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ORIGINAL RESEARCH

Endoscopic Joint Capsule and Articular Process Excision for the Treatment of Lumbar Facet Joint Syndrome: A Retrospective Study

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Background: Dorsal ramus medial branch radiofrequency ablation is reported to be effective for refractory lumbar facet joint syndrome. However, as nerve fibers can regenerate, the therapeutic effect was reported to be short and last only 6 to 12 months. Previously, we reported a novel endoscopic joint capsule and articular process excision procedure. In that case, a satisfying effect was achieved by removing the culprit hyperplastic articular synovial entrapped in the joint space endoscopically. We presume this treatment is an etiologic treatment and can exert longer-term efficacy.

Aim: This retrospective clinical trial aimed to elucidate the longer-term efficacy as well as the safety profile of the procedure.

Methods: This was a retrospective descriptive study. The participants underwent endoscopic joint capsule and articular process excision procedures. The Oswestry Disability Index (ODI) and Visual Analogue Scale (VAS) before the operation, and at 3 months, 6 months, 1 year, and 2 years post-operation were recorded by reviewing medical charts and conducting telephone interviews.

Results: A total of 234 participants were evaluated in the trial. After participant screening, 13 participants were included in the final analysis. The VAS score was reduced from (median (P25, P75)) 6 (4.5, 6) at pre-operation to 2 (0, 4) at 1-year post-operation and 0 (0, 1) at 2-year pre-operation. The ODI score was reduced from 37.78 (27.09, 59.95) at pre-operation to 8.89 (2.22, 24.34) at 1-year post-operation and 6 (0.02, 11.11) at 2-year post-operation. The difference was statistically significant. Further subgroup analysis demonstrated that a narrowed intervertebral space was a possible relevant factor for poor outcomes. No procedure-related complications were reported.

Conclusion: Endoscopic joint capsule and articular process excision is an effective and safe procedure for refractory lumbar facet joint syndrome. The effectiveness duration can last up to 1 to 2 years.

Keywords: endoscopic, lumbar facet joint syndrome, synovial entrapment, joint capsule, radiofrequency, VAS, ODI

Introduction

Lumbar facet joint syndrome (LFJS) is acknowledged to be a multi-causal disease. Facet joint arthritis, synovial entrapment, pseudogout and facet joint cysts, etc are all involved in the pathogenesis of it.[1] Furthermore, the symptoms are diverse. Some patients experience mild chronic pain with symptoms worsening during lumbar extension or unbending the waist, while some patients experience transient sharp pain triggered by sudden change in position. In some patients, severe pain may result in compulsory position. However, the present therapeutic modalities for LFJS are mainly symptomatic treatments. The treatment of LFJS starts with physical therapy or oral medication etc., while dorsal ramus medial branch radiofrequency ablation is

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reserved for refractory cases.[2,3] However, the long-term efficacy of dorsal ramus medial branch radiofrequency ablation cannot be guaranteed, as the nerve fibers can regenerate.[4] The therapeutic effect was reported to last for only 6 to 12 months.[2,5,6]

Previously, we had reported a novel treatment modality of endoscopic joint capsule and articular process excision (EJCE).[7] In that case, satisfying effect was achieved by removing the culprit hyperplastic articular synovial entrapped in the joint space endoscopically. We presume this treatment as an etiologic treatment and can exert longer term of efficacy. However, the previous article is merely a case report. The exact long-term efficacy with a larger sample size is unknown. Furthermore, we are concerned about whether there are complications after removal of the capsule, since the integrity of the joint is destroyed. Hence, we conducted this retrospective clinical trial to elucidate the long-term efficacy as well as the safety profile for the procedure.

Methods

Study Design

This study was a retrospective study approved by the ethical committee of the Nantong Hospital of Traditional Chinese Medicine, with the approval number of 20230515–1. The study adheres to the principles outlined in the Declaration of Helsinki. The valuable information was extracted from the medical charts. The follow-up data was recorded through telephone inquiry. These works were done by an independent nurse, and the statistical analysis was performed by an independent physician.

