Pain Physician 2017; 20:E653-E660 • ISSN 2150-1149

Retrospective Study

Management of Symptomatic Tarlov Cysts: A Retrospective Observational Study

Wei Jiang, PhD, Zhenming Hu, MD, PhD, and Jie Hao, MD, PhD

From: Department of Orthopaedic Surgery, The First Affiliated Hospital of Chongqing Medical University, 1 Youyi Rd, Chongqing 400016, China

Address Correspondence:
Jie Hao, MD, PhD
Department of Orthopaedic Surgery
The First Affiliated Hospital
Chongqing Medical University,
1 Youyi Rd Chongqing 400016, China
E-mail: spinehao@163.com

Disclaimer: There was no external funding in the preparation of this manuscript.
Conflict of interest: Each author certifies that he or she, or a member of his or her immediate family, has no commercial association (i.e., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted manuscript.

Manuscript received: 08-08-2016
Revised manuscript received: 11-29-2016
Accepted for publication: 12-30-2016

Free full manuscript: www.painphysicianjournal.com

Background: Symptomatic Tarlov cysts are a common cause of chronic pain. Many methods have been reported to treat this disease, with variable results. Most previous reports concerning the treatment methods of symptomatic Tarlov cysts were either sporadic case reports or series of limited cases.

Objective: This study aimed to further optimize the management for patients with symptomatic Tarlov cysts (TCs) by analyzing the results of 82 patients who were treated with different strategies.

Study Design: Three different strategies were applied to 82 patients with symptomatic TCs and their clinical effects were evaluated in 13 months to 12 years follow-up.

Setting: A pain management practice, a medical center, major metropolitan city, China.

Methods: From June 2003 to August 2015, a total number of 82 patients with symptomatic TCs were treated with 3 different methods (microsurgical cyst fenestration and imbrication, C-arm fluoroscopy guided percutaneous fibrin gel injection, and conservative management) in the first affiliated hospital of Chongqing Medical University. The pain severity was assessed according to visual analog scale (VAS), and imaging changes were evaluated by magnetic resonance imaging (MRI). Patient improvements in pain and neurologic function were evaluated during a follow-up the period of 13 months to 12 years.

Results: All the patients who underwent microsurgical cyst fenestration and imbrication had either complete (7 patients, 50%) or substantial (7 patients, 50%) resolution of their preoperative symptoms and neurological deficits. However, 3 patients (21%) had cerebrospinal fluid (CSF) leakage and 3 patients (21%) suffered from recurrent symptoms. In C-arm fluoroscopy guided percutaneous fibrin gel injection group, 34 patients (61%) had complete resolution and 22 patients had (39%) substantial resolution, and no CSF leakage or recurrence occurred. Only 3 patients (25%) got substantial resolution in the conservative management group, but 9 patients (75%) had aggravation.

Limitations: An observational study with a relatively small sample size.

Conclusions: C-arm fluoroscopy guided percutaneous fibrin gel injection therapy could be recommend as a better consideration for symptomatic TCs.

Key words: Tarlov cysts, C-arm fluoroscopy guided, fibrin gel, microsurgical cyst fenestration, conservative management

Pain Physician 2017; 20:E653-E660

Sacral perineural cysts, which were first reported by Tarlov as an incidental finding at autopsy in 1938, are also termed Tarlov cysts (TCs). They are collections of cerebrospinal fluid (CSF) involving the extradural components of sacral or coccygeal nerve roots (1). For a long time, TCs were an overlooked clinical problem because they often occurred asymptomatically. Approximately 1% of

cysts become symptomatic and should be treated when they are large enough to compress nerve roots or the sacral nerve plexus (2). The symptoms of symptomatic TCs include lower back pain, sacrococcygeal pain, perineal pain, sciatic pain, leg weakness, neurogenic claudication, bowel and bladder dysfunction, and even sexual dysfunction (2-10).

Though many methods have been applied to treat symptomatic TCs, there has been no consensus regarding the optimal treatment. Lumboperitoneal shunt was described with uncertain results and accompanied by a risk of infection (11). Percutaneous cyst drainage also has a poor effect because symptoms often recur due to re-collection of CSF (2). A direct microsurgical approach was reported to have good results for selected symptomatic patients by some researchers, but vigilance is needed due to the high risk of recurrence and complications (nerve damage, meningitis, and CSF leakage) (3,7,12,13). Recently, Shao et al (14) reported a new method of computed tomography (CT)-guided percutaneous injection of fibrin gel after cyst drainage to deal with symptomatic TCs and described 86.8% positive outcomes (excellent and good recovery). However, it is difficult for primary hospitals in China to finish the operation for lack of CT-guidance equipment.

The majority of previous reports concerning the management methods of symptomatic TCs were either series of limited cases or sporadic case reports (3,4,7,10,12,15-17). To further optimize the management for patients with symptomatic TCs, we retrospectively reviewed 82 cases of symptomatic TCs treated with 3 different strategies.

