# A novel microsurgical method for the treatment of spinal nerve root cysts

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## ABSTRACT

**INTRODUCTION:** The treatment of spinal nerve root cysts is not uniform. In the past decades, microsurgical resection to preserve nervous tissue has been reported. We report on our microsurgical method and present the clinical results in relation to surgical outcome.

**MATERIAL AND METHODS:** Retrospective review of a consecutive series of patients who underwent surgical cyst closure from 2006 to 2010.

**RESULTS:** Twelve patients, all female, with a total of 23 cysts underwent surgery for 20 symptomatic cysts. The mean age was 45 (range 13-75) years. Following treatment with this procedure, 95% of the cysts were closed and 5% had notably diminished at post-operative magnetic resonance imaging. Clinical improvement was seen in 67% of the patients; one improved temporarily, two remained unchanged and one had worsened at the last follow-up. The mean post-operative follow-up period was 11 (range 3-19) months. Clinical outcome was associated with none of the pre-operative parameters, i.e. pain-provoking postural position, cyst size, number of treated cysts, educational level or preoperative sick leave.

**CONCLUSIONS:** We find that our surgical technique is suitable for closure of spinal nerve root cysts; however, the clinical outcome after surgery was sub-optimal according to preoperative clinical judgement. Consequently, we have established a dedicated outpatient clinic that performs extensive preoperative assessment and investigation of patients with symptomatic spinal nerve root cysts. We hereby hope to improve surgical outcome in the future.

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The nomenclature used to define spinal fluid-filled extrathecal cavities is not uniform [1, 2]. Tarlov cysts or perineural cysts are derived from the perineurium around the nerve root sheath. Several theories have been proposed with regard to the aetiology of perineural (Tarlov) cysts [3-5]. Yet, none of these theories has been taken beyond the speculative level. These cysts do not account for all fluid-filled cavities with intimate contact to the nerve roots, and they are usually distinguished clinically from a myelography, which shows true Tarlov cysts with delayed or no filling [6, 7]. Besides Tarlov, also Goyal and Nabors have contributed to the nomenclature [2, 4, 8], and extant literature is not unanimous in its use of the terminology used to designate these cavities. We will here use the term »spinal nerve root cyst(s)« as a term that embraces all fluid-filled extrathecal formations.

A diagnosis of nerve root cysts is established by magnetic resonance imaging (MRI) [9]. The prevalence of nerve root cysts is uncertain; however, incidental MRI findings show a spinal nerve root cyst prevalence of 1-4.6%, and approximately one in five cysts is found to be clinically significant. The majority of the patients are women [9, 10]. Extant literature agrees that clinical symptomatology derives from local mechanical compression of neural structures, and that the symptoms therefore depend on cyst localization. Most cysts are found in a low lumbar or sacral position [2, 8]. Symptoms include low lumbar-sacro-coccygeal focal pain, radicular numbness, paraesthesia, reduced sensation, or urinary, bowel or sexual disturbances [11].

Treatment of perineural cysts has been largely empirical since Tarlov's first experiments in the early 1950s [3, 12]. Non-invasive approaches like physiotherapy and analgesic medication have had varying results [4, 13]. Invasive approaches such as simple cerebrospinal fluid (CSF) drainage [14] and guided cyst aspirations [9, 13] have had unacceptable recurrence rates and side effects. Lumbar-peritoneal and cysto-subarachnoidal shunting has been reported to be successful in very small series [14, 15]; however, this treatment modality has known high malfunction- and infection rates.

Simple decompression of the bone [16] and extirpation of the cyst including part of the nerve root [12] have been abandoned due to surgical decompression failure [7], the risk of nervous tissue damage [16] and pseudomeningocele development [17]. In the past decade, microsurgical and less invasive procedures with partial resection of the cyst wall have been reported to preserve neural tissue [7, 11]. The aim of this study is to present our novel microsurgical technique and to present clinical outcome following surgery.

