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Identification of epidural space in the sacral spine by means of a thermolesion needle and an radiofrequency (RF) generator — a preliminary report

Abstract

Caudal epidural injections are one of the commonly used interventions in managing chronic low back pain. The caudal approach to epidural space was first reported by Sicard in 1901. Injection of steroids to treat low back pain was introduced in 1952.

Corticosteroids delivered into epidural space demonstrate higher local concentrations over an inflamed nerve root and will be more effective than a steroid administered either orally or by intramuscular injection. The clinical effectiveness evaluations fill the literature with various types of reports including randomised clinical trials, prospective trials, retrospective studies, case reports, and meta-analyses. Evidence from all types of evaluations with regard to clinical outcomes and cost-effectiveness of caudal epidural injections is encouraging. Reports of the effectiveness of all types of epidural steroids vary from 18% to 90%. One of the reasons for this discrepancy is the difficulty in accurate identification of caudal epidural space and inaccurate needle placement when performed without imaging guidance in a substantial number of patients. Caudal epidural injection is a safe, effective technique when performed with due care. In many centres this procedure is performed under fluoroscopic or ultrasound guidance.

In our study we used stimulation with a radiofreqency needle to identify caudal epidural space for low back pain treatment (30 patients).

Key words: caudal epidural injections, steroids, chronic low back pain, chronic pelvic pain, radiofrequency (RF)

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Introduction

Sacral access to epidural space is one of the oldest techniques applied for the purpose of performing blocks or the injection of steroids. Sacrally administered epidural anaesthesia was described for the first time by Sicarda in 1901, who was the first to apply local anaesthesia via this route [1]. This technique is at present widely used to administer anaesthesia in paediatric units. Finding epidural space for sacral access in children is technically easier [2]. In adults, this access to epidural space is seldom used for the purpose of anaesthesia before surgical procedures owing to frequent difficulties

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rooted in anatomic variety, which cause technical difficulties in obtaining such access [3].

Sacral access to epidural space in adults gained popularity in 1952, when corticosteroids were added to local anaesthetics. At present, this technique is commonly used for the purpose of supplying steroids in the treatment of acute and chronic pain. Disk herniation, spinal stenosis or spondylolystesis accompanied by spinal stenosis constitute the most frequent reasons for lower back pain and the accompanying radicular symptoms. Epidural application of steroids is one of the more frequently used methods of treatment in exacerbations of pain symptoms in lumbar spine that radiate to limbs, in radicular pain and in pain syndromes following ineffective spinal surgery [4, 5].

Epidural sacral access can also be applied to the diagnostic stimulation of sacral nerves in interstitial cystitis.

When performing this procedure in our centre in three patients with interstitial cystitis using a thermolesion needle and an RF generator, distinct reactions were observed to motor stimulation at the frequency of 2 Hz and sensory stimulation at the frequency of 50–100 Hz [6]. This induced us to attempt to identify sacral epidural space using a thermolesion needle and an RF generator before the therapeutic delivery of steroids.

The focus of the present paper is to present a new method for the identification of sacral epidural space in using a thermolesion needle.

Anatomical and technical issues

When choosing sacral access to epidural space, one ought to consider certain anatomical matters and also a host of other factors that may cause technical problems in the correct identification of sacral epidural space, and thereby prevent the delivery of the medication in the intended location. The sacral bone is a triangular bone. It is a tilted-back structure containing five fused sacral vertebrae. The sacral bone articulates with four bones: the last lumbar vertebra above, the coccyx (tailbone) below and the illiac portion of the hip bone on either side. The sacral bone contains two sets of four pairs of openings: four pairs of anterior and four pairs of posterior sacral openings. The front sacral openings make it possible for the local anaesthetic to seep from the sacral canal and epidural space, which does not apply to the posterior openings, which are covered by adjoining muscles. The base of the coccyx is connected with the sacral bone via the sacrococcygeal joint. The sacrococcygeal ligament covers the median sacral hiatus and is limited laterally by the sacral horns. The sacral hiatus remains open in the lower part of the back wall, formed from the S5 lamella and usually partly S4 (that also form an incomplete arch), unite in the median part [7].

The sacral epidural space is shapes like an inverted "U" and is covered by dorsal fibres of the sacrococcygeal ligament.