Inclusion Criteria

1. The pain was located at unilateral side or bilateral side of the lower back, and lumbar extension or lateral bending to the painful side could aggravate the pain. In addition, the pain could be relieved during lumbar flexion and lateral bending to the healthy side;
2. Low back pain lasted for at least 3 months;
3. The VAS score of 3 or above was obtained;
4. The pain could not be relieved by conventional therapies, including oral medication, physical therapy or chiropractic care, etc.;
5. Controlled diagnostic fluoroscopy-guided intra-articular injections were positive.
6. Written informed consent was obtained;

Exclusion Criteria

1. Lumbar instability;
2. Lumbar vertebral fracture;
3. Coagulopathy or other bleeding disorders;
4. Active local infection;
5. Symptomatic herniated disc or spinal stenosis;
6. Rheumatic diseases, such as ankylosing spondylitis, rheumatoid arthritis, etc.;
7. Mental disorders;
8. Communication disorders;
9. Participants receiving interventional treatments other than EJCE, such as medial branch radiofrequency, pulsed radiofrequency, etc.;

Description of Interventions

For the description of the intervention, take L5-S1 segment for example.[7]

The patient lay prostrate with a pillow placed under the abdomen to gently flex the lumbar spine. Using a C-arm X-ray for guidance, the L5-S1 facet joint was located and marked. After thorough disinfection, draping, and local anesthesia, a 25-cm 18-gauge needle was carefully inserted into the dorsal surface of the L5 articular process, near the tip of the process.

Confirmation of needle placement was ensured with anteroposterior imaging. Subsequently, a guidewire was introduced through the stylet, followed by the insertion of successive dilation tubes and a working canal through a 0.7-cm skin incision centered on the guidewire. Anteroposterior and lateral views were used to confirm the correct positioning of the working cannula on the posterior surface of the L5-S1 facet joint (Figure 1). Through the working cannula, a spinal endoscope was introduced, allowing for the precise removal of microvascular tissue and muscle tissue attached to the L5 inferior articular process and S1 superior articular process using a grasper. Hemostasis was achieved using a bipolar radiofrequency probe. This allowed for exposure of the L5 inferior articular process, S1 superior articular process, and joint capsule (Figure 2). After removing the joint capsule, the joint space was clearly visualized (Figure 3). For some patients, if the joint space was not clearly visualized, a small portion of the L5 articular process was carefully excised using a chisel. Any tissue causing

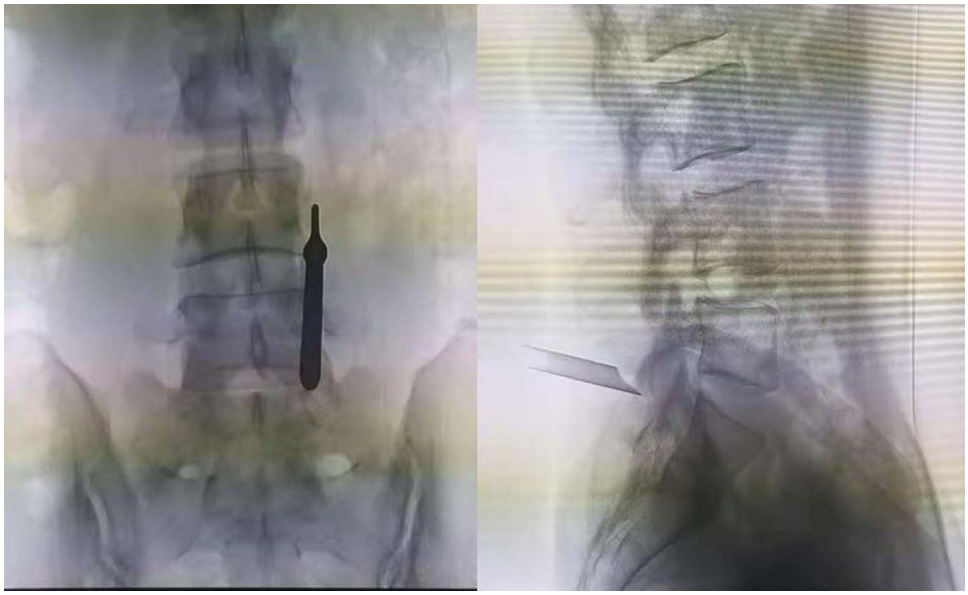

Figure 1 Anteroposterior and lateral views of the working cannula, indicating the tip of the cannula was lacated on the surface of the L5-S1 facet joint.

