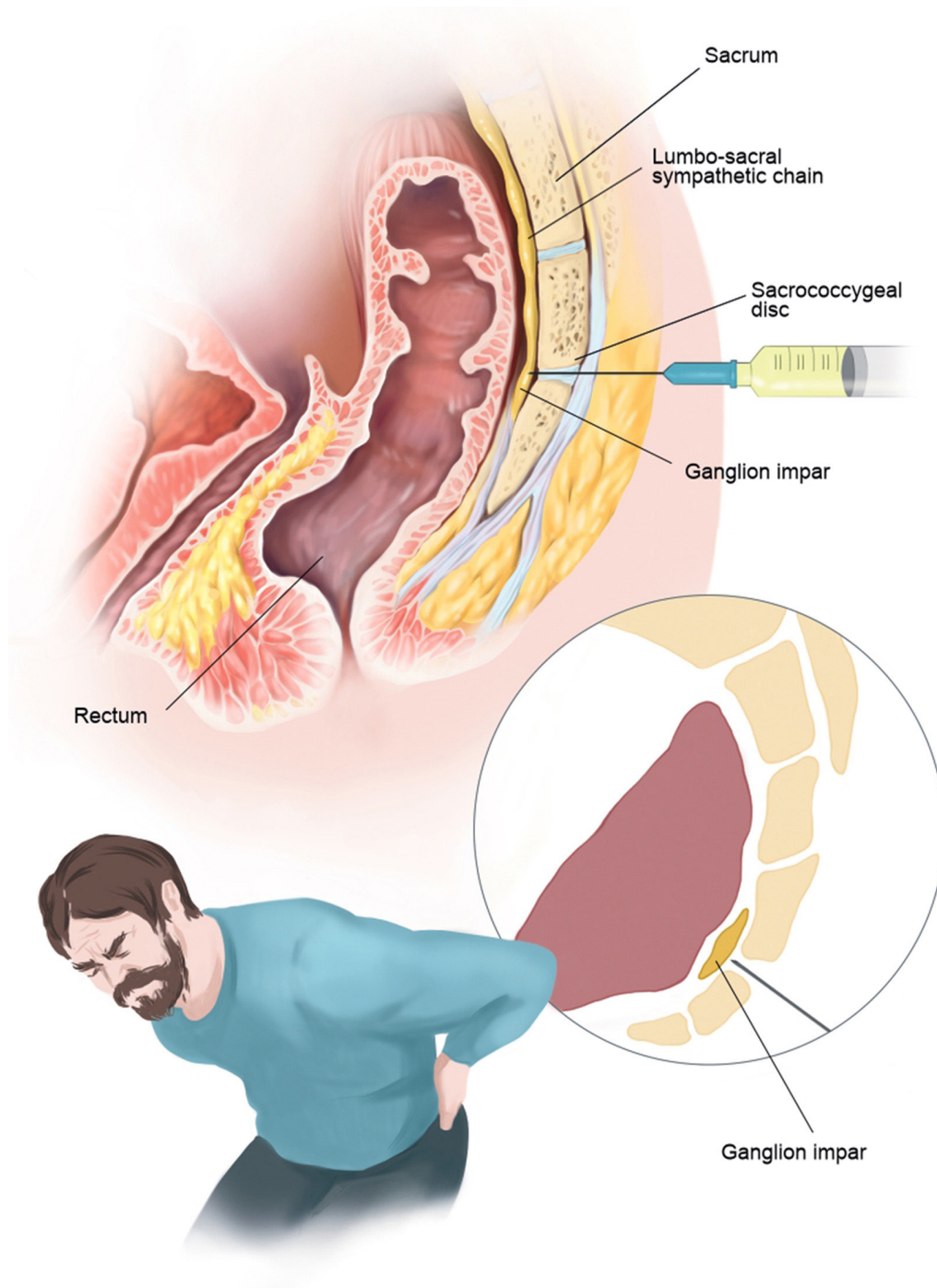


Fig. 2. Schematic representation of the intervention on ganglion impar and the anatomical arrangement of organs and structures

lower compared to the initial one in all studied periods. The average score for the KS before and one week after the procedure was (73.3 ± 6.3) and $(83.9 \pm 4.9)\%$, respectively, the difference in indicators was statistically significant.

