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CT-guided percutaneous radiofrequency denervation of the sacroiliac joint

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Abstract Defining the origin of low back pain is a challenging task. Among a variety of factors the sacroiliac joint (SIJ) is a possible pain generator, although precise diagnosis is difficult. Joint blocks may reduce pain, but are, in cases, of only temporary effect. This study was conducted to evaluate CT-guided percutaneous radiofrequency denervation of the sacroiliac joint in patients with low back pain. The procedure was performed on 38 patients who only temporarily responded to CT-guided SIJ blocks. The denervation was carried out in the posterior interosseous sacroiliac ligaments and on the dorsal rami of the fifth spinal nerve. All interventions were carried out under CT guidance as out-patient therapies. Three months after the therapy, 13 patients (34.2%) were completely free of pain. Twelve patients (31.6%) reported on a substantial pain reduction, 7 patients (18.4%) had obtained a slight and 3 patients (7.9%) no pain reduction. The data of 3 patients (7.9%) was missing. There were no intra- or postoperative complications. Computed tomography-guided percutaneous radiofrequency denervation of the sacroiliac joint appears safe and effective. The procedure may be a useful therapeutic modality, especially in patients with chronic low back pain, who only temporarily respond to therapeutic blocks.

Keywords Sacroiliac joint · Low back pain · Radiofrequency denervation

Introduction

Low back pain (LBP) is a complex clinical phenomenon that is mostly conditioned upon a variety of factors. Pain can be reproduced in cases of spondylarthrosis in the facet joints and can be reduced with anesthetic and corticosteroid injections [1] or denervation using ethanol or radiofrequency heat, in connection with or after a course of physical therapy. The role of the sacroiliac joint (SIJ) in LBP has been frequently discussed in the past decade [3, 4, 5, 6, 7]. Although there is no current standard criterion for SIJ-generated pain, positive image-guided diagnostic blocks [8] and clinical examination [9, 10, 11, 12] can indicate the need for specific SIJ treatment to reduce symptomatic pain that can be found in the lumbar spine, the gluteal region with radiation into the dorsal thigh, the popliteal space, the groin, and even the dorsal lower leg [13]. Current SIJ treatments include anesthetic as well as corticosteroid injections and denervation with ethanol. In our experience, especially patients with advanced arthropathy and resistant, chronic LBP often just temporarily benefit from injections and SIJ denervation with ethanol does offer only limited precision. These facts have motivated us to search for an alternative, precise, and lasting therapy modality.

Image-guided radiofrequency (RF) denervation is a reliable method of denervation in the cervical, thoracic, and lumbar spine [2, 14, 15]. Current flowing through the electrode generates heat in adjacent tissue based on its resistance or impedance, until the temperature of the probe and that of surrounding tissue reach equilibrium. This causes the desired lesion in a controllable size and enables a precise denervation.

The purpose of this prospective study was to evaluate the role of CT-guided RF denervation of the SIJ in the management of non-radicular LBP.

Materials and methods

Forty-three patients with resistant pain were included in a prospective observational study (22 women and 21 men; age range 30–79 years, mean age 57.2 years). LBP was present for at least 3 months. All patients complained about persistent LBP after one to two facet joint injections with local anesthetic, steroids, and adjacent ethanol denervation in levels L3/4, L4/5, and L5/S1. Although pain related to the facet joints was reduced, persistent LBP was localized in the SIJ area with radiation into the gluteal region, the dorsal thigh, the popliteal space, and occasionally the dorsal lower leg. Patients reported severe LBP during specific provocative maneuvers such as Patrick's test and pressure application to the sacroiliac ligaments at the sacral sulcus in prone position.

