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# Advances in Chinese and Western Diagnosis and Treatment of Bertolotti Syndrome

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**Abstract:** ***Bertolotti syndrome (BS), also known as fifth lumbar transverse process hypertrophy syndrome, is a clinical syndrome characterized by lumbosacral translocated vertebrae (LSTV), and is a relatively rare but easily overlooked chronic lower back pain condition. As a relatively rare but easily overlooked structural disorder, BS has long been categorized as "nonspecific lower back pain" in clinical practice. Nowadays, people's attention to lumbosacral migratory vertebrae causing low back pain has been increased, and the diagnosis and treatment of BS have been reported to be increasing in the international literature year by year. Through reviewing the relevant literature at home and abroad in recent years, the author found that Western medicine has made more in-depth research on the imaging and surgical interventions of BS, but lacks breakthrough treatments for the recurring lumbar pain, whereas traditional Chinese medicine has achieved certain clinical efficacy through the combination of traditional Chinese medicine, acupuncture, and massage. Traditional Chinese medicine (TCM) has achieved certain clinical efficacy through a combination of traditional Chinese medicine, acupuncture, tuina and other means, but more research is needed on the material basis and mechanism of its effect. However, more research is needed on the material basis of its effect and its mechanism of action. The combination of Chinese and Western medicine shows unique advantages in precise localization of lesions and improvement of pain and function, which is worthy of further in-depth study. In this paper, we review the Chinese and Western medicine diagnosis and treatment of BS, aiming to provide new ideas and methods for the diagnosis and treatment of BS.***

**Keywords:** Lumbosacral migratory vertebrae, Low back pain, Pseudoarthrosis, Chinese and Western medical treatment, Imaging diagnosis.

## 1. Introduction

LSTV is a common anatomical variant of the spine that refers to abnormal connections or morphological changes in the transition region between the lumbar and sacral vertebrae. Specifically, lumbosacral translocation vertebrae manifest as partial or complete fusion of the fifth lumbar vertebrae with the sacral vertebrae (lumbar sacralization) or partial or complete separation of the first sacral vertebrae from the lumbar vertebrae (sacral lumbarization) [1]. There are many clinical causes of low back pain, but only when LSTV leads to clinical symptoms such as low back pain and radiating pain in the lower extremities can it be called BS. The clinical manifestations of BS are varied, and clinicians do not pay much attention to it, and the syndrome is often misdiagnosed as lumbar intervertebral disc herniation, lumbar microarthritis, or sacroiliac arthropathy, which leads to inappropriate treatment and delays in the condition. The pathogenesis of BS is complex, and both its diagnosis and treatment There are certain challenges [2]. Western medicine explains the pathogenesis of BS from an anatomical and biomechanical point of view, and adopts a variety of treatment methods, such as drugs, physics, intervention, and surgery; traditional Chinese medicine (TCM) attributes BS to the categories of "lumbago" and "paralysis", and adopts a holistic concept of treatment, using the idea of identification of evidence and adopting a variety of treatment methods, such as traditional Chinese medicine, acupuncture, and tuina. In recent years, significant progress has been made in the management of low back pain by combining Chinese and Western medicine. By reviewing the relevant literature on BS research at home and abroad in recent years, the author summarizes the Chinese and Western medicine diagnosis and treatment of BS, with a view to guiding the clinical treatment.