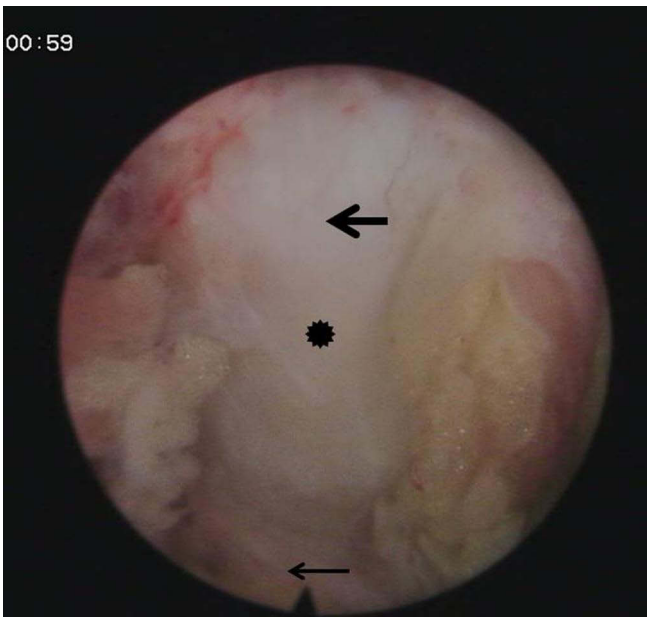

Figure 2 L5 articular process marked with a thick arrow, S1 articular process marked with a thin arrow, the joint capsule marked with an asterisk.

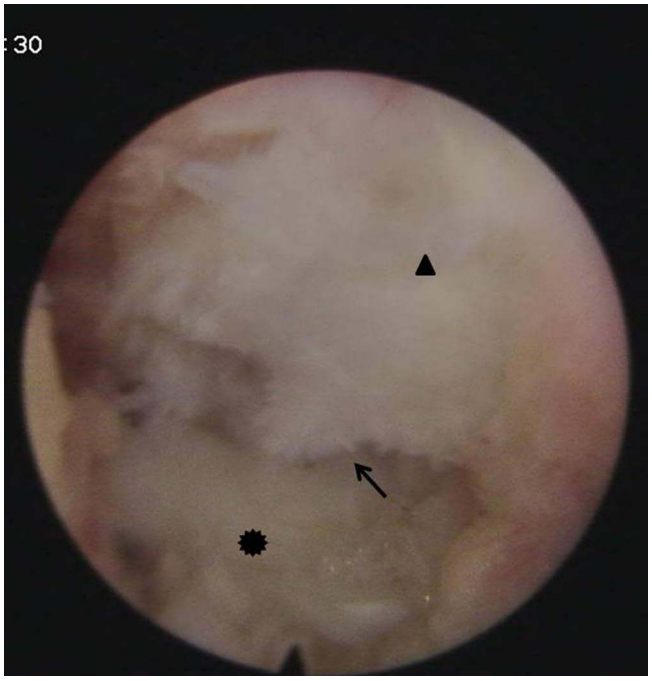

Figure 3 L5 articular process marked with a triangle, S1 articular process marked with an asterisk, the joint capsule marked with an arrow.

compression within the joint space was meticulously cleared. A small nerve hook was used to explore the joint space to confirm the joint space was clear (Figure 4), and with no bleeding points, the endoscope and working cannula were withdrawn, and the incision was closed with sutures.

For the diagnostic intra-articular injection, fluoroscopy-guided posterior approach facet injection was performed. For participant with curve-shape joint space or with severe joint osteophytes, CT guided lumbar facet joint injection was performed. We perform these injections twice for each participant. One with 0.2 mL lidocaine, other with 0.2 mL ropivacaine

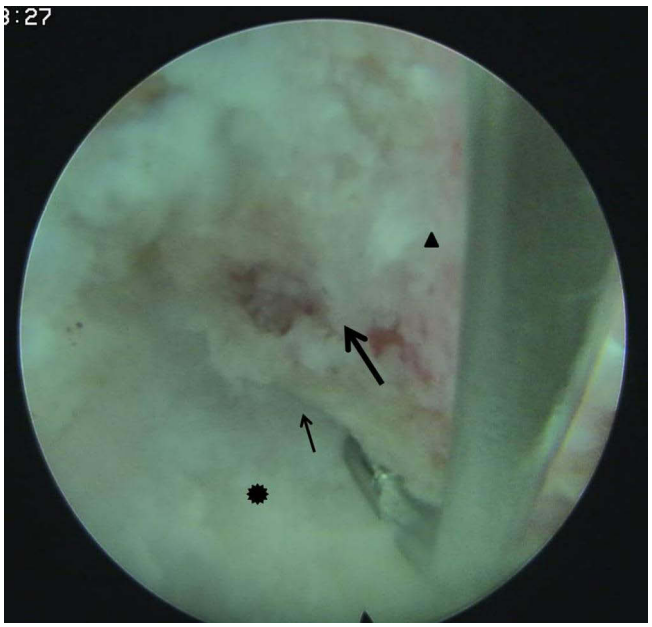

Figure 4 L5 articular process marked with a triangle, S1 articular process marked with an asterisk, the joint space marked with a thin arrow, the remaining bony surface after superior articular tip removal marked with a thick arrow.

with a one-week interval. If the pain-free time was obviously longer with ropivacaine block, it was termed as a positive diagnostic block.