## MATERIAL AND METHODS

### Patient material

Twelve patients, all female, underwent microsurgical repair of symptomatic spinal nerve root cysts from January

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2006 to May 2010. A total of 23 cysts were discovered. Twenty cysts were found to be symptomatic and surgery ad modum Mosdal was performed at our institution. The remaining cysts were diagnosed as incidental findings. The average age was 45 (range 13-75) years.

**Clinical assessment and indications for surgery**

Preoperatively, cysts were all diagnosed with MRI. All patients underwent neurological examination pre- and post-operatively. Co-morbidity, e.g. lower back pain, herniated disc and lumbar spinal stenosis, were excluded as the cause of symptoms before a decision on surgery was made. Patients with symptomatic cysts were offered surgery. On average, six (1-12) months passed from first outpatient clinic consultation to surgery. All patients, except one for whom the duration was not recorded, had symptoms one year or more before admission to our clinic. On preoperative MRI we found normal imaging, apart from cyst formation in four patients (cases 2, 3, 4, and 10, (**Table 1**)). Erosion of the bone was described in three patients (cases 1, 5 and 8 (Table 1)). In one of these and in the remaining five, we found signs of degenerative disc disease in addition to the cysts (cases 5, 6, 7, 9, 11 and 12 (Table 1)).

**Surgical treatment**

The sacral bone was exposed through a mid-line incision with the patient in prone position. The posterior wall over the cyst(s) was removed with rongeurs and with careful dissection of the epidural space respecting the cyst(s). Bone chips were preserved. After microsurgical opening of the cyst(s), an attempt was made to identify the CSF fistula. If no CSF fistula could be identified immediately, anti-Trendelenburg posture and modified Quekenstedt maneuver were instituted. In all cases, a fistula was found and a tiny (4-0 or 6-0 vicryl) absorbable tobacco-bag suture encircling the fistula was placed inside the cyst wall, respecting the nerve filaments. The sutured area was covered with a very small piece of muscle and fibrin glue before gentle tightening of the suture. The remaining wall of the cyst(s) was then filled with subcutaneous fat, more fibrin glue was added and the cyst was sutured (**Figure 1**). The exposed area of dura and the nerve roots were then covered with a double layer of polyanhydroglucuronic acid products and fibrin glue and on top a fair layer of bone chips was replaced in the osseous defect. Finally, fascia, subcutaneous tissues and skin were closed separately with absorbable sutures after final control of haemostasis. No drains were used.

**Follow-up after surgery**

All patients had a clinical follow-up in our outpatient clinic three months post-operatively. Further follow-up was offered as indicated. All patients underwent post-operative MRI or computed tomography (CT) to assess the surgical outcome. The last follow-up in the outpatient setting was performed at an average of 11 (range: 3-19) months.

**Statistics**

We analysed preoperative parameters (Table 1 and **Table 2**) in relation to a post-operative subjective evaluation of pain (**Table 3**) with 2 x 2 tables using Cornfield's method to calculate confidence limits for the odds ratio (OR).

*Trial registration:* not relevant.

## RESULTS

**Surgical objective endpoint**

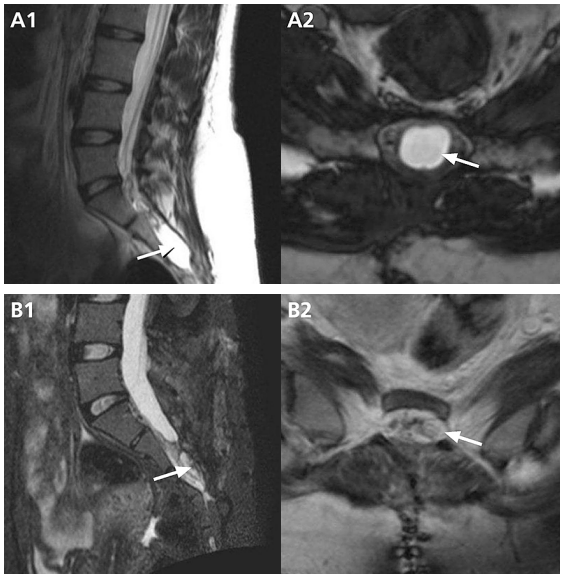
Nineteen (95%) of the 20 cysts were closed and one (5%) was notably diminished at imaging follow-up performed an average of eight (range 1-16) months post-operatively. One patient experienced leakage of blood through the wound during the first few days (case no. 10). No post-operative infections or other complications occurred. One additional patient reported post-operative incontinence for flatulence and faeces during the first two months after the operation after which the symptoms resolved (case no. 8 (Table 3)).