Methods

Study Population

From June 2003 to August 2015, a total number of 82 patients (33 men, 49 women; mean age, 45.2 years; range, 19 – 74 years; mean disease duration, 35.4 months; range, 6 – 360 months) with symptomatic TCs were treated in the First Affiliated Hospital of Chongqing Medical University. The main symptoms and neurological deficits of these patients included lower back pain or lumbosacral pain (n = 63), radicular pain (n = 25), numbness (n = 47), sensory abnormalities in the perineum/saddle area (n = 58), and bowel and bladder dysfunction (n = 39) (Table 1). Pain was recorded with a 10-cm visual analog pain scale (VAS) (Table 2). No patient had a history of trauma or infection. There were 61 patients whose symptoms were associated with postural changes: Standing or walking worsened these symptoms, while bed rest significantly alleviated these symptoms.

The diagnoses of TCs were confirmed by 1.5T magnetic resonance imaging (MRI) for all patients. The locations of these cysts are shown in Table 1. Sixty-four patients had a single cyst and the remaining 18 patients had multiple cysts. To confirm that these symptoms were caused by the cysts, patients' medical histories, clinical symptoms, and positive physical signs were examined carefully to exclude some diseases (anorectal diseases, gynecological diseases, urological diseases, and lumbar vertebral diseases such as lumbar disc herniation and lumbar spondylolisthesis) which have similar clinical manifestations.

Table 1. *Summary of included patients.*

Cyst Location	No. of Patients	Main Symptoms
L5-S1	21#	Radicular pain, local pain and local numbness
S1-S2	46#*	Local pain, local numbness and bladder dysfunction
S2-S3	17*	Local pain, local numbness and bladder dysfunction

* One patient has multiple cysts which occupy 2 segments (L5-S2). # One patient has multiple cysts which occupy 2 segments (S1- S3).

Table 2. *VAS score before treatment and at final follow-up.*

Intervention	Before treatment	Final follow-up
CRI	6.1 ± 2.0	3.4 ± 2.5*△
FGI	6.2 ± 1.8	1.3 ± 1.1*#
CM	5.8 ± 2.1	6.1 ± 2.2

Abbreviations: CRI, partial cyst wall resection and imbrication; FGI, C-arm fluoroscopy guided percutaneous fibrin gel injection; CM, conservative management. *Compared with before treatment, $P < 0.05$; △Compared with CM at final follow-up, $P < 0.05$; #Compared with CRI or CM at final follow-up, $P < 0.05$.

Ethics, Consent, and Permissions

This study was approved by the Institutional Review Board of The First Affiliated Hospital of Chongqing Medical University, and all aspects of the study complied with the Declaration of Helsinki. The Institutional Review Board of the First Affiliated Hospital of Chongqing Medical University waived the requirement for patient consent because this study was retrospective, the data were analyzed anonymously and patient care was not affected by the study.

Treatments

Patients who met the following criteria were treated surgically: 1) symptoms and signs are serious enough to warrant treatment; 2) symptoms over 6 months and failed conservative treatments (physical therapy, anti-inflammatory drugs, and neurotrophic drugs) more than 3 months.

Before 2009, 14 patients underwent microsurgical cyst fenestration and imbrication to treat this disease. Patients were placed in the prone position after general anesthesia. A lumbosacral midline incision was placed over the lesion (L5~S3). Then the following operations were done: sacral laminectomies, microsurgical cyst fenestration, and cyst wall imbrication with placement of fibrin gel or muscle grafts or free autologous fat over the closed wall. After operation, all patients accepted lumbar drainage. Moreover, 2 days of dexamethasone 10 mg and 20% mannitol 250 mL, and 1 – 3 days of prophylactic antibiotics were afforded along with an average of 3 days (range, 2 – 4 days) bed rest.

Since 2009, 56 patients underwent C-arm fluoroscopy guided percutaneous fibrin gel injection, a new minimally invasive technique, to treat this disease. Before the procedure, all patients were given an iodine allergy test. During the entire procedure, patients were placed in the prone position on the C-arm table. The localization of cysts was detected by MRI images obtained from the outpatient department or at hospital admission, and the image of the sacral vertebra was selected as the reference substance (for example, the cyst was located at "S1, left"). To locate the cysts during the procedure, a cross-shaped Kirschner wire was placed on the skin of the sacral region, and the image of the intersection point under fluoroscopy was used to match with the cyst location confirmed by MRI. Ultimately, the needle insertion point (middle area of the cyst) was confirmed when the image of intersection point coincided with the middle area of the cyst's MRI). After local anesthesia with 2% lidocaine, an appropriate size of bone-puncture needle (GuanLong Corporation, Shandong, China) was used to puncture through the skin, fascia, and sacral lamina in turn, and finally inserted into the cyst under C-arm fluoroscopy guidance. The intraoperative C-arm fluoroscopy image showed a metal needle shadow within the cavity (Fig.

