Acta Neurochir (2005) [Suppl] 92: 87–92

Printed in Austria

CT-guided oxygen-ozone treatment for first degree spondylolisthesis and spondylolysis

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Summary

Aim of this study was to assess the therapeutic outcome of CT-guided periganglionic infiltration of oxygen-ozone and injection of the gas mixture into the lysis points in patients with first grade spondylolisthesis and spondylolysis. We selected 18 patients presenting with low back pain and sciatica resistant to physical and medical management with a radiological diagnosis of spondylolisthesis and spondylolysis subsequently confirmed on CT scan. Following CT-guided bilateral periganglionic O_2-O_3 infiltration and injection into the lysis points, 15 patients (83.3%) obtained a complete remission of pain. None of the patients reported pain recurrence at clinical follow-up visits one, three and six months after treatment.

Oxygen-ozone therapy administered in this way is even more effective than CT-guided periganglionic infiltration alone as it has an additional anti-inflammatory and analgesic effect on the nerve structures in the neural arch, namely Luschka's recurrent nerve.

Keywords: Spondylolisthesis; spondylolysis; oxygen-ozone therapy; low back pain; sciatica.

Introduction

Spondylolysis is a bony defect of the neural arch, i.e. the part of the vertebral arch between the superior and inferior spinal processes. If the bony defect results in a forward shift of one vertebral body on another, this is called spondylolisthesis (a term coined by Kilian in 1854) [1, 25]. Symptoms include local pain varying in intensity and hyperlordosis of the lumbar spine. Spondylolisthesis is not a constant finding but when present it tends to gradually worsen. Diagnosis of spondylolysis is based on neuroradiological investigation, namely standard lateral and oblique x-ray views. Axial CT scan is an additional imaging technique used to determine the listhesis and demonstrate other lesions to the neural arch likely to supply information on the state of the intervertebral disc [11, 23, 24, 26].

Treatment varies in relation to the time of diagnosis [21]. During childhood and adolescence, i.e. the period of peak evolution and hence exacerbation of listhesis, an aggressive approach is required, warning relatives of possible evolution and the need for regular clinical and radiological monitoring even in the absence of symptoms. Conservative treatment involves physical exercises aimed at strengthening the abdominal and gluteal muscles to correct the exaggerated pelvic antiversion which often accompanies spondylolysis and is the result and also the cause of further worsening. Patients must avoid lifting heavy loads and sports or work entailing functional overload of the lumbosacral girdle [15]. When symptoms are present or forward subluxation is demonstrated, surgical decompression is necessary. The operation consists in fixing the sliding vertebra to the vertebral bodies above and below. For mild or moderate spondylolisthesis, the surgical treatment is in situ arthrodesis, i.e. fusion without reducing the forward shift. The postoperative course entails prolonged bed rest (from three to six months) until the graft has taken and fusion is complete [3, 4, 10, 14, 18, 20, 22]. Further vertebral dislocation leads to spondyloptosis, i.e. the sliding vertebral body falls in front of the underlying vertebra. Treatment for this severe condition is still the subject of controversy. Attempts at reducing spondyloptosis by different methods (Harrington, Bradford, Scaglietti) carry a high risk of neurological defects and caudal symptoms due to stretching of the nerves or roots during reductive manoeuvres. For these reasons, in most cases the spine is stabilized in position or the fifth lumbar vertebral body is removed fixing the fourth body to the sacrum.

We assessed the outcome of oxygen-ozone treatment in patients with first grade spondylolisthesis and spondylolysis administered by CT-guided periganglionic infiltration and injection of the gas mixture into the lysis points in the neural arch.

Classification

Congenital

Type A: abnormalities of the lumbosacral region are associated with occult L5-S1 spina bifida and incomplete development of the spinous processes with axial orientation of the facet joints. These combined factors preclude excess weight-bearing and lead to listhesis. The neural arch may be intact if the forward shift of the vertebral body does not exceed 35%. The male-female ratio shows a slight male prevalence for congenital forms. Both dysplastic abnormalities and neural arch spondylolisthesis have a genetic mechanism.

Type B: impaired congenital orientation of the spinous processes whose posterior parts are underdeveloped. Subluxation occurs due to instable orientation of the facet joints which are rotated rather than sagittally oriented.

Type C: other congenital abnormalities giving rise to a predisposition towards spondylolisthesis are: congenital kyphosis and abnormal development of the vertebral bodies.

Neural arch (fractures of the pars interarticularis)

Type A: are due to a separation of the pars interarticularis caused by a stress fracture. The lesion is rare below the age of five years and most commonly encountered between the ages of 5.5 and seven years. Already children may well have an anatomical predisposition for pars fracture. It is not known whether the pars is fractured in flexion or extension.

Type B: lengthening of the neural arch without fracture. This is secondary to repeated microfractures which allow the pars to recover in elongation when the body of L5 is shifted forward. A common congenital component may underlie all variations of congenital and neural arch forms of spondylolysis.

Degenerative

Lesions are due to longstanding intersegmental instability following multiple small fractures resulting from compression by the inferior spinous processes of the vertebra which is shifted forward. Tropism of the facet joints is important: when present one side slides more than the opposite one with rotation of the vertebra at the level of the listhesis. This form is six times more common in women than men and from six to nine times more common at L4. Forward displacement does not exceed 33%.