**Clinical outcome**

*Sensory dysfunction*

Eight of 12 (67%) patients had improvement of pain at

FIGURE 1




Magnetic resonance sagittal T2-weighted (**A1**) and axial T2-weighted **(A2**) imaging studies of the lumbar-sacral spine demonstrating a cystic lesion occupying the sacral canal preoperatively (arrow). Magnetic resonance sagittal T2-weighted imaging (**B1**) and axial T2-weighted (**B2**) of the lumbar-sacral spine visualizing the cysts no longer present and subcutaneous fat filling the superfluous space post-operatively (arrow).

TABLE 1

Surgical and imaging data on all patients displaying number and volume of all cysts, number of cysts treated, number of cysts successfully treated, imaging findings and hospitalization data. The time span from first preoperative scan to surgery represents an alternating waiting list for the outpatient clinic and surgery.

| Case no. | Cysts: pre-op. scan/intended to treat/closed at post-op. scan, n | Neurorad. cyst size, cm³ | | Time from first pre-op. scan to surgery, months | Modality of first pre-op. scan | Preoperative MRI findings besides cyst formation | Time from urgery until last post-op. scan, months | Modality for last post-op. scan |
|---|---|---|---|---|---|---|---|---|
| | | pre-op. | post-op. | | | | | |
| 1 | 1/1/0 | Right S1: 22.2 | Right S1: 11.4 | 6 | MRI | Erosion of the sacral bone | 6 | MRI |
| 2 | 1/1/1 | Left S1: 9.9 | Cyst closed | 10 | MRI | None | 2 | MRI |
| 3 | 1/1/1 | Left S3: 22.1 | Cyst closed | 55 | MRI | None | 3 | MRI |
| 4 | 1/1/1 | Left S2: 3.0 | Residual cyst asympt. and unchanged in follow-up | 3 | MRI | None | 3 | MRI |
| 5 | 1/1/1 | Right S2: 36.5 | Cyst closed | 13 | MRI | Erosion of the sacral bone, disc protrusion without neurogenic relation | 16 | MRI |
| 6 | 2/2/2 | Left S2: 11.3<br>Right S2: 5.4 | Cysts closed | 5 | MRI | 3rd intervertebral space reduced in height | 11 | MRI |
| 7 | 4/3/3 | Right S2: 5.1<br>Left S3: 2.5<br>(2 cysts, total size)<br>Right S3: 4.6 | Right S2 unchanged<br>Left S3 closed<br>Right S3 closed | 14 | MRI | Disc degeneration at all lumbar levels, MODIC type 2 | 3 | MRI |
| 8 | 1/1/1 | Right S2: 49 | Cyst closed | 12 | MRI | Erosion of the sacral bone | 13 | CT |
| 9 | 4/3/3 | Right S2: 2.9<br>(2 cysts, total size)<br>Left S2; 12<br>Right S1: 2.3 | Right S2 closed<br>Left S2 closed<br>Right S1 unchanged | 2 | MRI | 1st and 3rd intervertebral space reduced height<br>Reduced water signal 3rd and 4th intervertebral space<br>Right-sided paramedian protrusion, no neurogenic relation | 13 | |
| 10 | 2/1/1 | Right S2: 0.89<br>Left S2: 24 | Right S2 unchanged<br>Left S2 closed | 9 | MRI | None | 16 | MRI |
| 11 | 2/2/2 | Left S2: 5.1<br>Right S2: 2.9 | Cysts closed | 8 | MRI | Reduced water signal second and fourth intervertebral space | 1 | CT |
| 12 | 3/3/3 | Left S2: 8.5<br>(3 cysts, total size) | Cysts closed | 1 | MRI | Disc degenerative disease at 3rd-5th intervertebral space<br>Right-sided paramedian protrusion, no neurogenic relation | 6 | MRI |