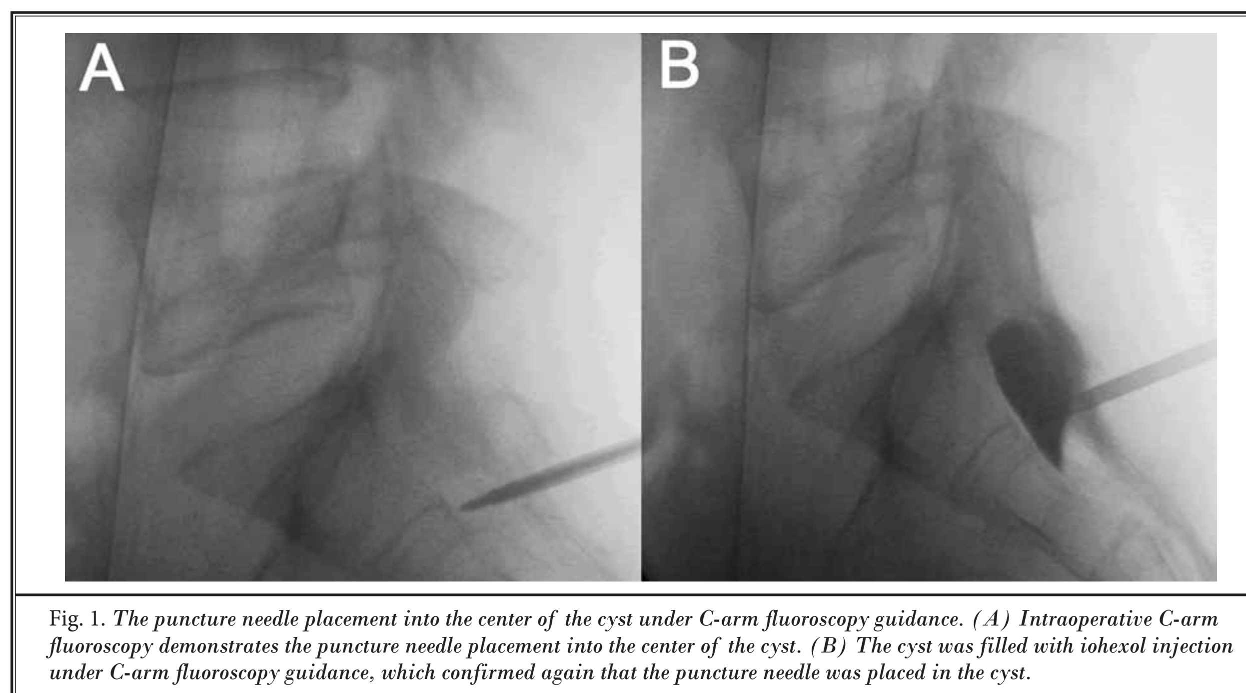

Fig. 1. *The puncture needle placement into the center of the cyst under C-arm fluoroscopy guidance. (A) Intraoperative C-arm fluoroscopy demonstrates the puncture needle placement into the center of the cyst. (B) The cyst was filled with iohexol injection under C-arm fluoroscopy guidance, which confirmed again that the puncture needle was placed in the cyst.*

1A), confirming that the puncture needle was inserted into the cyst. To prevent any discomfort during the aspiration procedure caused by sudden decompression, the CSF was aspirated slowly. Aspiration should stop when no more CSF could be removed, and the final volume was recorded (mean 3 mL; range, 2 – 5 mL). After that, about 1 – 2 mL iohexol (Yangtze River Pharmaceutical Group Co., LTD, China) was injected into the cyst. This also confirms that the puncture needle was in the cyst (Fig. 1B). Then, the iohexol injection was aspirated slowly and completely. After drainage of the cyst, fibrin gel was injected into the cavity of the cyst according to the manufacturer's instructions (PSW; Shanghai RAAS Blood Products, Minhang, Shanghai, China). The total volume of fibrin gel was equal to the amount of CSF aspirated from the cyst. If patients had more than 2 cysts, only one or 2 cysts, considered to be the chief culprit(s) of the symptoms, were treated with fibrin gel injection. At least one day bed rest should be afforded patients to prevent any postoperative discomfort. If the patients felt pain at the puncture site after the operation, we advise that an average of 3 days of bed rest is necessary. Some patients had side effects of fibrin gel therapy such as nausea, vomiting, low grade fevers, and headache after operation, we advised that they should have an average of 3 days (range, 2 – 4 days) bed rest. One day of prophylactic antibiotics, and 2 days of dexamethasone 10 mg and 20% mannitol 250 mL were also necessary.

Twelve patients who rejected surgical treatment were treated with conservative management including physical therapy and anti-inflammatory and neurotrophic drugs.