The sacral canal contains, apart from sacral and caudal nerves as well as the terminal filum (filium terminals), also epidural venous plexuses reaching the level of S4, located in the anterior part of the sacral canal. Besides, there is a certain amount of epidural fat. The terminal portion of the meningeal sac is relative to the age: in adults, it reaches S1, but in children in can reach up to S3. Certain anatomical details also vary by sex, race and age, should always be considered when deciding on the administration of medicines via the sacral epidural access. In patients with normal anatomy, needle insertion into the sacral epidural space is usually easy and safe. However, there are a number of reasons that make it difficult to insert the needle through the sacral hiatus. The injected solution may not reach the sacral canal, the needle may miss the sacral openings with the medicine not being delivered to the intended location. There are a number of reasons for failure to administer medicines epidurally, among others changes in the curvature of the sacral bone (the bone may be bent centrally or in its lower one-third), limiting the possibility of an accurate needle insertion, obesity which makes it difficult to locate the sacral horns by palpation, and consequently, the sacral hiatus, occurs in 5–10% patients. Attempts to perform the injection in an unguided manner usually result in technical difficulties and are unpleasant and traumatic for the patient. Such attempts often end in failure. Insufficient experience is one of the other reasons for failure in the epidural administration of medicines. Pre-existing concomitant arachnoiditis, both in its clinical and subclinical forms, can be the reason behind a protracted block after sacral epidural steroid administration (lengthened uptake and binding of medicine by 5–6). If the needle impinges on the body of the sacral bone, intraosseal application may occur [7, 8].

Potential reasons for the difficulty in access to sacral epidural space include: short height, short saggital dimension of the sacral bone, unguided injection, inexperienced physician performing the procedure, the end of the needle reaching above

S1, non-atypical anatomy, acute angle of the sacral bend, impossibility to identify individual anatomical structures (obesity), deformation of the sacral region or an excessively long coccyx [8].

In order to improve the effectiveness and ease of identification of epidural space, the use of imaging techniques is suggested, such as fluoroscopy or ultrasound, which permit an accurate location of the target site of application of medicines [9, 10].

A technique for the identification of epidural space by means of a thermolesion needle and an RF generator

In our study, for the purpose of identifying sacral epidural space we used the equipment available at our centre: Radiofrequency Lesion Generator System, Radinics Model RFG-3C. All epidural procedures were performed based on indications in outpatients of our Pain Treatment Centre after they expressed written informed consent.

The patient was placed on the side, with legs flexed at hips and knees and the head bent close to the trunk (foetal position). Then the sacral area was prepped with antiseptic solution (indispensable procedure due to the proximity of the anus). Sacral horns were palpated and then the sacral hiatus. After identifying the place of insertion and the subcutaneous tissue overlying the sacral hiatus was infiltrated with 1% lidocaine using a 5-ml syringe and 25-Gx 1,5 gauge needle. During the procedure, the administration of steroids guided by thermolesion equipment was performed using the Top Neuropole Needle XE 23G, length 60 mm, active tip length 5 mm. After initial anaesthesia at the place of insertion, the needle was inserted through the sacral hiatus at the 45° angle, but after insertion into the sacral hiatus, the angle was reduced so that the needle was placed almost horizontally. Subsequently, the needle was shifted cephalad so that the tip of the needle impinged on the dorsal part of the vertebral canal. The needle was then withdrawn gently approx. 2–3 mm. Then it was aspirated for blood or cerebrospinal fluid using a 10 ml syringe. In order to confirm proper needle placement, two kinds of stimulation were performed using our thermolesion equipment: motor stimulation at 50 Hz and sensory stimulation at 2 Hz. During motor stimulation, was observed the contraction of muscles supplied by the stimulated nerves. During sensory stimulation, the patient feels tingling or an sense of expansion in the region affected by the stimulation. Once the sensory and motor stimulation results have confirmed correct needle placement in the sacral epidural space, the patients received a mixture of a depot steroid. Most clinicians usually apply 14 mg of betamethasone in saline solution, volume 5–25 ml [11–13].

During the procedure, the following parameters are monitored: cardiac rhythm (cardiomonitor), pulseoxymetry and arterial blood pressure.

After the procedure, patients are transferred to the observation room, where they remain under the care of a qualified surgical nurse for 40–60 min, and before leaving the Centre, are seen by the physician who has performed the procedure.