CT = computed tomography; MRI = magnetic resonance imaging.

the last post-operative follow-up. One had a temporary improvement during the first two months (case no 9 (Table 3)), two were unchanged (case no. 1 and 12 (Table 3)) and one reported an increased pain level (case no. 10 (Table 3)). Two patients had changed location of sensory disturbances post-operatively (case no. 4 and 11 (Table 3)); however they were satisfied with the surgical outcome.

*Urological, bowel or sexual dysfunction*

Seven of 12 patients had preoperative subjective urinary disturbance (cases 1-4, 7, 9 and 12 (Table 2)). Three underwent preoperative urodynamic investigation (cases 3, 9 and 12); one demonstrated unstable detrusor and a variable pressure; and two had normal findings. Of the seven patients with urinary disturbances, three had complete relief at post-operative follow-up, two improved and two were unchanged (Table 3).

No patient reported bowel or sexual dysfunction preoperatively; however, one patient had painful defecation prior to surgery (case no. 7 (Table 2)), interpreted as a pain mechanism rather than actual bowel dysfunction. Symptoms were absent at follow-up.

Statistical correlation between preoperative parameters and surgical outcome:

Pain provoked by postural position or by use of a valsalva-like manoeuvre was described by six of 12 patients (cases number 3, 5, 6, 10-12 (Table 2)). One had simultaneous worsening in horizontal position (case no. 10 (Table 2)). The five patients with pure pain-provoking postural positioning were analyzed against the six remaining. Furthermore, we explored the number of cysts (one cyst versus multiple cysts), cyst size (> 15 $cm^3$ (cases 1, 3, 5, 8, 10 (Table 1)) to ≤ 15 $cm^3$ (remaining patients)), educated patients (cases 2, 4-6 (Table 2)) against none-educated (case no. 1 (Table 2) attended ground school and was excluded from this calculation) and preoperative sick leave (cases 3, 5 8 and 9 (Table 2))

TABLE 2

Pre-operative clinical portrayal of the 12 patients undergoing microsurgical closure of sacral cysts ad modum Mosdal.