Consequently, all 43 patients underwent CT-guided diagnostic sacroiliac joint blocks with a mixture of 2 ml 0.5% bupivacaine, 20 mg of methylprednisolon (Volon A), and 0.5 ml ionic contrast medium (Fig. 1). The SIJ injections were performed with the patient positioned prone. On the follow-up 2 weeks later, 38 patients reported a definite, but only temporary pain relief. They were scheduled for RF denervation of the SIJ after complete informed consent was obtained. Five patients did not feel any pain difference within the 2 weeks after the injections and were therefore not considered for the RF denervation. The remaining 38 participants met the requirements according to Table 1, which also presents the indications for a RF denervation of the SIJ.

Fig. 1 Before the sacroiliac joint (SIJ) was blocked with bupivacaine and methylprednisolone, contrast medium was applied to ensure secure drug spread. In the CT image, needle and contrast medium are clearly visible (*arrow*)

Radiofrequency denervation of the sacroiliac joint

The CT-guided interventions were performed on an outpatient basis only. A total of 51 interventions were carried out on 38 patients. Thirteen patients were treated bilaterally and 25 patients received unilateral denervation. The patient was placed on the CT table in prone position. Following that was a short scout image of the pelvis. The SIJ was scanned with a section thickness of 3 mm and a table advancement of 3 mm, viewing in the bone window on a Somatom Plus 4 Volume Zoom CT (Siemens) or EBT (Imatron C-150XLP). For the therapy we used a 50-W radiofrequency generator (NEURO NSO, Leibinger GmbH, Freiburg, Germany).

The denervation was carried out on two locations.

Posterior interosseous sacroiliac ligaments

The section position with the most suitable access to the posterior interosseous sacroiliac ligaments was set as the intervention position. The planning line was drawn on the monitor mediolateral in an extremely plane angle (approximately 40°) and marked accordingly on the patient's skin. Then a neutral electrode was placed on the contralateral side, on a level with the RF denervation. After preceding skin disinfection, sterile covering, and local anesthesia, a 10- or 15-cm, 23-G insulated RF cannula with 5-mm uninsulated tip (Leibinger) was placed percutaneously in the target region as planned on the monitor. Two to three corrections were necessary until the cannula was in the desired position controlled by two 5-mm axial CT scans after each correction. Once the cannula was securely positioned and after corresponding anesthesia with 2–4 ml bupivacain 0.5%, we injected 3–5 ml 0.9% isoton saline for enhanced temperature spreading and to reduce local impedance. We then led the monopolar RF electrode into the insulated therapy cannula and started RF coagulation. Current temperature was measured by the cannula tip during the whole procedure. To produce an overlapping coagulation we used three steps with 90°C applied temperature. In each step we drew the set backwards approximately 5 mm after 90 s of heat application (Fig. 2).

The passage of sacral ala and transverse process of the vertebral body L5

We then replaced the sound to the upper part of the junction sacral ala and transverse process of the segment L5/S1 to lesion the dor-

Table 1 Inclusion and exclusion criteria for radiofrequency denervation of the sacroiliac joint (SIJ)

Inclusion criteria	Exclusion criteria
Persistent, non-radicular back pain in the SIJ region after CT-guided facet joint denervation in at least two segments, L4/5 and L5/S1, and possibly L3/4	Preceding, negative, CT-guided, intraligamentous neural blockade of the SIJ
Preceding, positive, CT-guided intraligamentous neural blockade of the SIJ	Hemorrhagic diathesis
Chronic SIJ pain	–

Fig. 3 The intraoperative CT image shows the radiofrequency set placed at the upper part of the junction sacral ala and transverse process of the segment L5/S1 to lesion the dorsal branches of the fifth spinal nerve. Hereby we aimed at denervating large portions of the proximal SIJ, which are innervated by these structures

Table 2 The radiofrequency (RF) parameters. These parameters can be adjusted on the RF generator. The energy output was controlled automatically according to tissue impedance and the desired temperature to ensure a controlled RF temperature

RF temperature (°C)	Energy output (W)	Tissue impedance (Ω)	Total average coagulation time (min)
90	1.8–7.3	145–240	7.2

sal branches of the fifth spinal nerve, once again applying 90°C of heat for 90 s (Fig. 3).