Evaluation of Therapeutic Effect

For each participant, baseline outcomes including height, weight, BMI, age, sex, affected segment, laterality, symptom duration were evaluated. CT, MRI, and X-ray imaging of the lumbar spine were observed to determine whether there was lumbar intervertebral height narrowing. Oswestry disability index (ODI) and visual analogue scale (VAS) prior to operation, at 3-month, 6-month, 1-year, and 2-year post-operation were evaluated. Patients' global assessment for the procedures were also recorded through medical chart reviewing and telephone interviews. We directly asked patients whether they regarded the procedures as effective or not. One patient reported that the pain on the treated side was utterly relieved, however the contralateral side became painful similar to the onset of LFJS. This patient also regarded the procedure as effective. Complications such as lower leg numbness, muscle weakness, local infection, post-operation lumbar instability were not observed during the study.

Statistical Analysis

VAS and ODI scores were expressed as median (P25, P75). The VAS scores and ODI scores before treatment and after treatment were compared using Wilcoxon signed-rank test. Fisher's exact test was applied to determine whether lumbar intervertebral height decrease was a relevant factor to the efficacy. $P < 0.05$ was regarded as statistically significant. SPSS version 26 was used for the statistical analysis.

Results

From July 2020 to February 2022, a total of 234 participants were evaluated in the trial. Twenty-two of them were included in the study. Nine participants were excluded due to the exclusion criteria, and 13 participants were included in the final analysis. Six patients completed 24-month follow-up work, and the remaining 7 patients completed 12-month follow-up. The baseline demographic data was illustrated on Table 1. The detailed VAS and ODI scores before and after operation, and patients' global assessment for the procedures were illustrated on Table 2. And the VAS scores at pre-

Table 1 The Baseline Demographic Data of the Participants

Case Number	Age	Height	Weight	Sex	Laterality	Course of Disease	Affected Segment	Classification of Disc Degeneration	Classification of Facet Joint Degeneration	Intervertebral Height Decrease
1	56	160	65	2	Right	72	L4/5	3	2	Normal
2	43	164	65	2	Right	6	L5/S1	3	1	Normal
3	57	160	59	2	Left	3	L4/5	3	2	Normal
4	53	175	67	1	Right	36	L4/5	4	1	Decreased
5	42	170	68	1	Left	36	L1/2	5	2	Decreased
6	61	165	60	2	Left	48	L4/5	2	2	Normal
7	47	166	62	1	Right	24	L5/S1	5	1	Decreased
8	47	168	55	2	Left	120	L5/S1	5	1	Decreased
9	62	159	57	2	Right	24	L5/S1	1	2	Normal
10	58	162	66	2	Right	60	L3/4	2	1	Normal
11	45	178	80	1	Left	60	L5/S1	4	2	Decreased
12	63	174	60	1	Bilateral	240	L5/S1	5	1	Decreased
13	50	164	52	2	Left	120	L5/S1	2	1	Normal

Table 2 The VAS Score, ODI Scores and Patients' Global Assessment Before and After Operation