There was a decrease in the VAS pain index in the first group from 8.0 cm (95% confidence interval (CI) – 7–8 cm) before the procedure to 2.0 cm (95% CI – 2–3 cm) after the procedure ($p < 0.0001$), in the second group – from 7.0 cm (95% CI – 5.8–8.1 cm) to 2.7 (95% CI – 2.4–3.1 cm, $p < 0.001$). An improvement

in functional status according to the KS was registered in the first group from 70% (95% confidence interval (CI) – 60–90%) before the procedure to 90% (95% CI – 70–100%, $p < 0.0001$) after the procedure, in the second group, from 70% (95% CI 70–90%) to 90% (95% CI 80–100%, $p = 0.001$).

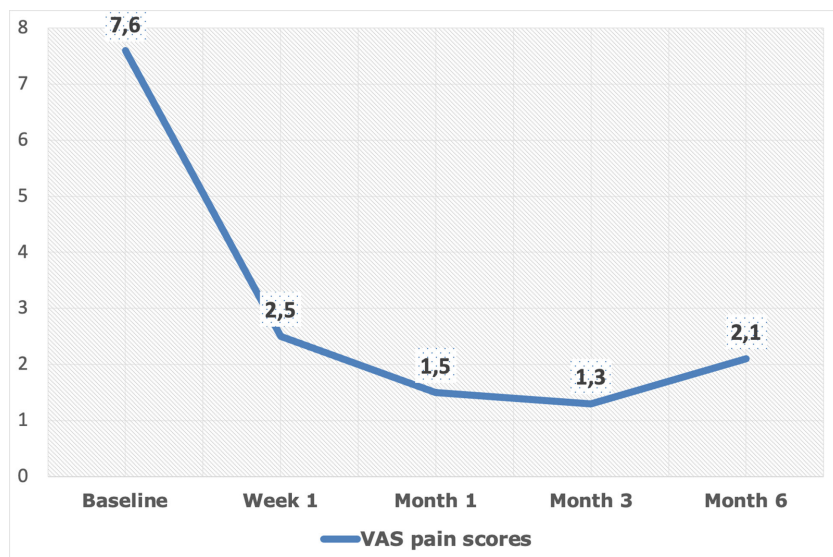
Consequently, in both groups, the treatment outcome improved after the interventions, but no significant difference between the groups was found either in terms of the VAS score ($p = 0.07$) or in the KS score ($p = 0.62$).

Table 1. Characteristics of the patient group (n=42)

| Indicator | Number | |
|-------------------------|-------------------|------|
| | Abs. | % |
| Sex: | | |
| males | 15 | 35,7 |
| females | 27 | 64,3 |
| Age, years | 47,5±14,9 (23–71) | |
| Etiology of pain: | | |
| Idiopathic coccygodynia | 36 | 86,0 |
| trauma | 6 | 14,0 |

Table 2. Changes of VAS and KS scores (n=48)

| Study period | VAS score, cm | P | KS score, % | P |
|------------------|---------------|--------|-------------|--------|
| Before procedure | 7,6±1,5 | <0,001 | 73,3±6,3 | <0,001 |
| In 1 week | 2,5±0,9 | <0,001 | 83,9±4,9 | <0,001 |
| In 1 month | 1,5±1,9 | <0,001 | 93,5±9,1 | <0,001 |
| In 3 months | 1,3±1,5 | <0,001 | 94,7±6,9 | <0,001 |
| In 6 months | 2,1±1,2 | <0,001 | 91,1±7,7 | <0,001 |

**Fig. 3.** Changes of the average VAS value

The discovery of GI belongs to the doctor Augustin Walther. He described its location on the anterior surface of the coccyx in the 1720s. It was not until 1990 that the first report on GI blockade appeared in the medical literature. R. Plancarte et al. described a neurolytic blockade technique used in 16 patients with advanced cancer and persistent perineal pain. The technique involved placing a previously curved needle through the anococcygeal ligament toward the anterior surface of the coccyx under fluoroscopic guidance. A finger was placed into the rectum to detect the misplaced needle. This series of cases resulted in good pain intensity reduction, as reported by the patients. [13, 14].