Material

The decision to administer steroids epidurally was taken if the patient complained about moderate to strong pain, while previous treatment was not effective [11–13]. Before the execution of the procedure, they were interviewed for demographic data, information concerning pain complaints — time of onset, type, location, radiating or not, duration, aggravating factors and pain-reducing factors. Questions were also asked concerning previous treatment both of the presenting complaint and any other concomitant conditions, previous procedures, hospitalisations, medicines applied, including analgesics (type, dosage, duration of administration). Also assessed was the impact of pain on patient's functional capacity. Clinical assessment, including radiological imaging, was also performed. Pain intensity was evaluated using a numerical rating scale (NRS). Pain evaluation was conducted during standard activities (standing, walking) and at rest.

The identification of sacral epidural space using the needle and the radiofrequency equipment was carried out in 30 adult patients treated at the Pain Treatment Centre in 2009. Patients were qualified to epidural steroid administration because of persistent pain complaints of the lower back caused by a pathology of the intervertebral disk with concomitant radicular pain, stenosis of the vertebral canal, a failed back surgery syndrome (post-ineffective spinal surgery pain syndrome) and coccygodynia. After the above-described identification of epidural space, these patients were administered the steroid to epidural space.

Effects of the procedure performed were evaluated on day 7 and 30 after the epidural administration of steroids after the identification of sacral epidural space using the needle and radiofrequency

Table 1. The type of pain and the number of patients evaluated, sex

Diagnosis	Number of patients (N)	Sex (male/female)
Discogenic pain, radicular (ds.)	20	11/9
Spinal stenosis (St.)	2	1/1
Coccygodynia (Cc.)	3	0/3
Failed back surgery syndrome. Pain syndromes after ineffective operations involving the spine (Fbss.)	5	2/3

(thermolesion) equipment. At selected points of time, patients were asked about the mean pain intensity measured on a Numerical Scale (NRS), treatment satisfaction rate using a five-point Treatment Satisfaction Scale (1 — complete improvement, 2 — slight improvement, 3 — no change, 4 — slight deterioration, 5 — complete deterioration) and functional improvement expressed as percentage points.

Middle age of the patients 45, 56 years (33–70).Complaints and the number of patients undergoing the procedures are shown in Table 1.

Results

The study of the effectiveness of the stimulation by means of the needle and thermolesion equipment as methods of identification of sacral epidural space was carried out on a group of 30 patients. In all cases, this method was applied before the planned administration of steroids to sacral epidural space. The mean duration of the complaint was 255.1 days (7–1825 days). Mean pain intensity measured on the numerical rating scale during the preprocedural patient evaluation was 8.2 during activity (6–10), and 3.86 at rest (0–6). NRS at one week after treatment was 2.16 (0–6) and at one month 2.89 (0–6).

The improvement of overall functional capacity was evaluated in percentage points. At one week after treatment, the mean improvement rate was 53.33% (0–85%) and at one month 54.8% (0–90%).

Treatment satisfaction was measured on a five-point scale at one week (mean value 1.93) and at one month (with similar results). It follows that most patients reported complete or significant relief in pain complaints, which additionally confirms that epidural space was correctly located with the steroids deposited in the right location. The results obtained are shown in Table 2.

Discussion

There are a number of access options to epidural space in the lumbosacral spine, however sacral access is usually used for the purpose of injecting local anaesthetics or steroids [7, 9]. Bogduk et al. and Manchikanti et al. compared the efficacy of steroid injection into epidural space via the transforaminal and the intralaminar routes with the sacral epidural route. In their research, they demonstrated the superiority of spinal access over intralaminar access and comparable with transforaminal access. Intralaminar access permits the administration of medicines close to places with an identifiable pathology, whereas transforaminal access permits the use of relatively small volumes to act locally, where pain experiences arise. Epidural sacral access is considered to be the safest and easiest, while at the same time the carrying the least risk of inadvertent dural puncture. The evidence quoted above also proved the superiority of this method over the intralaminar access [13, 14].