## 2. Progress of Research on Western Medical Treatment of BS

### 2.1 Pathogenesis in Western Medicine

The pathogenesis of BS has not been fully elucidated, and it is generally believed that the pseudojoint formed by the transverse process of the LSTV and the sacrum or ilium can undergo degeneration or inflammatory reaction and become a source of pain. The report of Adams [3] et al. concluded that cartilage degeneration, osteophytes and synovial inflammatory changes were seen at the pseudojoint, which were positively correlated with clinical symptoms. Secondly, LSTV leads to a reduction in the number of mobile segments in the lumbar spine, which increases the stresses on the adjacent discs and small joints and accelerates degeneration. It was found [4] that patients with type II LSTV may have nerve root compression manifestations, and neurogenic pain may occur if the pseudojoints or bony cribriforms at the LSTV irritate or compress the neighboring nerve roots. Zhu [5] et al. found that the incidence of degeneration of the superior discs in LSTV was significantly higher than that in the general population. For unilateral LSTV, local stress imbalance may lead to vertebral rotational instability, which increases the stress load on the sacroiliac joints and contralateral small joints, triggering pain, and the incidence of contralateral sacroiliac joint pain in patients with unilateral LSTV is significantly higher than that in the general population.

### 2.2 Clinical Manifestations and Diagnostic Methods

The clinical manifestations of BS are diverse, and the most common symptom is low back pain, which is usually chronic, intermittent, dull or stabbing, located in the lumbosacral or gluteal region, and is mostly unilateral, in line with the side

where LSTV is located, or it may manifest as bilateral or contralateral pain. The pain is often aggravated by prolonged sitting, standing, bending or heavy physical activity and relieved by rest [6]. When the enlarged pseudoarthrosis compresses the nerve roots, patients may experience radiating pain in the lower extremities, often along the L5 or S1 nerve roots, but imaging may not show clear evidence of nerve root compression. LSTV reduces lumbar spine mobility, and therefore patients may experience limited lumbar spine mobility, especially forward flexion and ipsilateral lateral flexion. At the same time, LSTV also causes tension and spasm in the peripheral spinal musculature, and palpation may reveal pressure points, and some patients may be accompanied by sacroiliac joint pain, lumbar spondylolisthesis, scoliosis, or intervertebral disc degeneration and other related symptoms [7], and most of them are located in the junction of the transverse process of the LSTV with the sacrum or the ilium.The BS may overlap with other low back pain disorders to a certain extent in terms of clinical manifestations, but in terms of imaging, it is usually possible to clearly detect the presence of LSTV (lumbosacral translocated vertebrae). In patients with suspected BS, other common causes of low back pain should be ruled out or identified with the help of various imaging methods such as X-ray, CT and MRI on the basis of careful history taking, appropriate functional tests and routine lumbar spine and sacroiliac joint examinations [8].

Confirmation of the diagnosis of BS centers on imaging evidence. Traditional radiographs can show the features of LSTV, including transverse process hypertrophy, fusion, and pseudoarthrosis. Meanwhile, CT scanning and three-dimensional reconstruction can further clarify the bony structural variations; MRI is helpful to evaluate the intervertebral discs, vertebral endplates, nerve root compression, and soft tissue alterations, etc. [9].There is no internationally recognized diagnostic criterion for BS, and it is usually based on a combination of the following: first, the patient has persistent or recurring low back pain, which is often unilateral and located in the lumbosacral or gluteal region; second, the presence of LSTV is confirmed by imaging, and localized physical examination is positive; and second, the presence of LSTV is confirmed by radiography. The presence of LSTV and positive local physical examination (pressure pain at the pseudo joint or positive special evoked test); Third, diagnostic injection has a relieving effect on symptoms, i.e., injection of local anesthetics and glucocorticosteroids into the pseudo joints of LSTV or the related nerve roots, and observation of symptomatic improvement, which can be used as a method to clarify the source of pain and to predict the effect of treatment; Fourth, there is no other clear etiology of low back pain[10].

**2.3 Western Medical Treatment Methods and Progress**

Bertolotti's syndrome (BS) is centered on the structural abnormalities and pain caused by LSTV, and the goals of treatment are to alleviate pain, reduce local mechanical irritation, and restore spinal stability. Castellvi's classification method can visualize the degree of spinal biomechanical alterations caused by LSTV, and it also provides a reference for clinical diagnosis and selection of intervention strategies [11]. It also provides a reference for clinical diagnosis and selection of intervention strategies [11]. Western medical treatment mainly includes conservative treatment and surgery. For BS patients with mild to moderate symptoms and no obvious signs of instability, conservative treatment, including medication, physical therapy and rehabilitation training, is usually adopted first.