In the past, bent and curved needles were used for GI interventions, which was associated with

significant discomfort, tissue damage, high risk of rectal perforation, periosteal injection, and high failure rates [15]. To eliminate these technical difficulties, R. Wemm Jr. and L. Serbeski introduced the trans-sacrococcygeal GIB technique, which is faster and easier to perform [16]. They inserted the needle through the sacrococcygeal disc to reach the retroperitoneal space. There is a risk of discitis, since the transcoccygeal technique causes disc space disruption. Therefore, strict asepsis should be observed during the procedure.

Many authors report the use of a direct spinal needle approach, which avoids the above-mentioned problems, in particular reducing the risk of discitis and the number of cases of needle breakage [4, 8, 9, 11, 15]. To apply this technique, a 22G needle

is first inserted into the sacrococcygeal disc, through which a 25G needle is passed to reach the retroperitoneal space. In our case series, a single 23G needle was used, which was inserted via a transdisc-transsacral-coccygeal approach. No complications or problems related to the use of this gauge needle or access have been reported.

Occasionally, in elderly patients, there is ossification of the sacrococcygeal disc, resulting in difficult passage of the needle. In this situation, the needle can be passed through the intracoccygeal joints or a paracoccygeal approach can be used [17, 18]. However, intracoccygeal approach is difficult because the intracoccygeal joints are too small. Paramedian access is performed from the lateral side of the coccyx using a curved spinal needle, which requires repeated manipulations of the needle to reach the retroperitoneum. This can be uncomfortable and quite traumatic for the patient. In our opinion, these approaches should be performed only when an approach through the sacrococcygeal joint is not possible.

Coccygodynia is a clinical condition with various etiologies. Its diagnostic criteria are lacking [4]. Clinical history and physical examination are sufficient to make the diagnosis. The perineum should be carefully examined to rule out another etiology of coccyx pain. Pilonidal cysts, pilonidal sinus, hemorrhoids, and perineal abscess may also present with coccyx pain. The coccyx should be examined to detect instability of the sacrococcygeal joint. A rectal examination can be very informative. Pain elicited upon coccygeal mobilization indicates a nociceptive origin of the pain originating from the lower pelvis. The Valsalva test is usually suggested to establish the neuropathic component of CD. Increasing pain during the Valsalva test indicates the neuropathic origin of CD [19]. Radiography with dynamic tests is especially useful for the diagnosis of the sacrococcygeal joint instability [20].

CD develops more frequently in women due to a more posterior location of the sacrum and a larger coccyx [21], as well as due to greater pressure during pregnancy and childbirth [11]. The sex ratio was consistent with other authors' data: there were almost twice as many women as men. The mean age of our patients was also comparable to general statistical data.

The proportion of patients with post-traumatic CD in our study was 16.0%. According to other authors, the frequency of traumatic etiology of CD ranges from 0% [9, 22] to 72.4% [23]. S. Adas et al. reported 29.3% of cases of idiopathic origin and 51.2% of cases of CD with a history of trauma [24]. According to A.E. Galhom et al. reported a similar incidence of injuries leading to CD and idiopathic causes [25].

Obesity is another risk factor, its association with CD occurs three times more common than in the general population [8, 9, 11]. However, the impact of body mass index as a risk factor for CD has not been studied in the case series presented.