After the 30-min intervention, the patients were rested and monitored for approximately 2 h and finally discharged home.

The treatment did not require narcosis or sedation but local anesthesia in the area of the puncture.

All patients were treated with standardized coagulative parameters as described in Table 2.

Subjective pain sensation was measured with the help of a patient questionnaire on the second, seventh, thirteenth and nineteenth day post intervention. In the questionnaire the patients were asked to report on their pain sensation after the therapy. They were asked to choose one of four options: 1=no pain; 2=substantial pain reduction; 3=slight pain reduction; and 4=no pain reduction.

◀ **Fig. 2a–c** A CT image of the cannula position. **a** At first, the cannula is placed in the ventral portion of the ligamentous SIJ compartment. **b, c** To produce an overlapping lesion, the system was drawn backward between each denervation. With this technique as much as possible of the accessible proximal portion of the SIJ was treated with radiofrequency heat

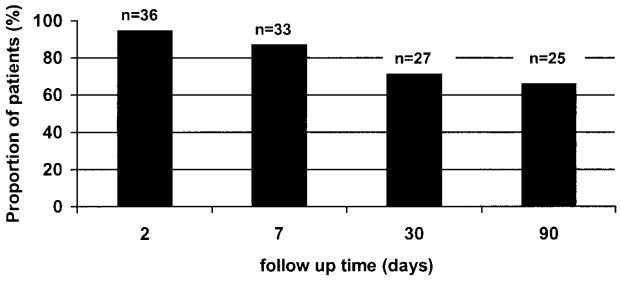

Fig. 4 Proportion of patients with successful therapies (at least a substantial pain reduction) at different follow-up times

If "no pain" or "substantial pain reduction" were chosen, the treatment was considered to be successful.

Results

All 51 interventions were carried out without intra- or postoperative complications such as bleedings, sensorimotoric disorders, hematoma, septic sacroilitis, articular abscesses, or osteomyelitis. Seven patients reported postoperative pain of up to 5 days, which required additional CT-guided blocks with corticoids and local anesthesia in 2 cases.

After 2 days, 27 patients (71%) were totally free of pain. Nine patients (23.7%3) reported a substantial pain reduction and 2 patients (5.3%) felt a slight pain reduction after the therapy.

On the seventh postinterventional day 23 patients (60.5%) were free of pain, 10 patients (26.3%) had a substantial reduction, and 4 patients (10.6%) only a slight reduction of pain. The data of 1 patient (2.6%) was not available.

One month after the intervention, 15 patients (39.5%) were pain free, 12 patients (31.6%) still had a substantial pain reduction, 7 patients (18.3%) a slight reduction, and 2 patients (5.3%) no pain reduction. Here the data of 2 patients (5.3%) was missing.

On the last follow-up, 3 months after the therapy, the data of 3 patients (7.9%) was missing and 13 patients (34.2%) said that they still felt no pain. Twelve patients (31.6%) reported a substantial pain reduction, 7 patients (18.4%) a slight reduction, and 3 patients (7.9%) experienced no pain reduction 3 months after the RF denervation (see Fig. 4).

Fig. 5a, b Injecting a fluid medium into the SIJ may cause severe complications in cases of, for example, advanced degenerative processes. **a** Contrast medium leaking from the SIJ (*arrow*). In cases of ethanol injection this would possibly lead to peritonitis, involvement of the lumbar plexus, or tissue necrosis. **b** Contrast medium is missing the SIJ (*arrow*) during a check-up before a neural blockade. The application of drugs or alcohol could result in, for example, unwanted denervation such as S1 or S2 denervation and neuritis. The visualization of these incidents is an essential advantage of CT guidance in order to prevent severe complications