2.3.1 Conservative treatment

Medication is one of the important conservative treatments, and conventional pharmacologic interventions are effective in relieving pain and muscle spasms. Nonsteroidal anti-inflammatory drugs (NSAIDs) such as ibuprofen and diclofenac sodium have anti-inflammatory and analgesic effects, which can alleviate patients' pain symptoms. These drugs reduce the inflammatory response by inhibiting the synthesis of prostaglandins in the body, which results in pain relief [12]. Muscle relaxants such as chlorzoxazone are helpful in relieving lumbar muscle tension. When the patient's lumbar muscles are tense, it will increase the pressure on the lumbar spine and aggravate the pain symptoms, and muscle relaxants can relax the muscles and reduce the pressure on the lumbar region. For those with high pain intensity or neurogenic symptoms, a short-term combination of weak opioid analgesics (e.g., tramadol) or neuromodulators (e.g., pregabalin, gabapentin) may also be used to strengthen the analgesic effect. Although medication is a relatively simple and initially effective means, it is necessary to be alert to the gastrointestinal, hepatic, renal and addiction risks associated with long-term high-dose use of NSAIDs or opioids, so patients are usually advised to use medication in phases and intermittently according to the fluctuation of the pain situation, and try to avoid overdependence [13].

Local block therapy is also an effective conservative treatment. Epidural injections of steroids or anesthetic drugs, such as triamcinolone acetonide and lidocaine, at the pseudoarthrosis or intervertebral foramen can reduce the local inflammatory response and relieve pain. These drugs can act directly on the lesion, inhibit the release of inflammatory mediators, and reduce nerve compression and irritation [14]. If the symptoms are rapidly relieved after injection, it can be one of the important bases for the diagnosis of BS. However, the effect of local block therapy is often temporary and requires multiple injections.

However, for some patients, it is difficult to achieve satisfactory pain relief with conservative treatments alone, or the pain may recur over time and worsen with impaired function. At this time, interventional therapy can be considered, through minimally invasive means to act more directly on the lesion or nerve conduction pathway, to achieve more efficient and long-lasting analgesic effect. Common interventions include local injections and radiofrequency (RF) ablation: local injections (e.g., pseudoarticular cavity or nerve root blocks) provide rapid pain relief from pseudoarticular wear and tear or nerve irritation, while RF ablation "denervates" or modulates the nociceptive pathways so that pain signals are not transmitted efficiently. Pulsed radiofrequency (RF) is an alternative to traditional RF with intermittent pulses to minimize thermal damage, resulting in fewer side effects and complications and a wider range of patients [15, 16].

2.3.2 Surgical treatment

Traditional surgery mainly consists of resection of the transverse process on the diseased side and decompression of the nerve root [17]. For patients with ineffective conservative treatment, severe pain or preexisting significant segmental instability, and severe disc degeneration affecting the quality of life, surgical treatment becomes another option. Traditional surgery can directly remove the cause of the disease and reduce nerve compression. Transverse process resection targets the most direct "abnormal structure" of LSTV - the abnormally enlarged transverse process and its articulating surfaces with the sacrum or ilium are completely removed through surgery to avoid bony contact and pain caused by abnormal friction. During surgery, the area of the lesion is exposed by incising the skin and muscles, and the hypertrophied transverse process is removed, relieving the compression on the nerve root. When removing the transverse process, care needs to be taken to protect the surrounding nerves and blood vessels to avoid injury [18]. However, traditional surgery is more traumatic, with longer postoperative recovery time, and complications such as infection and bleeding may occur. Minimally invasive surgery has been widely used in recent years, with the advantages of less trauma and faster recovery. Common minimally invasive surgical procedures include microscopic or endoscopic hypertrophic transverse process resection and intervertebral foraminoscopic decompression. Microscopic or endoscopic surgery can accurately remove the enlarged transverse process and decompress the nerve root through a tiny incision with the magnifying effect of microscope or endoscope. Intervertebral foraminal decompression, on the other hand, is performed by creating a channel at the intervertebral foramen and utilizing the intervertebral foramina to directly observe and decompress the nerve root. Research has shown [19] that a follow-up study of 16-year-old adolescent BS patients who underwent endoscopic treatment found that the patients experienced significant relief of pain symptoms after the procedure and returned to the basketball court 3 months after the procedure. Minimally invasive surgery provided similar levels of postoperative pain relief compared to conventional surgery, but minimally invasive patients had shorter hospital stays, faster postoperative recovery, and lower complication rates. [20, 21, 22]