Pain was evaluated before treatment and at final follow-up according to a 10-cm visual analog pain scale (VAS). The total effects of treatment were assessed by comparison between pre-treatment and final follow-up examination results. All patients were followed up for 13 months to 12 years (an average follow-up of 39.8 months) and had another MRI after one year.

Table 3. *Outcomes of different treatments.*

Treatment (n)	Outcomes (n)	CSF leakage (n)
CRI (14)	CR (7); SR (7)#; R (3)#; A (0)	3
FGI (56)	CR (34); SR (22); R (0); A (0)	0
CM (12)	CR (0); SR (3); R (0); A (9)	0

Abbreviations: CRI, partial cyst wall resection and imbrication; FGI, C-arm fluoroscopy guided percutaneous fibrin gel injection; CM, conservative management; CR, complete remission; SR, substantial relief; R, recurrence; A, aggravation; CSF, cerebral spinal fluid.
#Of the 7 patients who had substantial relief, 3 suffered from recurrent symptoms several months after the operation.

Statistical Analysis

Data of VAS were expressed as mean ± SD (standard deviation). SPSS 13 statistical software program (SPSS Inc., IL, USA) was used for statistical analyses. Statistical differences were measured with Student's t-test for comparison between 2 groups, and $P < 0.05$ was considered statistically significant.

Results

At final follow-up inthe microsurgical cyst fenestration and imbrication group, the VAS score was reduced from the pre-operation score. Moreover, there was also a significant difference between the microsurgical cyst fenestration and imbrication group and the conservative management group for VAS score (Table 2). All the symptoms and neurological deficits had been either completly or substantially resolved immediately after operation or during follow-up visits in the microsurgical cyst fenestration and imbrication group (Table 3). During the follow-up visits, 3 patients (of the 7 patients who had substantial relief) suffered from recurrent symptoms after the surgery and all of them were confirmed by MRI as the recurrence of the cysts (Fig. 2). One of them received a second operation thereafter, and had no symptom improvement. The other 2 patients refuse a second surgical treatment because of many unknown reasons. Three patients had CSF leakage, and all of them underwent an artificial dural patch in the second operation and postoperative lumbar drainage for about one week.

All the patients who underwent percutaneous fibrin gel injection by C-arm fluoroscopy guidance get obvious pain relief at final follow-up (Table 2). They also had complete or substantial relief of their preoperative symptoms and neurological deficits immediately after surgery or during follow-up visits (Table 3). No postoperative infections, nerve damage, CSF leaks, or recurrence occurred in any of the patients. Seven cases had slight headache, low grade fever (37.5°C – 37.9°C), nausea, and vomiting without neck stiffness after fibrin injection. These discomforts disappeared completely after effective treatments: 20% mannitol 250 mL and dexamethasone 10 mg for 2 days, prophylactic antibiotics for one day, and an average of 3 days (range, 2 – 4 days) bed rest. MRI examinations in most patients showed that the cysts disappeared or decreased in size during follow-up visits (Fig. 3).