Low back pain is commonly associated with CD, which can complicate diagnosis and treatment. In our series, 12 (28.6%) patients had pain in the lumbosacral region of the spine. After treatment of CD, all patients noted a significant reduction in low back pain. Four (9.5%) patients complained of the relationship between the CD onset and urination process or issues related

to urinary dysfunction. In our study, there were no cases of treatment of CD associated with cancer, bulky neoplasms of pelvic organs, particularly following surgical interventions on the pelvic organs, which caused pain syndrome. However, in 4 (9.5%) observations, the intervention on GI was performed after stabilizing surgery in the lumbosacral spine.

There are differences in the anatomical location, shape and size of GI. In addition, the ventral branch of the sacral nerves may pass near the GI, which may be damaged during neurolysis or RFA [26]. Damage to the ventral branch of the sacral nerves has not been recorded in any of our patients. Anatomical variability of GI was confirmed in the study. In some cases, instead of the characteristic "coma sign", a "crescent sign" was observed (**Fig. 4**).

In 3 (50.0%) patients with a history of trauma, a more horizontal position of the coccyx was observed, which made manipulation somewhat difficult. The shape and position of the GI were also altered: the ganglion is more elongated, thinner, like the coccyx, and occupied a more horizontal position (a sharp angle relative to the sacrum) (**Fig. 5**).

A number of strategies are available for the treatment of CD. However, if pharmacotherapeutic and physiotherapeutic methods are ineffective, patients should be offered injection therapy. Soft tissue infiltration around the coccyx with local anesthetics with or without steroids is a simple and common procedure. However, this technique does not always provide a stable analgesic effect [9, 27].

GI interventions are usually considered for the treatment of CD that is unresponsive to other conservative or injectable treatments. A diagnostic GIB with a local anesthetic may be performed beforehand to confirm the efficacy of the procedure. Pain reduction is achieved by blocking nociceptive and sympathetic fibers [9, 28]. In case of pain recurrence after a single GIB, the procedure can be repeated or the technique of radiofrequency neuromodulation or ablation can be used, due to which the effect of long-term analgesia is achieved [8, 29]. Neurolysis of GI with ethyl alcohol or phenol is commonly used in oncology for the treatment of persistent pain syndrome [14, 30]. In our series, chemical neurolysis was used in patients without oncological history who had persistent recurrent resistant pain syndrome. A positive effect was obtained in all cases.

Comparison of the efficacy of GI intervention techniques in the literature revealed contradictory results. R. Choudhary et al. conducted a systematic review of the literature (189 patients, 104 of them underwent GIB, 85 - RFA). The authors found no significant difference when comparing the two treatment methods. Both blockade and RFA produced good persistent results during a 6-month follow-up period. The choice of blockade or RFA depends on the availability of resources, the doctor's qualifications and the patient's choice [8].

E. Sir and S. Eksert compared GIB (25 observations) and RFM (14) and concluded that both techniques in CD reduce pain in the short-term (3 weeks) and medium-term (3 months) period, but in the long-term period (after 6 months) RFM provides a better analgesic effect than GIB [31].

N. Usmani et al. conducted a comparison of RFA (n=34) and RFM (n=31) of GI in patients with non-oncological pain with a 6-week follow-up. A significantly greater reduction in pain was found in the RFA group compared to the RFM group. At the end of follow-up, 28 (82.0%) patients in the RFA group and only 4 (13.0%) in the RFM group had good

results according to the subjective patient satisfaction questionnaire [32].

K.V. Nalini et al. demonstrated high efficiency of neurolysis of GI with ethyl alcohol in oncological patients. Although the follow-up period was only 2 months, and the sample was 5 observations, the researchers noted that it was neurolysis that made it possible to obtain a