## 3. TCM's Understanding of BS

### 3.1 Chinese Medicine Etiology and Pathogenesis

Chinese medicine, although there is no direct record of "BS", but according to its clinical manifestations, can be attributed to Chinese medicine, "lumbago", "paralysis" category. Huangdi Neijing said: "the waist of the kidney of the house, turn shake can not, the kidney will be exhausted", revealing the close relationship between the kidney and low back pain. Chinese medicine believes that the occurrence of this disease is mainly related to qi and blood stasis, deficiency of liver and kidney, and exogenous evil factors. Qi and blood stagnation is one of the important etiologic mechanisms. The lumbar region is the capital of the kidney, and various causes of poor qi and blood circulation in the lumbar region, such as trauma and labor injury, can cause qi and blood stagnation, meridian obstruction, and pain when there is no circulation. When the lumbar region is hit by external force or overworked for a long time, the local circulation of qi and blood is hindered, forming blood stasis, which blocks the meridians and channels, preventing the normal circulation of qi and blood in the lumbar region, thus causing pain [23]. the body's liver and kidneys gradually deficient, or due to the lack of innate endowment, prolonged illnesses and labor injuries, resulting in the insufficiency of the essence of liver and kidneys, which is not able to nourish the waist's tendons and bones, so that the waist's bones and muscles become fragile and prone to injuries, which can lead to pain. In addition, Liver and kidney deficiency also play a key role in the onset of the disease. These etiologic factors and mechanisms interact and work together to lead to the complex clinical manifestations of BS.

In general, BS is dealt with in the TCM category as "low back pain" or "paralysis", and the pathogenesis often involves kidney deficiency, blood stasis, wind-cold-dampness, phlegm-dampness obstruction, and other aspects. The TCM dialectical view emphasizes holistic regulation--not only considering the relationship between internal organs, meridians, qi and blood, but also incorporating the assessment of individual factors such as the patient's physical differences, external climatic environment, and work habits [24]. Through the comprehensive intervention of "combining internal medicines and external treatments, overall adjustment and focused treatment", recurrent episodes of low back pain can be prevented, and the long-term lumbosacral burden brought by LSTV structural abnormality can be alleviated to a certain extent, so as to improve the overall function and quality of life of the patients.