Discussion

Our findings indicate that CT-guided radiofrequency denervation of the SIJ may be an effective alternative to reduce LBP in patients who only temporarily respond to SIJ injections. Image-guided SIJ blocks with local anesthetic and corticosteroids are gaining in popularity to reduce pain in symptomatic patients. Maldjian et al. [16] report that image-guided injection of steroid compounds into the joint can give good and long-lasting results, which is contrary to our experience especially in the present study. One reason for this discrepancy may lie in the relatively high age of our participants which often results in advanced arthropathy and greater chronicity [17]. The injection of 96% ethanol is an effective method

for denervation but is often entailed with complications such as S1, S2, and S3 part-nerve denervation and neuritis which may cause lasting pain, especially in the SIJ with its special anatomical features (Fig. 5). These complications were not observed in RF denervation, which we found easier to control and more precise than the chemical option. RF heat does not cause intra- or periarticular scar formation and muscular, ligamentous as well as osseous structures of the motion segment remain unharmed due to the percutaneous technique. The thermic sterilization effect minimizes the risk of contamination during the intervention. With respect to the effectiveness in pain reduction, similar results were recently reported by Ferrante et al., who performed RF denervation in 33 patients with sacroiliac joint syndrome [18].

Under CT guidance instruments can be precisely placed within the target region and a controlled lesion can be caused, which is essential not only for the therapy outcome but also for the protection of nearby vessels and other neural structures [19, 36]. We consider CT guidance with or without external laser marker systems essential for the effectiveness and safety of interventional procedures, especially in complicated structures such as the SIJ, the spine, the hip joint, or for sympathectomies and diagnostic biopsies [19, 20, 21, 22]. Additional safety is achieved by the close communication with the nonsedated patient during the treatment.

The role of the SIJ in the symptomatology of pain in the lower back, the pelvis, and the lower extremities is not exactly clear. Up to now the lack of valid diagnostic standards for SIJ-generated pain and dysfunction, respectively, is a limitation in present studies and published treatment results. Clinical examination methods of the SIJ, such as stress maneuver, and Patrick's, Gaenslen's, and Yeoman's tests, or compression of the sacral alae on prone-positioned patients, can provoke SIJ pain but are considered to be very unspecific. Examinations with CT of the SIJ can display erosions of the joint surfaces or subchondral sclerosis of the iliac or sacral bones [23, 24]. The normal anatomy of the joint, however, also features certain asymmetries of the cartilage thickness (thinner on the side of the iliac bone) as well as irregular cartilage covering of the articular surface. These differences are more often found in men and lead in the long run to capsule thickening, rough cartilage surface, and the development of marginal osteophytes [25]; therefore, we consider the diagnostic value of CT in sacroiliac joint disease limited because of its low sensitivity and specificity. Several investigations on the role of the SIJ in lower back pain can be found in the literature. Various recent publications discuss the issue of image-guided diagnostic and therapeutic injections [26, 27, 28, 29, 30, 31], and numerous anatomic and clinical papers have shown that the SIJ is thoroughly innervated and the presence of nerves in SIJ tissues make the joint likely to be a source of lower back pain when exposed to abnormal loading, excessive movements, and inflammation. Several investigators have found excessive sensory innervation in the ligamentous SIJ structures [32, 33, 34, 35]. Currently, image-guided diagnostic blocks and clinical pain provocation tests seem to be the only means for confirming sacroiliac origin of pain. In this study the therapeutic facet joint blocks allowed additional examination of the SIJ and helped to specify its role in LBP symptomatology. Another reason for back pain in the SIJ region can be the myofascial syndrome of the sacrospinal muscles; therefore, it is suggested to infiltrate this group of muscles with local anesthesia, before the SIJ is blocked.

Conclusion

In conclusion, we describe CT-guided radiofrequency denervation of the SIJ joint as a new, minimally invasive technique that appears safe and effective. This method may be a useful therapeutic modality, especially in patients with chronic low back pain, who only temporarily respond to therapeutic blocks. Controlled, randomized investigations with greater sample size over a longer period of time will be necessary to judge this technique more closely. Since chronic low back pain is such an intricate clinical phenomenon, we consider a far-reaching multi-disciplinary cooperation as the basis of more patient comfort, cost efficacy, and better therapy results.

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