

Advances in the Diagnosis and Treatment of Lumbar Facet Joint Pain: A Critical Perspective on Precision Intervention

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Abstract: Objectives: The facet joint-derived low back pain (FJOLBP) is one of the common causes of chronic low back pain, and its diagnosis and treatment is still a major challenge in the management of spinal pain. The purpose of this study is to systematically evaluate the latest progress of FJOLBP research and provide guidance for clinical accurate intervention strategies. **Methods:** We conducted a comprehensive literature search and summarized the latest research on FJOLBP, mainly summarizing the diagnostic challenges and sustainable development of the treatment model of FJOLBP. The evidence came from recent randomized controlled trials, systematic reviews and clinical guidelines. **Results:** From the epidemiological point of view, the incidence of facet joint-derived low back pain is not low, but it is impossible to accurately determine the root cause by relying on patients' oral symptoms and filming. At present, it is recognized as a reliable means of diagnosis, or image-guided medial branch diagnosis block. The whole treatment process also has clear stratification, from light to heavy, conservative treatment, traditional radiofrequency ablation and endoscopic neurotomy, which has been gradually popularized in recent years. However, many high-quality randomized controlled trials have given different conclusions, and the actual effect of nerve damage surgery is not as stable as everyone imagined. In fact, we can see several key points here: the placebo effect of interventional surgery should not be underestimated, screening suitable patient groups is particularly critical, and postoperative rehabilitation training can not be omitted. Comparing the clinical data of various surgical procedures, it can be found that the effect of radiofrequency ablation is better when the electrodes are placed in parallel than vertically. The long-term analgesic effect of endoscopic neurotomy is better than that of traditional radio frequency. **Conclusion:** The standardized diagnosis and treatment of facet joint-derived low back pain lies in that clinicians should master all kinds of minimally invasive interventional procedures skillfully, and at the same time, they should make rational judgments based on the existing clinical evidence, instead of blindly relying on surgery. The idea of follow-up diagnosis and treatment can be adjusted as follows: first, complete the diagnosis with accurate block, then optimize the details of ablation operation, and at the same time, cooperate with systematic rehabilitation training all the time, and the combination of the three can stabilize the long-term curative effect.

Keywords: Facet Joint Pain; Medial Branch Block; Radiofrequency Ablation; Endoscopic Neurotomy; Precision Medicine.

1. Background

The lumbar spine has a set of "three-joint complex", and the lumbar facet joints and intervertebral discs together constitute this structure, which is also the core biomechanical unit of the lumbar spine. This structure is not only as simple as propping up the trunk and sharing the weight of the body, but also can limit the excessive rotation and flexion and extension of the lumbar spine and avoid the nerve in the spinal canal from being squeezed by external forces.

If the articular capsule, subchondral bone, synovial fold, or the soft tissue around the joint is degenerated, inflamed and traumatized, it will cause facet-derived low back pain. The nerve that transmits pain mainly comes from the medial branch of the dorsal branch of the lumbar spine. When patients bend over and stand for a long time, the pain usually increases obviously. However, this disease has a very troublesome point. Its pain manifestations are not special, and it is easy to be mixed with discogenic low back pain, myofascial pain and nerve root stimulation symptoms. In the daily outpatient clinic, many doctors are prone to missed diagnosis and misdiagnosis, and directly classify low back pain as other spinal problems. It is not difficult to accurately distinguish and treat symptoms. Many epidemiological

studies based on diagnosis block show that 15% ~ 45% of patients with chronic low back pain are rooted in small joints. The older they are, the more serious the intervertebral disc degeneration is, the higher the incidence probability is, which also brings a lot of economic burden to society and patients [1].

In the past, everyone always thought that seeing facet osteoarthritis on the film meant that the patient would have low back pain. But now there is a more comprehensive understanding in the field of pain medicine. The pathogenesis of this disease involves complex neuroinflammation and lumbar mechanical imbalance. After degeneration, the synovium of facet joints will release inflammatory substances such as tumor necrosis factor- α and interleukin -1 β , and the joint capsule will be covered with nociceptive nerves, and the sensitivity will be greatly improved.

At the same time, the decrease of intervertebral disc height will change the stress on the lumbar spine, and all the pressure will be transferred to the facet joints, and cartilage wear, bone hyperplasia and tiny tear of the joint capsule will form a vicious circle. Continuous pain signals will also induce central sensitization, which will enlarge the pain range of patients and reduce the effect of follow-up treatment.

To put it bluntly, now we can't simply treat facet joint-

derived low back pain as a local joint lesion. It is a set of chain reaction, local tissue injury, neuralgia signal conduction and abnormal pain perception in brain center, and the three mechanisms interact with each other. This review doesn't want to copy the same literature summary in the past. I intend to disassemble it one by one along the complete diagnosis and treatment process: first talk about the pits that are easy to step on in the diagnosis process, then compare the advantages and disputes of various interventional operations, and combine the existing clinical evidence to talk about the future direction of precision medicine.