### 3.2 Traditional Chinese Medicine (TCM)

Chinese medicine treatment of BS is based on the Syndrome Differentiation and Treatment. For the liver and kidney deficiency type, commonly used formulas include Liu Wei Di Huang Wan and Jin Gui Ren Qi Wan. Jin Gui Ren Qi Wan, on the other hand, is based on Liu Wei Di Huang Wan, with the addition of Gui Zhi and Fuzi, to warm and tonify kidney yang, and is suitable for patients with kidney yang deficiency. Network pharmacological studies have shown [25] that Liu Wei Di Huang Wan can regulate cell proliferation and apoptosis, promote angiogenesis, inhibit inflammation and oxidative stress, thus nourishing the liver and kidneys and strengthening the muscles and bones. Patients with qi stagnation and blood stasis type are commonly treated with the addition of Shentong Zhuyu Decoction. Modern pharmacological studies have found [26] that a total of 59 chemical components and 24 serum migratory components were identified in Shentong Zhuyu Decoction, which can improve local blood circulation, promote the absorption of blood stasis and have good analgesic effects. Patients with cold-damp paralytic obstruction type can use Duhuo Jisheng Decoction. Experimental studies have shown [27] that Chuanxiaong Rhizoma in Duhuo Jisheng Decoction can increase osteogenic activity in hMSCs by activating SMAD 1/5/8 and ERK signaling, up-regulate BMP-2 and RUNX2, and inhibit inflammatory responses and reduce joint pain and swelling by activating SMAD 1/5/8 and ERK signaling for gene expression. Damp-heat blocking type patients are often used to add flavor to Si Miao Wan, and when adding flavor, other drugs that clear heat and eliminate dampness, clear the

channels and relieve pain can be added according to the specific symptoms.

### 3.3 Research on BS Single Flavor Herbal Medicines

In addition to prescriptions, some single-flavored Chinese medicines also have therapeutic effects. For example, Eucommia ulmoides is a commonly used traditional Chinese medicine, which is warm and sweet in nature, and belongs to the liver and kidney meridians, with the effects of tonifying the liver and kidney and strengthening the muscles and bones. It has been found [28] that various active ingredients in Eucommia ulmoides can exert anti-inflammatory and analgesic effects by lowering the levels of inflammatory cytokines (e.g., TNF-α, IL-1β, and IL-6). Cortex Eucommia ulmoides can bring benefits at dual levels: on the one hand, it inhibits the release of inflammatory mediators by regulating the nuclear factor kB (NF-kB) signaling pathway, thus reducing the irritation of the pseudojoints and soft-tissue edema, and indirectly relieving pain; on the other hand, Eucommia ulmoides has a regulating effect on skeletal cells, accelerating the repair and regeneration of bone tissues, and further reinforcing the stability of the lumbar vertebrae and its surrounding structures, which is particularly suitable for those with BS combined with tissue degeneration. In addition, in tonifying the liver and kidney and enhancing muscle strength, eucommia ulmoides may avoid the imbalance of muscle strength caused by prolonged pain and improve the tolerance of daily activities. Clinically, eucommia ulmoides is usually used in soups or pills, accompanied by products that nourish the kidney and activate blood, such as Dipsaci Radix and Achyranthes bidentata, so that the lumbosacral region can obtain better blood transportation and mechanical support through the combination of internal use and functional training. Modern pharmacological studies have pointed out [29, 30] that the total saponins and flavonoids contained in hyssop have multiple biological properties such as anti-inflammatory, analgesic and regulation of bone metabolism, and its mechanism of inhibiting the scorched death of intervertebral disc fibrous annulus cells may be related to the regulation of the Wnt/β-catenin signaling pathway. The response to chronic lesions in the joints of the lower limbs and the lumbar and knee regions is particularly significant. Pharmacological studies have found [31, 32] that the effects of Dipsaci Radix and its extracts on the treatment of osteoarthritis are mainly exerted through the protection of chondrocyte and tissue integrity. rhizoma drynariae and Dipsaci Radix are commonly used as a clinical drug pairing to intervene in the further progression of osteoarthritis. Taken together, single herbs have potential applications in the prevention and treatment of BS, which can help reduce local chronic inflammation, promote bone tissue remodeling, and play a positive role in improving lumbar function, which is worthy of further in-depth research and development.