| Case no. | Age at surgery, years | Time from 1st out-patient clinic until surgery, months | Education | Sickleave because of symptoms | Duration of pain and symptoms prior to surgery, years | Pain localization | Clinical examination | Pain provoking position | Co-morbidity | Urological dysfunction | Sexual or bowel dysfunction |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 13 | 4 | Attending secondary school | No | Several | Bilateral lower extremity (dysaesthesia) | Normal | None | Chronic headache | Frequent voiding | No |
| 2 | 19 | 5 | Student | No | 1 | Sacral, gluteal, lower extremity (left, posterior phantom pain) | Hypoaestesia left gluteal and lateral femoral | None | Traumatic amputation of left leg (femoral) | Intermittent urinary incontinence, disrupted urinary sensation | No |
| 3 | 22 | 9 | Social careworker | Yes | 2 | Sacral, lower back | Sore os sacrum, otherwise normal | Postural, coughing, sneezing | Several abdominal and gynaecological surgical procedures | Late initiation Cystometry: use of abdominal muscle, othervise normal | No |
| 4 | 28 | 2 | Self-employed | No | Several | Sacral, lower extremity (left, posterior) | Normal | None | Appendectomy, otherwise none | Intermittent urinary incontinence | No |
| 5 | 36 | 5 | Riding master | Yes | Several | Sacral and lower extremity (right) | Normal | Postural | None | No | No |
| 6 | 42 | 3 | Academic | No | Unknown | Sacral, lower extremity (left, posterior, paresthaesia) | Sore os sacrum, otherwise normal | Postural | Liposuction, otherwise none | No | No |
| 7 | 52 | 12 | Unknown | Early retirement pension | > 1 | Lower sacral | Normal | None | Hypertension, arthritis | Disrupted urinary sensation | Painful defaecation |
| 8 | 54 | 6 | Unskilled worker | Yes | Several | Lower back | Numbness right gluteal, inner thigh, nonresp. anocutan. reflex | Horizontal | Lower back pain (trauma), dizziness | No | No |
| 9 | 58 | 1 | Social care worker | Yes | Several | Sacral, lower back, gluteal both lower legs (left dominant) | Sore os sacrum, otherwise normal | Horizontal | Hyperthyroid | Frequent voiding, incontinence Cystometri: frequent voiding, otherwise normal | No |
| 10 | 65 | 7 | Unskilled worker | Retired | Several | Sacral, lower back, genital, left lower extremity | Normal | Postural, horizontal | Hypertension, hyper-cholestorolaemia | No | No |
| 11 | 70 | 4 | Unskilled worker | No | 1 | Sacral, lower back | Normal | Postural, coughing | Hypothyroid | No | No |
| 12 | 75 | 10 | Unknown | Retired | Several | Lower back, genital, paraesthetic bilateral lower extremity | Normal | Postural | Hormone replacement therapy | Light urge incontinence Cystometri: instable detrusor and variable pressure | No |

against the remaining (retired patients excluded from this calculation). In all cases where sick leave was present, it was related to their cyst complaints. Formal analyses of quality of life and activity of daily living were not included in this retrospective follow-up.

No statistically significant differences between any of the compared groups were found. OR (improvement in postural positioning) = 0.50; 95% confidence interval (CI): 0.00-6.04; OR (improvement in small cysts) = 1.67; 95% CI: 0.18-16.0; OR (improvement in multiple cysts) = 0.60; 95% CI: 0.06-5.56; OR (improvement if educated) = ∞; 95% CI: 0.44-∞; OR (improvement if not on sick leave) = 1.33; 95% CI: 0.00-∞.

## DISCUSSION

We suggest treating symptomatic spinal nerve root cysts

TABLE 3

Clinical outcome post-operatively of the 12 patients undergoing microsurgical closure of sacral cysts ad modum Mosdal.

| Case no. | Days of mobilization/total days in hospital, n | Time from surgery until last outpatient clinic follow-up, months | Pain localization | Clinical examination | Pain provoking position/ movement | Subjective evaluation of pain | Urological dysfunction | Sexual or bowel dysfunction |
|---|---|---|---|---|---|---|---|---|
| 1 | 3/6 | 19 | None | Normal | None | Unchanged | Improved | No |
| 2 | 3/3 | 4 | None | Normal | None | Improved | No | No |
| 3 | 4/6 | 17 | Sacral | Normal | Lying | Improved | No | No |
| 4 | 1/2 | 10 | Genital (dysaestesia), lower extremity (left, intermittent) | Normal | None | Improved | Unchanged | No |
| 5 | 1/3 | 3 | None | Normal | None | Improved | No | No |
| 6 | 2/2 | 11 | Lower extremity (left, posterior) | Normal | None | Improved | No | No |
| 7 | 3/3 | 4 | Unchanged localization | Normal | None | Improved | No | No |
| 8 | 1/2 | 14 | Unchanged localization | Unchanged | None | Improved | No | Intermittent incontinence of flatulence and faeces, first two months, then asymptomatic |
| 9 | 1/1 | 17 | Unchanged localization | Normal | Not recorded | Two month pain relief, at last follow-up unchanged | Unchanged | No |
| 10 | 1/3 | 16 | Unchanged localization | Normal | Sitting | Increased | Residual urine first two days | No |
| 11 | 3/5 | 3 | Genital and rectal (dysaestesia) | Normal | None | Improved | No | No |
| 12 | 1/1 | 12 | Lower back, bilateral lower extremities | Normal | Unchanged | Unchanged | Slight urge incontinence | No |