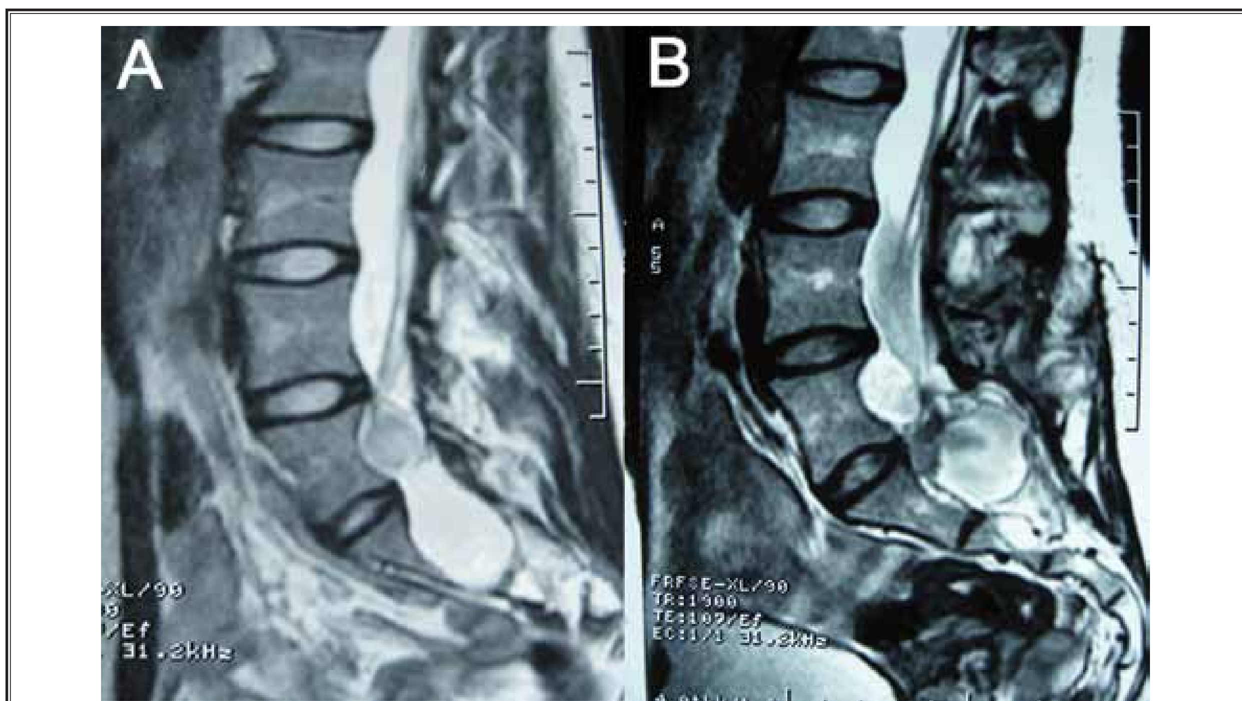

Fig. 2. *MRI study of recurrence of the cyst after microsurgical cyst fenestration and imbrication. (A) Preoperative MRI showing a cyst in sacral spinal canal. (B) Postoperative MRI showing the cyst reoccurring one year after the operation.*

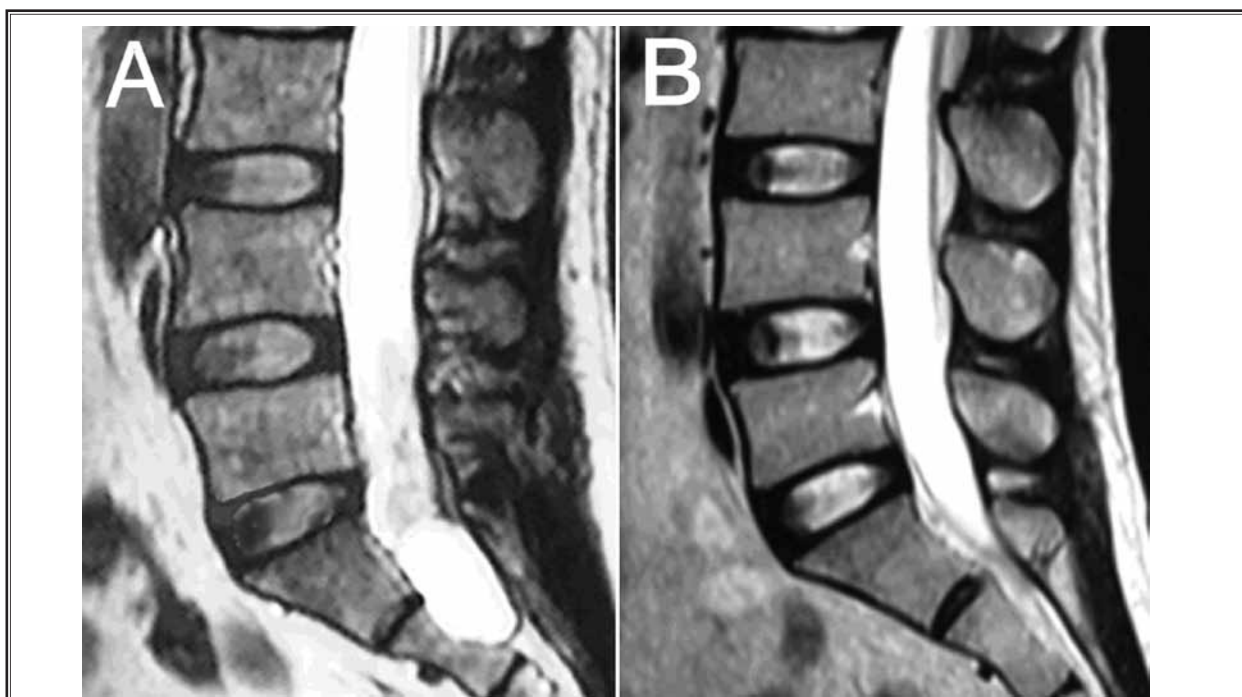

Fig. 3. *MRI study of disappearance of the cyst after C-arm fluoroscopy guided percutaneous fibrin gel injection therapy. (A) Preoperative MRI showing a 2.2 × 1.1 cm cyst in sacral spinal canal. (B) Postoperative MRI showing the cyst disappearing 5 months after the operation.*

At final follow-up of the conservative management group, the VAS score had no obviously change from that at pre-operation (Table 2). Of the 12 patients who accepted conservative management, only 3 patients had substantial relief of their preoperative symptoms and neurological deficits. The remaining 9 patients reported no symptom and neurological deficit resolution. In addition, their symptoms were aggravated with time (Table 3). These patients' cysts were also confirmed continuously by MRI examinations (Fig. 4).