### 3.4 Acupuncture and Tuina Therapy

Acupuncture treatment for BS often selects acupuncture points in the lower back and lower limbs. The main acupuncture points include kidney acupoints, Weizhong Acupoints, Yaoyangguan, and large intestine shu. By stimulating specific meridian points, acupuncture can, on the one hand, dredge the meridians and channels, run qi and blood, and reduce soft tissue tension and stasis due to lumbar sacralization, thus relieving pain and muscle spasm; on the other hand, it can also balance central and peripheral neuromodulation, inhibit the release of excessive inflammatory factors, and assist in the alleviation of localized edema and nerve compression [33, 34]. Tuina, on the other hand, has an important role in restoring the elasticity of soft tissues and joint mobility, and correcting abnormal postures through the manipulation of lumbosacral muscles, joints, and ligaments to release fascial adhesions, improve blood circulation, and relax tense or contracted muscle groups [35]. The combination of acupuncture and tuina can enhance the analgesic effect and emphasize the restoration and coordination of overall function [36]. Moderate massage techniques can help loosen potential trigger points and nodes, enhance blood and lymphatic return after acupuncture, and accelerate the metabolism of aseptic inflammatory products; the precise stimulation of meridian acupoints can stabilize the excitation and inhibition of the nervous system, and with the means of "point kneading, rolling and pressing, and orthopedic bone setting" in Tui na to adjust the mechanical structure, gradually reducing the pain caused by transverse pseudojoints or vertebrae, and gradually reducing the pain caused by transverse pseudojoints or vertebrae. This can gradually reduce the recurrent pain caused by trauma to the transverse pseudo joints or intervertebral joints. Zheng Xi et al [37] found that in a randomized controlled study of 70 patients with low back pain, the total effective rate, JOA score, and peroneal nerve and superficial peroneal nerve conduction velocities of the acupuncture and massage group were significantly higher than those of the control group before treatment. Warm acupuncture and moxibustion combined with manipulative tuina treatment, the therapeutic effect is accurate, can help pain relief and symptomatic improvement, and is conducive to the recovery of patients. In these studies, it is illustrated that acupuncture and massage in the treatment of BS can not only effectively relieve pain, but also improve the mechanical environment of the lumbosacral region, which is of unique and important significance in reducing the recurrence of the disease and promoting the functional stabilization.

### 3.5 Other External Chinese Medicine Treatments

External treatments include herbal fumigation, medicated rubbing and plastering, which can improve local blood circulation and relieve pain symptoms. The use of Chuanxiong Rhizoma, peach kernel and Honghuar, which invigorate blood circulation and remove blood stasis, or cinnamon sticks, fine acacia and moxa leaves, which warm the meridians and open the collaterals, to make lotions or plasters, supplemented by hot compresses, may have a certain analgesic and anti-inflammatory effect. Cupping therapy is a common method used in TCM to treat low back pain. Cupping therapy, by drawing cupping pots on the painful parts of the lower back or related acupoints, can make the pots form negative pressure, adsorbed on the skin, promote the local qi and blood operation, dispersing cold and removing dampness, and clearing the collaterals and relieving pain. Zhang et al. showed that [38], cupping therapy can increase the local skin temperature of patients with low back pain, increase blood flow, and alleviate the muscle spasms.

## 4. Summarize

As a chronic low back pain syndrome caused by congenital "transitional vertebrae", BS has certain complexity and diversity in clinical practice. Western medical treatments have matured from conservative treatments to surgical interventions, but there are still controversies about long-term efficacy, timing and indications for surgery. Chinese medicine, on the other hand, has accumulated rich experience in the overall management, rehabilitation and functional reconstruction of chronic low back pain, and has demonstrated possible efficacy in acupuncture, massage and internal-external combination therapy, although research on BS is still limited. The combination of Chinese and Western medicine is expected to provide a personalized and comprehensive treatment plan for this disease by combining local and holistic approaches and regulating structure and function together. Future research should focus on the combination of basic and clinical aspects, in-depth exploration of pathogenesis, optimization of diagnostic and therapeutic strategies, and promotion of the in-depth integration of Chinese and Western medicine to provide more effective diagnostic and therapeutic services for patients.

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