2. Diagnostic Challenge: Going Beyond Imaging to Precision Module

2.1. Limitations of Clinical and Radiological Diagnosis

The most difficult thing about facet joint-derived low back pain is that the symptoms displayed by patients are not recognizable. Most patients have dull pain in the deep waist, and the pain will involve the buttocks and the back of thighs, but it will rarely radiate below the knee. Physical examination may be able to touch the tenderness of unilateral facet joints, and the pain will be aggravated when leaning back and rotating the waist, but the sensitivity and specificity of these signs are very low, so they can not be used for diagnosis alone. Schuster's team once pointed out this clinical misunderstanding in "Pain Medicine". It is impossible to be 100% sure that the pain is caused by facet joints only by the patient's oral medical history and physical examination, which is more common in clinical practice [2].

X-ray, CT, nuclear magnetic resonance imaging examination, the actual reference value is limited. The film can clearly see degenerative manifestations such as narrowing of joint space, hyperosteoecy, subchondral sclerosis, joint effusion, etc., but the research of Van der Graff's team confirmed that many healthy people who have no low back pain will also have similar degeneration on the images, and there is almost no corresponding relationship between the image changes and the severity of pain [3]. To some extent, the greater role of imaging examination is to exclude infection, tumor, lumbar instability and other serious spinal problems, which can not be used as the basis for the diagnosis of minor joint pain.

2.2. Diagnostic Blocks: Gold Standard and Optimization

At present, it is universally recognized that image-guided medial collateral block is the gold standard for the diagnosis of facet joint-derived low back pain. The operation logic is not complicated. A small amount of local anesthetic is injected into the medial branch of the affected facet accurately, and the pain relief of the patient reaches more than 80%, so the diagnosis of facet joint-derived low back pain can be made with high probability [4]. However, this test itself is controversial, and the most prominent problem is that there are too many false positive results. In order to reduce the probability of misdiagnosis, most clinical guidelines recommend that long-acting and short-acting local anesthetics be blocked twice to improve the diagnostic accuracy [5,6].

Patel's team recently completed a prospective observation study, and reached a very referential conclusion: sedation with midazolam during block will neither significantly

change the patient's own pain feedback nor increase the false positive probability of subsequent radiofrequency surgery [7]. This conclusion has dispelled the previous concerns in the industry. Many people were worried that sedation would interfere with patients' judgment of pain. Now there is evidence to support it. Patients who are anxious and difficult to cooperate can use sedation with peace of mind, which can not only ensure the reliable examination results, but also reduce the discomfort of patients during operation.

3. Evolution of Treatment Strategy: From Conservative Treatment to Precise Nerve Ablation.

The treatment of facet joint-derived low back pain follows a step-by-step approach. First, try a conservative scheme, and then do minimally invasive intervention if the effect is not good. It is really impossible to control the symptoms, and finally consider open surgery.

3.1. Conservative and Pharmacological Management

For patients with first onset and mild symptoms, priority should be given to two basic schemes: oral non-steroidal anti-inflammatory drugs, rehabilitation physiotherapy (core muscle group stabilization training and manual relaxation), and popular science education. The goal of the whole scheme is to eliminate local inflammation, correct the abnormal stress on the lumbar spine, and break the cycle of mutual aggravation of pain and limited activity. But to be honest, it is difficult for many patients with moderate and severe chronic low back pain to achieve satisfactory analgesic and recovery effects only by conservative treatment.

3.2. Conventional Intervention: Radiofrequency Ablation and Technical Optimization

Patients with positive results after two blocks, radiofrequency ablation is the minimally invasive treatment with the most extensive clinical application and the most sufficient evidence. The principle of operation is to coagulate and necrotize the medial branch nerve through high temperature and block the upward transmission of pain signals for a long time.

The manipulation will directly affect the final effect of the operation. De Andres' team did a prospective randomized controlled trial, which specifically compared the two operation modes of parallel electrode placement and vertical electrode placement. After 6 months' follow-up, there was no obvious difference between the two groups in the continuous visual analogue pain score and the Oswestry dysfunction index, but in terms of the effective number of pain improvement and functional recovery, the advantage of placing electrodes in parallel was more prominent [8]. The author believes that parallel placement is more suitable for the anatomical structure of nerve running, nerve damage will be more thorough, and long-term curative effect will be more stable. This study also provides a high-quality basis for clinical standardized operation.

3.3. Emerging Technique: Endoscopic Neurotomy

In recent years, the development of endoscopic neurotomy

may shake the mainstream position of radiofrequency ablation. Only a small incision is needed to insert the endoscope, and the doctor can directly look at the medial branch nerve, accompanying blood vessels and surrounding soft tissues, and accurately complete mechanical amputation or high temperature cautery.