Discussion

The etiology of TCs remains unclear (7). The most important hypotheses include 1) congenital origin; 2) hemosiderin deposition after trauma results in breakage of venous drainage in the perineurium and epineurium; and 3) inflammation of nerve root cysts followed by inoculation of fluid, arachnoidal proliferation along and around the sacral nerve root (7,10). Congenital arachnoidal defect as the origin of this disease is widely accepted. The mechanism could be described briefly as follows: The increased hydrostatic pressure caused by increased abdominal pressure or arterial pulsation forced the CSF to enter the congenital arachnoidal defect (the cyst) but is unable to return to the thecal dura through the same portal (the ball–valve effect) (13). And finally, the continuous infusion of CSF results in the cyst's enlargement (18,19).

Although only approximately 1% or less of cysts became large enough to compress nerve roots or the sacral nerve plexus, and cause obvious discomfort, this does not mean that it should be neglected (2,20,21). TCs are often misdiagnosed as other diseases, especially lumbar spinal stenosis or lumbar disc herniation. Therefore, candidates for surgery should be chosen after taking into consideration both the special clinical characteristics and imaging studies (especially MRI) while meeting the surgical criteria. MRI is considered to be most sensitive noninvasive way to detect sacral TCs. MRI was also used to plan surgical treatment because it shows the cysts and the surrounding structures clearly (22).

Since they were first reported by Tarlov in 1938, various methods have been tried to treat TCs, without

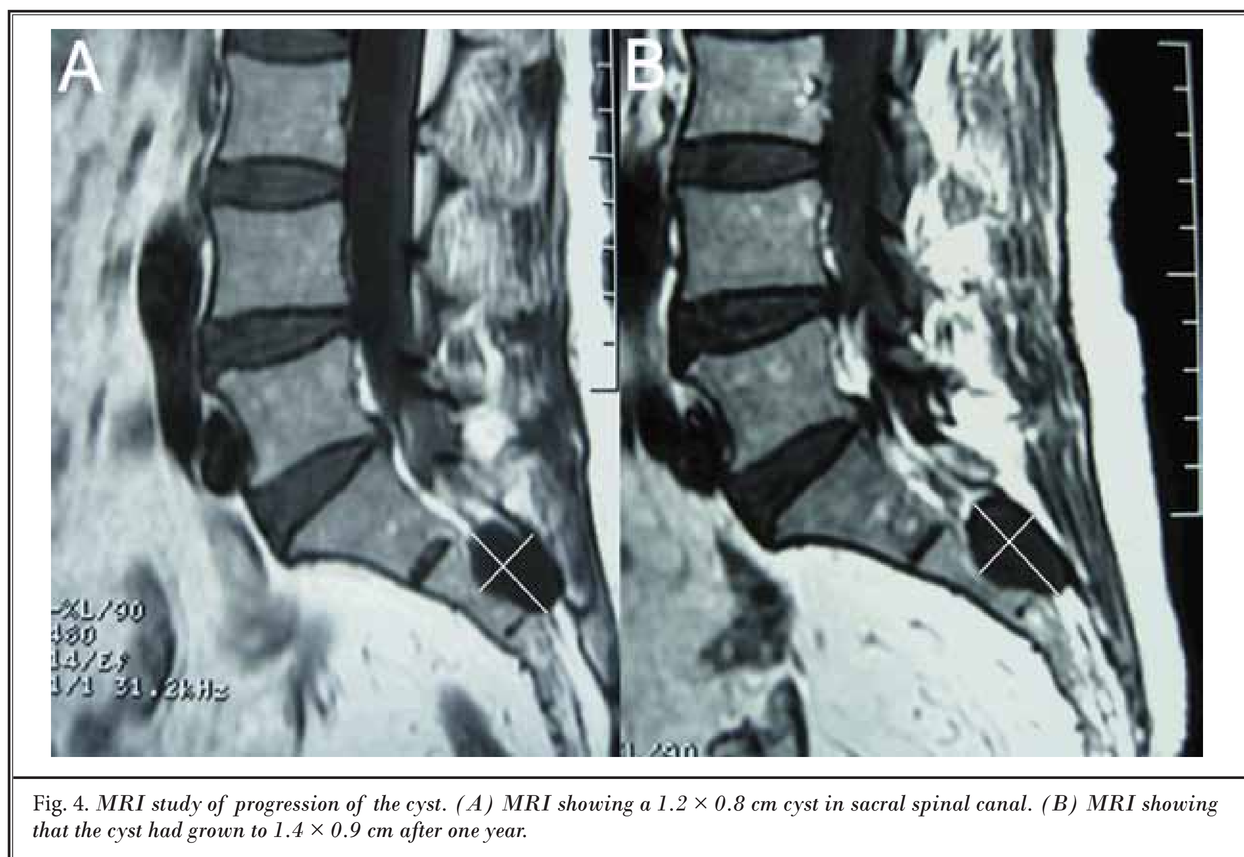

Fig. 4. *MRI study of progression of the cyst. (A) MRI showing a 1.2 × 0.8 cm cyst in sacral spinal canal. (B) MRI showing that the cyst had grown to 1.4 × 0.9 cm after one year.*