In the case of corticosteroid injections into sacral epidural space after accurate identification of the target location (sacral hiatus), the needle is insetred into epidural space in the sacral canal. Many authors suggest the necessity of the exercise of this procedure under fluoroscopic control. A number of publications indicate that the performance of an unguided injection, i.e. without fluoroscopic control, causes incorrect needle positioning (i.e. outside epidural space, intravascular, at a different level from planned access site) in ca. 30–40% of cases . Sacral epidural application of medicines undertaken under fluoroscopic control is acknowledged to constitute the golden standard that improves the efficacy of this procedure owing to the opportunity to accurately locate the needle in epidural space, as long as there are no contraindications to the use of fluoroscopy [15].

Other possibilities facilitating the identification of sacral bone horns, and consequently, the sacral hiatus and accurate needle placement in epidural space include ultrasound techniques. This technology is used especially for sacral epidural anaesthesia in children [2].

The identification of epidural space can be aided by the so-called "whoosh test", which consists in

Table 2. Patients: age, duration of complaint

Patient initials	Age	Pain type	Pain duration	NRS (a)	NRS (s)	NRS (7)	NRS (30)	Satisfaction (7)	Satisfaction (30)	Procedure	Functional improvement 7 (%)	Functional improvement 30 (%)
ZO	37	Cc.	210	8	6	6	6	3	3	SI	0	0
AO	47	Cc.	270	6	4	3	3	2	2	SI	50	50
TJ	64	Cc.	560	7	5	4	3	3	3	SI	30	40
PJ	26	Ds.	14	10	4	2	4	2	2	SI	50	60
JP	42	Ds.	425	10	3	4	4	4	4	SI	0	0
JF	53	Ds.	1825	10	2	2	2	1	1	SI	80	80
FT	51	Ds.	180	8	3	3	2	2	2	SI	60	60
MH	35	Ds.	14	7	5	1	1	1	1	SI	80	80
ZS	65	Ds.	87	9	0	0	0	1	1	SI	85	90
BB	40	Ds.	42	10	3	3	3	2	2	SI	60	70
TP	51	Ds.	30	10	5	2	3	2	2	SI	70	70
WP	62	Ds.	40	8	3	2	3	2	2	SI	40	50
JW.	57	Ds.	7	8	2	3	3	2	2	SI	50	60
AP	69	Ds.	30	8	3	3	2	1	1	SI	80	80
IO	29	Ds.	360	10	3	1	1	1	1	SI	80	90
AS	32	Fbss.	30	10	6	3	6	2	3	SI	50	30
WW	51	Fbss.	720	6	4	3	4	2	2	SI	30	20
TW	33	Fbss.	450	7	5	4	4	3	2	SI	20	20
BR	35	Fbss.	570	6	4	2	3	2	2	SI	50	50
KŁ	49	Ds.	14	9	5	2	2	1	1	SI	80	80
WR	38	St.	560	9	2	4	4	2	2	SI	40	40
JJ	740	Ds.	21	8	5	2	2	2	2	SI	50	50
SJ	35	Ds.	21	9	4	2	2	2	2	SI	75	80
JP	40	Ds.	90	6	4	1	4	1	2	SI	60	60
BK	36	Ds.	56	10	4	2	2	1	1	SI	80	80
JM	58	St.	560	8	3	3	3	3	2	SI	30	30
MŁ	52	Fbss.	360	7	5	4	4	3	3	SI	30	30
AG	38	Ds.	40	7	4	2	2	1	1	SI	80	80
AŁ	35	Ds.	36	8	5	3	2	2	2	SI	60	65
SW	37	Ds.	32	7	5	2	2	2	2	SI	50	50

Pain type: Cc. — coccycodynia, Ds. — dyscogenic, St. — stenosis, Fbss. — failed back surgery syndrome; NRS (s) — pain intensity at rest; NRS (a) — pain intensity at activity; NRS (7) — pain intensity at seven days after the procedure; NRS (30) — pain intensity at thirty days after the procedure. Treatment satisfaction at seven and thirty days, functional improvement — percentage (%) at seven and thirty days

stethoscopic auscultation of the sacral bone area during the administration of air to epidural space after its identification [16, 17]. The modification of this test for children is the "swoosh test," in which saline is administered instead of air to epidural space [18].

Additionally, correct needle placement in epidural space can be verified by the sense of expansion pressure or compression felt by the patient when the solution is injected into epidural space.