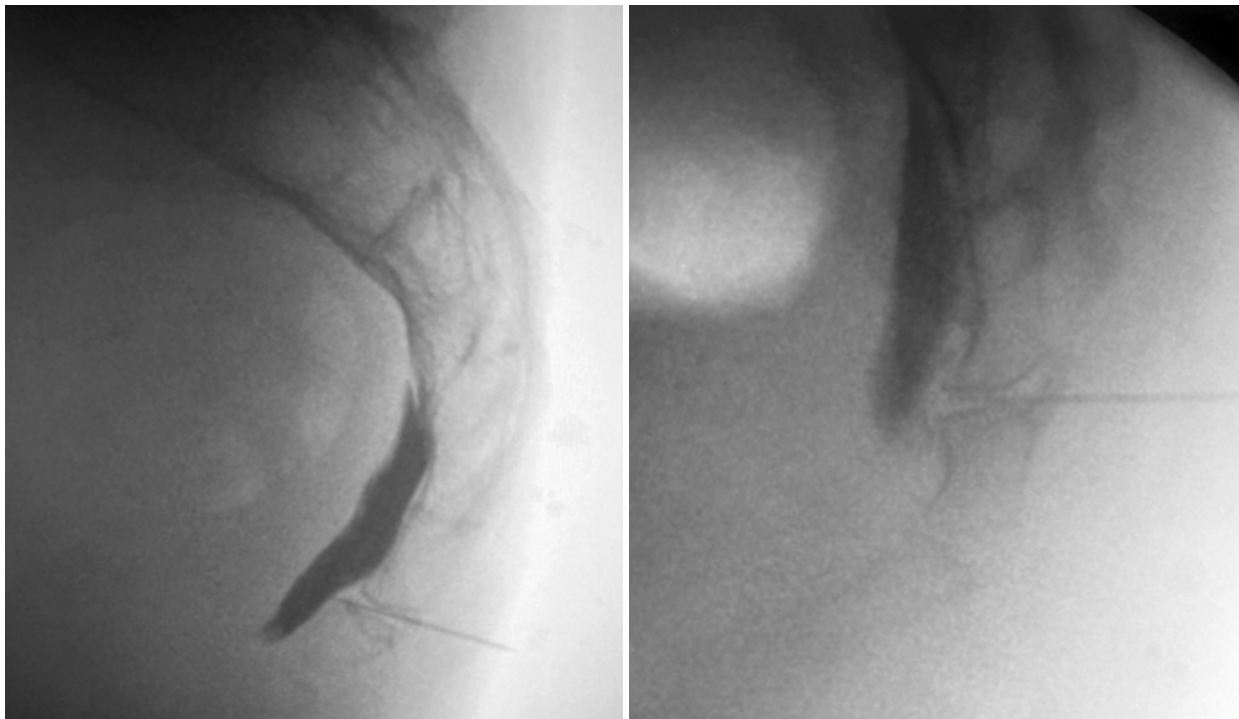


Fig. 4. Fluoroscopy of ganglion impar interventions in different patients: trans-sacrococcygeal approach, lateral projection. Visualization of the "crescent sign" confirming the anatomical variability of the ganglion impar