Song et al. conducted a randomized controlled trial to directly compare endoscopic neurotomy with fluoroscopy-guided radiofrequency ablation. Three weeks after operation, there was no significant difference in analgesic and functional recovery between the two groups. However, the data of follow-up for half a year, one year and two years showed that the pain score and activity ability of patients in endoscopic surgery group were significantly improved [9]. The advantage of endoscopic surgery comes from the visualization operation during the operation, which can completely cut off the target nerve, and will not be completely damaged by tissue resistance like radiofrequency ablation. The review of streeter Mann's team also recognizes the long-term advantages of endoscopic surgery, and the painless period of patients after surgery is longer; But at the same time, it also objectively points out the shortcomings. This technology has high learning threshold, long operation time and higher cost of supporting equipment [10].

3.4. Surgical Management

All minimally invasive interventions have failed, and the pain seriously affects the daily life of patients. Finally, lumbar fusion surgery can be considered. Mobbs's review clearly listed facet-derived low back pain as the surgical indication of lumbar interbody fusion. The logic of operation is to fix the diseased segment and eliminate the abnormal activity of facet joints, so as to relieve pain [11]. However, open surgery is traumatic, and the risk of complications is higher, and it will also change the original stress mode of lumbar spine. Therefore, the criteria for screening surgical patients must be strict and cannot be recommended at will.

4. Objective Reflection and Industry Controversy: There are Many Loopholes in The Existing Treatment Ideas

Although all kinds of minimally invasive interventional surgery have been widely used in clinic, the highest level of evidence-based medicine research has raised many questions about the actual efficacy of this kind of surgery. The randomized controlled trial of COPE published by Truong et al. in RMD Open in 2024 is regarded as the most influential related research in recent years. In the experiment, patients with facet joint-derived low back pain were divided into three groups: cryoneurolysis group, radiofrequency ablation group and sham operation placebo group. All patients were given rehabilitation physiotherapy around the operation. The results were a little unexpected. The core index of four-week follow-up (self-evaluation of patients' overall improvement), the comparison of two kinds of destruction surgery and placebo, there was no significant advantage at the statistical level; Most minor indicators, such as pain degree, quality of life, dysfunction, etc., have no obvious difference among the three groups [12].

The results of this study deserve our calm down and reflection on several practical problems:

First, the placebo effect is far stronger than we expected.

Invasive operation of pain diseases will give patients strong psychological hints, and the surgical effects observed in the past may be mixed with a lot of non-specific psychological effects.

Second, there is still much room for optimization of patient screening criteria. Even if the standardized diagnosis of block is completed, the existing screening criteria are still not fine enough. Perhaps we need biomarkers and predictive models to distinguish which patients will benefit more from nerve damage surgery.

Third, supporting comprehensive treatment is essential. In the COPE experiment, all subjects received physical therapy at the same time, which also showed that nerve damage surgery could not be used as a radical cure alone. For patients with chronic low back pain, interventional surgery is more like a "breakthrough". Interrupting the continuous pain cycle first, followed by systematic rehabilitation training, is the key to stabilize the long-term curative effect and restore the activity ability.

5. Conclusion and Prospect

At present, the clinical diagnosis and treatment of low back pain caused by facet joints is at the transition node. On the one hand, a large number of clinical evidence is constantly updated, on the other hand, the overall diagnosis and treatment thinking of the industry is slowly changing to the direction of precision and minimally invasive.

The follow-up complete diagnosis process can be constructed as follows: firstly, the patient's typical symptoms and physical examination results are highly suspected of minor joint pain, and then the final diagnosis is completed by relying on standardized images to guide contrast block; When patients are anxious, sedation can be used as appropriate, which can not only alleviate the pain during operation, but also avoid false positive results. If the block result is definitely positive, radiofrequency ablation is preferred in clinical routine scheme, and electrodes are placed in parallel as far as possible during operation to ensure the complete range of nerve damage; Endoscopic neurotomy is an alternative, and relying on intraoperative direct vision, the long-term analgesic effect is more likely and more lasting. However, one thing can't be ignored. No matter which interventional operation is chosen, the whole intervention process must be matched: explain the disease principle to the patient, objectively explain the operation expectation, and then cooperate with core muscle group training, posture correction, systematic physical therapy and other rehabilitation contents to reduce the recurrence and restore the lumbar motion function for a long time.

To be honest, in order to properly handle the low back pain caused by facet joints, doctors should not only skillfully operate all kinds of minimally invasive instruments, but also look at the surgical effect objectively with evidence-based thinking, evaluate the patient's situation from an overall perspective, and find a balance between accurate intervention and long-term rehabilitation management.

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