with microsurgery to ensure effective closure and preservation of nervous tissue. The surgical closure includes suture and ligation of delicate and very fragile structures. Not surprisingly, the recurrence or new formation of cysts related to the site of repair is frequent, which is most probably due to lack of resistance against the intrathecalhydrostastic pressure. We believe that the underlying pathogenesis is a spatial mismatch that can be reduced or eliminated by filling superfluous intraspinal space with a mouldable, non-compressive substance. Subcutaneous fat has this quality and will remain grossly unchanged for weeks to months and may be kept in situ because of obliteration of osseous defects with the bony transplant.

Our method is the first microsurgical procedure to report an objective validation of the effectiveness of cyst closure with post-operative imaging of all patients in the series. Our results present a very appropriate surgical technique for closure of spinal nerve root cysts with 95% successful closure and a volume decrease in the remainder on average eight month after surgery. Furthermore, we obtained an optimal decompression of the nerve root(s) and a preservation of the integrity of the cyst wall, as part of it contained nervous tissue. Lumbar drainage is not required with this procedure. Indeed, we advise against lumbar drainage to prevent CSF fistula formation. In our experience, bed rest extending three days is unnecessary.

Fibrin-glue injected percutaneously has been reported to induce aseptic meningitis [13]. Similar products were applied with our method and we saw no postoperative signs of this condition. This is probably owed to the closing of the cyst, which seals it off from the subarachnoid space and hence avoidance of a major load into the CSF in the case of a communicating cyst.

A total of 67% of our patients experienced improvement of preoperative complaints. This is not an ideal success rate. The decision on surgery in spinal nerve root cysts is complicated and no common guidelines are outlined. Even the clinical significance of a true Tarlov cyst is uncertain. Several authors have pointed towards Tarlov cysts as the subgroup of the spinal nerve root cysts of potential clinical interest. The logical presumption behind this is probably that a closed fluid-filled cavity will apply pressure to a nerve root, whereas a communicating structure will not. However, a valve mechanism in the neck may develop a pressure gradient, even though communication exists. And even a small communicating fluid-filled structure with intimate relation to a nerve root in narrow spaces could cause

nerve root compression leading to neuropathy. Papers published on the matter are based on small patient series and are all retrospective [6, 7, 11, 18, 19].

There is a general agreement only to treat symptomatic spinal nerve root cysts. Pain provoked by postural positioning and the use of the Valsalva-manoeuvre is often presented as a sign of a true Tarlov cyst and, hence, a selection criteria favouring surgery [6, 7, 11]. Another small retrospective study found that large cysts were an indication for treatment [19]. These findings cannot be supported by our material. Perhaps these are criteria only related to true Tarlov cysts? Surprisingly to us, neither the number of treated cysts, nor the educational level or sick leave was associated with outcome. Certainly, our material is small and retrospective and minor differences between the compared groups could be hidden.

The optimal study – a prospective randomized study to validate treatment methods – seems very difficult to perform given the low incidence of treatable cysts. Based on our results in this study, we conclude that simple clinical assessment is not valid as the only decision maker concerning spinal nerve root surgery. As a consequence, we have established a dedicated outpatient clinic specifically for this challenging patient group to gather experience and provide all patients with a standardized assessment. Patients who are referred to our outpatient clinic will undergo anamnestic and clinical examination. If surgery is considered, MRI, post-myelography CT to define subgroups of cysts, urodynamic investigations, anorectal physiological evaluation and neurophysiological examination will be performed before a decision is made on treatment modality. We hereby hope to improve patient selection and hence surgical outcome.

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**CONFLICTS OF INTEREST:** Disclosure forms provided by the authors are available with the full text of this article at www.danmedj.dk.

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