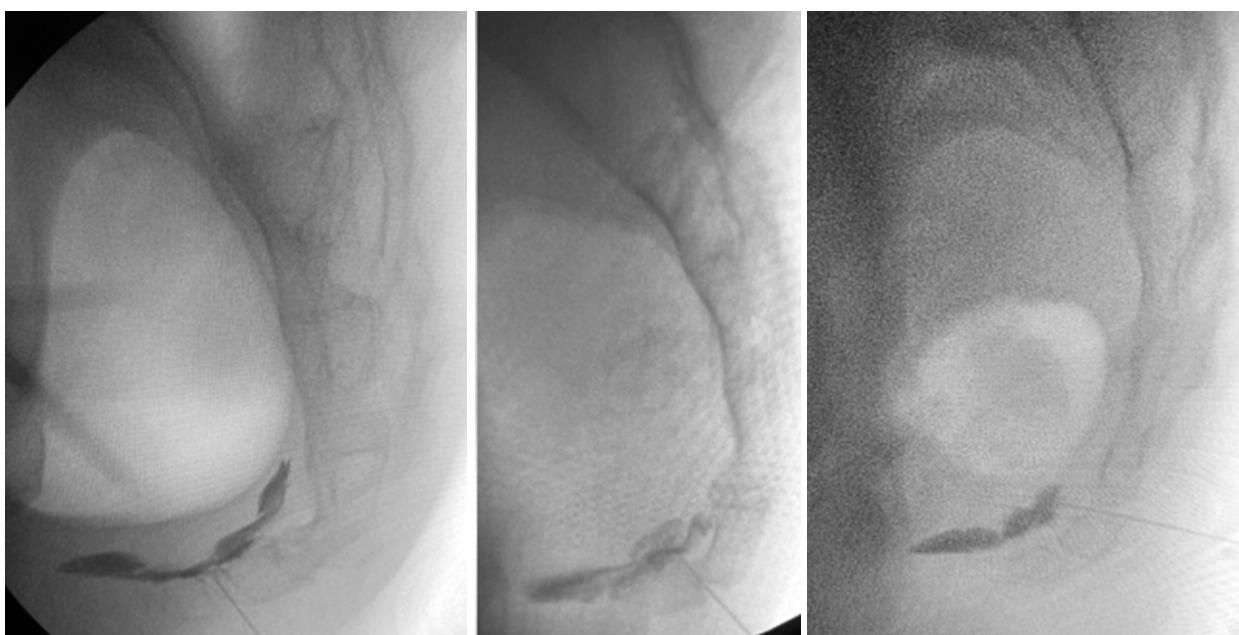


Fig. 5. Fluoroscopy of ganglion impar interventions in three patients with post-traumatic coccydynia

stable analgesic effect, prevent repeated injections of anesthetics and steroids leading to infection, increased blood glucose levels, and suppression of immunity in patients weakened by oncology. No complications were recorded. A post-intervention control study revealed a decrease in the VAS score, opioid requirements, and an increase in quality of life [29].

O. Sagir et al. analyzed 29 observations (20 patients underwent only GIB, 9 - additional RFM). The results showed that the VAS score for the period from 3 to 6 months and from 6 months to 1 year was significantly lower in patients who received RFM. Consequently, the analgesic effect can be prolonged by combining the blockade with RFM [23]. In our study, if the blockade was not effective enough, the analgesic effect was prolonged by other methods of injection treatment.

A case of treatment of a patient with post-traumatic CD (hypermobile coccyx) who was subjected to neurolysis with ethyl alcohol immediately after neuroablation is described [33]. The intervention made it possible to abandon painkillers, to reduce the intensity of pain on the VAS from 8-9 to 1-2 cm. The authors note that a combination of steroids and local anaesthetics, neurolytics (alcohol, phenol), cryodestruction and thermal destruction by radiofrequency thermocoagulation can be used for therapeutic purposes. Therefore, the question of the optimal method for GI interventions is a matter of debate, requiring an increase in the number of participants and follow-up period and systematic comparative literature reviews.

Common indications for coccygectomy are coccyx instability, subluxation, and coccygeal spicule (osteophyte) [34]. In our series, injectable GI treatment was sufficient to provide long-lasting pain relief in all patients. Coccygodynia should be treated in time, before the onset of chronic pain with deep emotional and psychological consequences. Treatment of patients with long-term CD should be approached comprehensively, combining drug and injection therapy, physical therapy and psychosocial treatment.

Conclusions

1. Interventions on GI are an effective treatment method of patients with CD of various etiologies. They significantly reduce pain according to VAS ($p < 0.001$) and improve functional status according to KS ($p < 0.001$) after 1, 3 and 6 months.

2. Minimally invasive interventions on GI allow for less tissue traumatization, rapid recovery after the procedure and minimize any complications.

Disclosure

Conflict of interest

The authors declare no conflict of interest.

Ethical approval

All procedures performed on patients comply with the ethical standards of institutional and national ethics committees, the 1964 Declaration of Helsinki and its amendments or similar ethical standards.

Informed consent

Informed consent was obtained from each of the patients.

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