The mechanism mediating the effects of epidurally administered local anaesthetics and steroids is not yet well understood. It is thought that medicines cause a nerve fibre block, causing inhibition of conductance in afferent fibres, also inhibit self-induced neurone stimulations in the central nervous system. Corticosteroids inhibit the inflammatory response by inhibiting the synthesis or release of inflammatory mediators and also by the reversible local anaesthetic effect [19, 20]. The action of glycocorticosteroids in epidural space is explained by their strong anti-inflammatory effects. Lower back pain is often related to a coexisting inflammatory process. The coexistence of the inflammatory process with radicular pain was demonstrated in 1981. Ryan and Taylor, while examining the cerebrospinal fluid drawn during subarachnoid and epidural injections, observed that the inflammatory response constituted the most important factor in radicular pain. They also noted a markedly better response to intraspinal steroids during the acute phase of the complaint, i.e. before the fibrination of the nervous roots or axon degeneration occurs [21].

Advantages that accrue from the use of steroids, especially pain relief that lasts for hours, days or even weeks, are related to the pharmacological influence of medicines used.

A number of studies have demonstrated the efficacy of sacral epidural steroids in patients with lower back pain and radicular pain (EBM for short-lasting level I relief, moderate EBM for long-lasting relief). There are no well documented studied on the use of steroids in patients with the failed back surgery syndrome (pain syndrome after ineffective operations involving the spine) and spinal stenosis [22, 23].

One prospective randomised double-blind study which compared the efficacy of epidural steroid administration under fluoroscopic control with local steroid placement aided by an endoscope placed in epidural space in patients with radicular pain. In patients who received steroids under fluoroscopic control, pain relief was maintained for up to six months. There was no noticeable difference in the pain sensation in the group of patients who received the steroid under endoscopic control [24].

In a number of publications over the years concerning the efficacy of epidural steroids regardless of the manner of their administration, the efficacy is estimated at 18–90%. One of the reasons of such variance are difficulties with the proper identification of epidural space and the impossibility to place needle accurately if the procedure is performed without guidance [12, 13, 25].

Incorrect needle location during sacral epidural steroid administration occurs 25–38.5% of patients when performed without fluoroscopic control [25–27]. It may occur even if the sacral hiatus is well palpated and is described in 12.5% to 14.2% of cases (needle located outside epidural space or intravascularly) [19, 21, 26]. White demonstrated inaccurate needle placement during epidural administration of steroids in nearly 25% of patients in whom the procedure was performed by experienced anaesthetists and orthopaedists [5].

Manchikanti documented incorrect needle placement in 20% of patients, of which intravascular needle placement was observed in 7%, whereas needle placement outside epidural space was observed in 13% [25]. Renfrew evaluated epidural steroid administration by radiologists and documented inaccurate needle placement in 38% of patients [9].

Preliminary results of our observations of 30 patients with lower back pain who received epidural steroids with epidural space being identified by means of the needle and thermolesion equipment have shown the efficacy of this method and pain relief by > 50% in 70% of patients.

In our study, we have demonstrated the efficacy of epidural steroid administration at seven days from injection, which additionally confirms correct needle placement in epidural space, aside from for the clearly felt motor and sensory stimulation using thermolesion equipment to identify epidural space.

Correct needle-tip placement was additionally confirmed by the sense of expansion pressure or compression during the injection of several millilitres of saline solution into epidural space before glycocorticosteroid administration. This symptom was described by many authors, however, it cannot be treated as the only test confirming the correct needle-tip placement in epidural space [17, 18, 28].

An even clearer proof of correct needle placement by means of electric sensory and motor stimulation was offered by comparative studies in which, after obtaining the desired response to electric stim-

ulation, imaging control of needle placement was also performed. Further comparative research using both methods is planned in our centre.

A defect of the proposed identification technique is the relatively high cost of the needle indispensable for the execution of the procedure and the need for thermolesion equipment. However, in centres that already have such equipment, this procedure may be performed without exposing the patient and the staff to RTG radiation.

The identification of epidural space using the needle and radiofrequency (thermolesion) equipment can improve the efficacy of epidural steroid administration in patients in whom this treatment method can offer a good therapeutic effect. Results of our preliminary studies inspired us to further research. The stimulation by means of the needle and thermolesion equipment is an easy and safe method and can improve treatment efficiency. In order to confirm our initial observations, further studies are necessary involving a larger group of patients.

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