Case Number	VAS Before Treatment	VAS at Three-Month Post-Treatment	VAS at Six-Month Post-Treatment	VAS at One-Year Post-Treatment	VAS at Two-Year Post-Treatment	ODI Before Treatment	ODI at Three-Month Post-Treatment	ODI at six-month post-treatment	ODI at one-year post-treatment	ODI at two-year post-treatment	comments	patients' global assessment for the procedure
1	6	0	0	0	0	77.78	8.89	8.89	8.89	4.44		Effective
2	4	2	4	4	2	26	14	18	22	20	The position induced lancinating pain disappeared, the patient can only feel constant moderate dull pain.	Effective
3	6	6	2	2	1	71	68.89	11.11	11.11	6.67	The position induced lancinating pain disappeared at six-month post-treatment.	Effective
4	6	1	1	1	0	26.67	8.89	8.89	4.44	0	The pain attack frequency decreased gradually, and at one-year post-treatment the symptoms disappeared totally.	Effective
5	6	2	1	0	0	48.89	24.44	2.22	2.22	0		Effective
6	5	2	1	0	0	27.5	7.5	2.5	2.22	0.02		Effective
7	6	2	4	4	4	31.11	28.89	28.89	35.56	28.57	The paroxysmal lancinating pain disappear at one-year post-treatment, however the intermediate pain continued.	Ineffective
8	4	2	2	2	1	38	20	8.89	8.89	5	The pre-treatment severe pain with compulsive posture disappeared, however, the patient still experienced dull pain triggered by long-term sitting and standing.	Effective
9	5	0	0	0	0	44.44	4.44	0	0	7		Effective
10	6	0	0	0	0	84.44	0	0	0	6		Effective
11	5	1	2	2	1	20	4.44	6.67	11.11	11.11	The pain location shifted after the treatment.	Ineffective
12	8	7	6	7		35.56	28.89	31.11	26.67		Low back pain on the right side relieved, however the pain on the left side continued at the same degree as before.	Ineffective
13	4	3	5	5		37.78	20	35.56	33.33		The symptoms relieved after the treatments, however, the low back pain on the contralateral side which was similar to the before-treatment symptoms occurred at one-year post-treatment.The patient was satisfactory to the treatment, but denied further surgery.	Effective

operation, and at 3-month, 6-month, 12-month, and 24-month post-operation were 6 (4.5, 6), 2 (0.5, 2.5), 0.5 (0.5, 4), and 0 (0, 1) respectively. The ODI scores at pre-operation, and at 3-month, 6-month, 12-month, and 24-month post-operation were 37.78 (27.09, 59.95), 14 (5.97, 26.67), 8.89 (2.36, 23.45), 8.89 (2.22, 24.34) and 6 (0.02, 11.11) respectively (Table 3).

Further subgroup analysis of the effective and uneffective cases was implemented. All the 3 unsatisfactory cases were with narrowed intervertebral spaces, compared with 3 out of 10 satisfactory cases with narrowed intervertebral spaces. The difference was very obvious though with no statistical significance (Table 4).

No major procedure-related complication was reported in the trial.

Discussion

We have introduced a novel procedure of EJCE with a favorable outcome previously, however it was only a case report with short-term follow-up.[7] The long-term efficacy and safety profile remain unknown. Therefore, we implemented this retrospective descriptive study. In this study, we found that the average VAS score as well as the average ODI score reduced dramatically, the efficacy remained stable until one to 2 years postoperatively. This result validated our hypothesis that EJCE is an effective procedure. Furthermore, no major complications happened after the procedures. This result indicated that the procedure is safe. The possible reason should be that only a small part of the joint capsule was removed and the intrathecal structure and spinal stability was not affected.

By analyzing the characteristics of successful and unsuccessful cases, we found that decreased intervertebral space was correlated to poor efficacy of the procedure and the difference was very obvious although no statistical significance was detected. We speculate the sample size is not large enough to demonstrate the statistical significance.

Table 3 The VAS and ODI Scores Before and After the Procedures

	No. of Participants	VAS score	P
Baseline	13	6 (4.5, 6)	
3 mo	13	2 (0.5, 2.5)	0.002
6 mo	13	0.5 (0.5, 4)	0.003
12 mo	13	2 (0, 4)	0.003
24 mo	10	0 (0, 1)	0.003
		ODI score	
Baseline	13	37.78 (27.09, 59.95)	
3 mo	13	14 (5.97, 26.67)	0.001
6 mo	13	8.89 (2.36, 23.45)	0.001
12 mo	13	8.89 (2.22, 24.34)	0.003
24 mo	10	6 (0.02, 11.11)	0.003

Table 4 The Relationship Between Efficacy and Intervertebral Space Decrease

	Normal Intervertebral Space	Decreased Intervertebral Space	P
Satisfactory cases	7	3	
Unsatisfactory cases	0	3	0.07

In this procedure, in order to clear away the culprit hyperplastic articular synovial entrapped in the joint space, part of the joint capsule, and articular tip if necessary had to be removed. As compared with medial branch radiofrequency ablation, the procedure is relatively more invasive. Therefore, we tried to identify the exact culprit joints to minimize the number of the treated joints and avoid affecting the innocent joints. According to relevant reports, paraspinal tenderness is the main positive finding of physical examination on patients with LFJS, and it locates at the same level.[8] Furthermore, facet joint degeneration is highly associated with disc height loss at the same level.[9] Therefore, the method we tried to identify the exact culprit joints was as follows. We first chose the segment with paraspinal tenderness or with narrowed intervertebral space. If disc height narrowing and paraspinal tenderness did not locate at the same level, we implemented x-ray guided facet joint injections, respectively. If neither the tenderness nor the disc height narrowing existed, we had facet joint intra-articular injection from L5-S1, L4-5, L3-4, L2-3, to L1-2, respectively.