consensus on the optimal treatment. Lumboperitoneal shunt and cyst subarachnoid shunt have been used with unsatisfying results (11,15). Am icrosurgical approach, such as laminectomies with cyst wall fenestration and imbrication, for selected symptomatic patients have shown good results. However, the main drawbacks include a high risk of recurrence and complications such as CSF leakage, meningitis, and nerve damage (3,7,12,13). In 1994, Paulsen et al (2) reported 5 patients with symptomatic TCs got symptom relief from percutaneous cyst drainage. However, the symptoms recurred 3 months after this therapy. Recently, Shao et al (14) reported that patients with symptomatic TCs treated with intracystic fibrin glue injection achieved satisfactory relief with low recurrence and complications. CT was selected as the guidance tool during this operation. However, we considered that this operation is difficult to generalize because most primary hospitals in China lack CT-guidance equipment. Instead, C-arm fluoroscopy is more economical and common as an intraoperative guidance tool. We improved the procedure of CT-guided percutaneous injection of fibrin gel and completed percutaneous fibrin gel injection therapy on 56 patients with symptomatic TCs. In order to explore the better method to treat symptomatic TCs comprehensively, we retrospectively reviewed 26 cases of symptomatic TCs treated with microsurgical cyst fenestration and imbrication (n = 14) or conservative management (n = 12).

In our series, there were 14 patients treated with sacral laminectomies, microsurgical cyst fenestration, and cyst wall imbrication with placement of autologous muscle or fat grafts over the closed wall. We found this treatment could completely or partially resolve patients' symptoms. However, 3 patients had CSF leakage and 3 patients suffered from recurrent symptoms several months after the operation. These results were similar to previous reports (7,13). Therefore, it seems that microsurgical cyst fenestration and imbrication should not be recommended as the first choice for symptomatic TCs.

Previous studies have confirmed the effect of fibrin gel injection therapy for symptomatic TCs (14,23,24). In our study of the 56 patients who underwent C-arm fluoroscopy guided percutaneous fibrin gel injection therapy, 34 patients experienced complete remission of their preoperative symptoms and neurological deficits and 22 patients experienced substantial relief. MRI examinations in most patients showed that the cysts disappeared or decreased in size during follow-up visits. Moreover, no nerve damage, CSF leaks, surgical infections, and recurrence were reported. Only 7 cases had side effects from fibrin gel injection, such as headache, low grade fever, nausea, and vomiting without neck stiffness (14). Why is the fibrin gel used in the injection procedure effective in treating symptomatic TCs for the long-term? The fibrin gel has the property of resorption (25). We proposed hypothesis that the cyst cavity was filled and the traffic pore between the cysts and the subarachnoid space was sealed by fibrin gel. Subsequently, the cyst was absorbed, by fibroblast proliferation and fibrous scar formation. Finally, the CSF entry into the cyst from the subarachnoid space was reduced, thereby preventing the cyst from distending and compressing local nerves or stimulating nearby nociceptors.

In our series, 12 patients who refused surgical treatment were treated conservatively. Only 3 patients had relief through conservative treatment. The remaining patients had no relief of their symptoms and neurological deficits, and their symptoms were aggravated with time. Follow-up MRI examinations in these patients revealed that their cysts had grown with time. These observations may show that for most symptomatic TCs, the effect of surgical intervention is better than nonsurgical treatment.

Conclusions

Although often asymptomatic, enlarging TCs can cause serious clinical symptoms and, therefore, should not be overlooked. Both C-arm fluoroscopy guided percutaneous fibrin gel injection and microsurgical cyst fenestration and imbrication could relieve patients' symptoms. C-arm fluoroscopy guided percutaneous fibrin gel got better results with less complications. Therefore, we recommend that C-arm fluoroscopy guided percutaneous fibrin gel injection therapy should be a treatment consideration for symptomatic TCs.

Acknowledgments

The authors would like to thank the editors of *Pain Physician* journal for their review and constructive criticism in improving the manuscript.