According to the method we previous described,[7] we removed the dorsal part of the capsule and cleared away dorsal part of the joint space, instead of other part of the joint. The reason was as follows. Under the posture of lumbar dorsal extension, the dorsal part of joint space is narrowed, while under the posture of lumbar flexion, the dorsal part of the joint space is widened. Considering the symptoms of worsened low back pain during lumbar extension and relieved pain after lumbar flexion, it is reasonable to deduce that the entrapped synovium locates at the dorsal part of the joint space.

Due to the similar reason, we adopted pain triggered by lumbar extension or ipsilateral bending and relieved by lumbar flexion or contralateral bending as an inclusion criterion, although it is not a commonly recognized diagnostic criterion for LFJS.[10] We presumed it would help to distinguish from other etiologies of the LFJS, since EJCE is merely suitable for LFJS with synovium impingement.

In this study, we further analyzed relevant factors for the effective cases. Apart from the close relationship between normal intervertebral height and superior efficacy, we found this treatment was especially effective for LFJS patients with intermittent pricking pain. Most of the participants reported that the intermittent pricking pains especially position-shifting-induced pricking pain were utterly relieved, except for one participant who reported post-operation pain onset on the contralateral side. And for minority of the patients, the dull back pain still remained. We presume that the intermittent pricking pain was caused by joint synovium entrapment and the entrapped synovium was hyperalgesic, while the persistent dull pains were multifactorial. The EJCE can effectively clear away the entrapped synovium tissue.

Regarding the treatment modalities for LFJS, medial branch radiofrequency ablation was reported to be the evidence-based mature technique.[11,12] However, due to the fact that the nerve fiber can regenerate, the efficacy is not permanent. The reported efficacy duration is 6 months to 1 year. This research testified that EJCE treatment would exert longer efficacy up to one to 2 years and possibly even longer. However, the possible limitation compared to radiofrequency ablation is that the indication of our technique is narrower. In contrast to radiofrequency ablation, only LFJS with the etiology of synovium entrapment is the indication for our procedure. However, no clinical examination available to determine the exact etiology of LFJS. In this research, we roughly determined the etiology of synovium entrapment through symptom characteristics and diagnostic intra-articular injections, it was not rigorous anyway. Therefore further research is required in this regard.

There are also some treatment modalities for refractory LFJS similar to our procedure. Moussa WM introduced a novel treatment named “Percutaneous radiofrequency facet capsule denervation”. In the procedure, the denervation target was shifted from the medial branch to the joint capsule, with the aim to denervate joint capsule. The indication and the underlying mechanism were different from ours.[13]

Scott M W Haufe introduced a novel treatment named “Endoscopic facet debridement”, which was similar to ours.[14] The study did not identify the culprit facet joints and instead treated almost all the facet joints. The underlying mechanism was to remove the nociceptive nerve endings in the facet joint capsule. That was quite different from ours. We instead aimed to remove the entrapped hyperplastic joint synovium. Furthermore, the technical details of the surgery were not described in the article.

There were some limitations in our study. First, the sample size was too small, although one of the reasons was due to the concern that we could not guarantee there was no serious complications for the procedure, we implemented limited number of procedures in clinical practice. Second, no comparison group was available in the trial. We plan to have a more rigorous randomized controlled trial in the future. Furthermore, it was reported that the capsule has spinal

functions of limiting rotation and resisting sliding during extension.[15–17] Theoretically, the less damage to the capsule, the less complications there will be. Further study should focus on how to minimize the damage to the joint capsule during removing impinged synovium. For example, to apply endoscopes with smaller diameters in the procedure.

Conclusions

EJCE is an effective and safe procedure for refractory LFJS caused by joint synovium entrapment. The efficacy duration can last for up to 1 to 2 years.

Data Sharing Statement

All the clinical data are available from the corresponding author on reasonable request.

Ethical Approval

This study was approved by the ethical committee of the Nantong Hospital of Traditional Chinese Medicine, with the approval number of 20230515-1.

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Disclosure

The authors report no conflicts of interest in this work.

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