References

1. Tarlov IM. Spinal perineurial and meningeal cysts. *J Neurol Neurosur PS* 1970; 33:833-843.
2. Paulsen RD, Call GA, Murtagh FR. Prevalence and percutaneous drainage of cysts of the sacral nerve root sheath (Tarlov cysts). *AJNR Am J Neuroradiol* 1994; 15:293-297.
3. Acosta FL, Jr., Quinones-Hinojosa A, Schmidt MH, Weinstein PR. Diagnosis and management of sacral Tarlov cysts. Case report and review of the literature. *Neurosurg Focus* 2003; 15:E15.
4. Caspar W, Papavero L, Nabhan A, Loew C, Ahlhelm F. Microsurgical excision of symptomatic sacral perineurial cysts: A study of 15 cases. *Surg Neurol* 2003; 59:101-105.
5. Chaiyabud P, Suwanpratheep K. Symptomatic Tarlov cyst: Report and review. *J Med Assoc Thai* 2006; 89:1047-1050.
6. Guest JD, Silbert L, Casas CE. Use of percutaneous endoscopy to place syringopleural or cystoperitoneal cerebrospinal fluid shunts: Technical note. *J Neurosurg Spine* 2005; 2:498-504.
7. Guo D, Shu K, Chen R, Ke C, Zhu Y, Lei T. Microsurgical treatment of symptomatic sacral perineurial cysts. *Neurosurgery* 2007; 60:1059-1065.
8. Lee JY, Impekoven P, Stenzel W, Löhr M, Ernestus RI, Klug N. CT-guided percutaneous aspiration of Tarlov cyst as a useful diagnostic procedure prior to operative intervention. *Acta Neurochir (Wien)* 2004; 146:667-670.
9. Tanaka M, Nakahara S, Ito Y, Nakanishi K, Sugimoto Y, Ikuma H, Ozaki T. Surgical results of sacral perineural (Tarlov) cysts. *Acta Med Okayama* 2006; 60:65-70.
10. Voyadzis JM, Bhargava P, Henderson FC. Tarlov cysts: A study of 10 cases with review of the literature. *J Neurosurg* 2001; 95:25-32.
11. Morio Y, Nanjo Y, Nagashima H, Minamizaki T, Teshima R. Sacral cyst managed with cyst-subarachnoid shunt: A technical case report. *Spine* 2001; 26:451-453.
12. Kunz U, Mauer UM, Waldbaur H. Lumbosacral extradural arachnoid cysts: Diagnostic and indication for surgery. *Eur Spine J* 1999; 8:218-222.
13. Mummaneni PV, Pitts LH, McCormack BM, Corroo JM, Weinstein PR. Microsurgical treatment of symptomatic sacral Tarlov cysts. *Neurosurgery* 2000; 47:74-78.
14. Shao Z, Wang B, Wu Y, Zhang Z, Wu Q, Yang S. CT-guided percutaneous injection of fibrin glue for the therapy of symptomatic arachnoid cysts. *AJNR Am J Neuroradiol* 2011; 32:1469-1473.
15. Bartels RH, van Overbeeke JJ. Lumbar cerebrospinal fluid drainage for symptomatic sacral nerve root cysts: An adjuvant diagnostic procedure and/or alternative treatment? Technical case report. *Neurosurgery* 1997; 40:861-864.
16. Prashad B, Jain AK, Dhammi IK. Tarlov cyst: Case report and review of literature. *Indian J Orthop* 2007; 41:401-403.
17. Smith ZA, Li Z, Raphael D, Khoo LT. Sacral laminoplasty and cystic fenestration in the treatment of symptomatic sacral perineural (Tarlov) cysts: Technical case report. *Surg Neurol Int* 2011; 2:129.
18. Murphy KJ, Nussbaum DA, Schnupp S, Long D. Tarlov cysts: An overlooked clinical problem. *Semin Musculoskelet Radiol* 2011; 15:163-167.
19. Rexed BA, Wennstrom KG. Arachnoidal proliferation and cystic formation in the spinal nerve-root pouches of man. *J Neurosurg* 1959; 16:73-84.
20. Langdown AJ, Grundy JR, Birch NC. The clinical relevance of Tarlov cysts. *J Spinal Disord Tech* 2005; 18:29-33.
21. Park HJ, Kim IS, Lee SW, Son BC. Two cases of symptomatic perineural cysts (tarlov cysts) in one family: A case report. *J Korean Neurosurg S* 2008; 44:174-177.
22. Lucantoni C, Than KD, Wang AC, Valdivia-Valdivia JM, Maher CO, La Marca F, Park P. Tarlov cysts: A controversial lesion of the sacral spine. *Neurosurg Focus* 2011; 31:E14.
23. Patel MR, Louie W, Rachlin J. Percutaneous fibrin glue therapy of meningeal cysts of the sacral spine. *AJR Am J Roentgenol* 1997; 168:367-370.
24. Zhang T, Li Z, Gong W, Sun B, Liu S, Zhang K, Yin D, Xu P, Jia T. Percutaneous fibrin glue therapy for meningeal cysts of the sacral spine with or without aspiration of the cerebrospinal fluid. *J Neurosurg Spine* 2007; 7:145-150.
25. Siedentop KH, Harris DM, Ham K, Sanchez B. Extended experimental and preliminary surgical findings with autologous fibrin tissue adhesive made from patients own blood. *Laryngoscope* 1986; 96:1062-1064.