Post-traumatic

The lesion is secondary to acute injury which breaks the weight-bearing bony structures causing forward shift of one vertebral body on another. It is always the result of severe trauma.

Pathological

This form is encountered in local or disseminated bone disease.

Post-surgical

The lesion is due to a complete or partial loss of posterior bone support or disc support or a stress fracture of the inferior spinous processes following surgery.

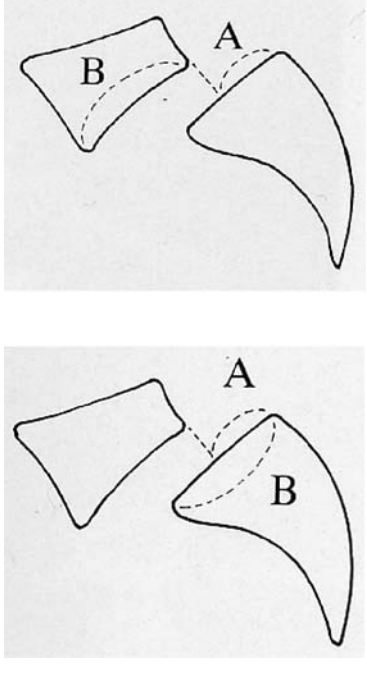

Fig. 1. Meyerding's grades.
1° = A/B = 0–33%
2° = A/B = 34–66%
3° = A/B = 67–99%
4° = 100% and spondyloptosis

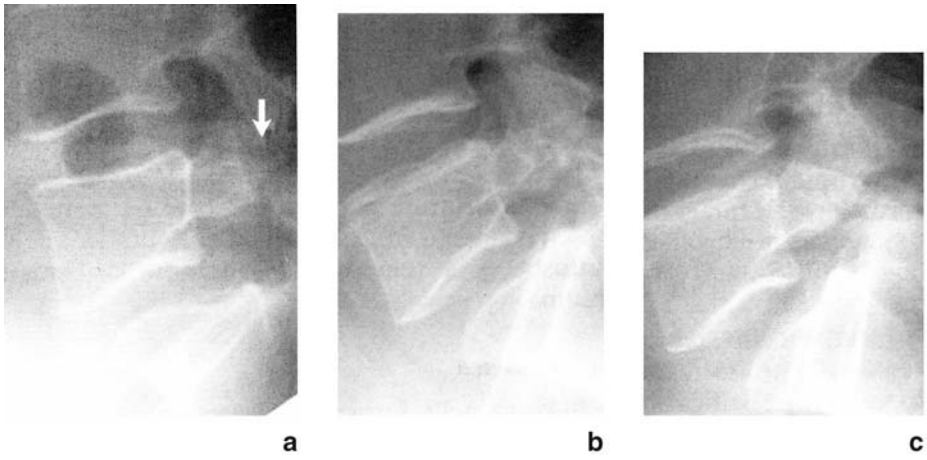

Fig. 2(a–c). Standard x-ray with morphodynamic tests (flexion-extension): First grade spondylolisthesis according to Meyerding with bilateral isthmic spondylolysis (a) standard view, (b) flexion, (c) extension

Meyerding's classification

The degree of forward shift of one vertebral body on another is measured as a percentage according to Meyerding's classification (Fig. 1 A–B) [19]:

Grade I 0–33%
Grade II 34–66%
Grade III 67–99%
Grade IV 100% and spondyloptosis

Materials and methods

In our series, from November 2001 to September 2002 we treated 18 patients aged between 24 and 42 years (mean 32.6), 12 men and six women with low back pain and sciatic secondary to first grade spondylolisthesis with spondylolysis. On enrolment, a case record was drawn up for each patient listing: name, date of birth, date of enrolment, date of treatment and information on the clinical examination defining the type of pain, irradiation, possible parasthesias, Lasègue's sign, degree of sensitivity, leg reflexes, plantar extension and dorsal extension of the big toe. All patients had previously undergone standard spine x-ray investigation including morphodynamic tests (flexion-extension) (Fig. 2) subsequently completed by computed tomography (CT) of the lumbosacral spine demonstrating spondylolisthesis complicated by spondylolysis (Fig. 3).

All patients were treated by CT-guided bilateral periganglionic infiltration of O_2-O_3 [2, 9, 12, 13] and O_2-O_3 injection into the lysis points in the neural arch. Treatment was administered in the day-hospital using the same infiltration technique adopted for discography after CT examination to fix the point of infiltration on the skin and subsequent measurement of the distance between the point marked and the root canal. The injection area was anaesthetised using ethyl chloride spray. A 22G 9 cm needle was used in all cases. Further CT scans were done to check the correct positioning of the needle in the periganglionic region and then in the lysis points (Fig. 4). We injected 3/4 cc of O_2-O_3 gas mixture at 25 µg/ml into the periganglionic area followed by another 3/4 cc of gas mixture into the lysis points. Another CT scan was done to display the correct distribution of the O_2-O_3 mixture (Fig. 5). All patients were monitored clinically for two hours before being discharged. The clinical benefit of treatment was almost immediate. Patients were then reassessed clinically one, three and six months later without repeating the treatment. No long-term CT follow-up was done. Treatment involved L5-S1 in 11 patients and L4-L5 in the remaining seven.

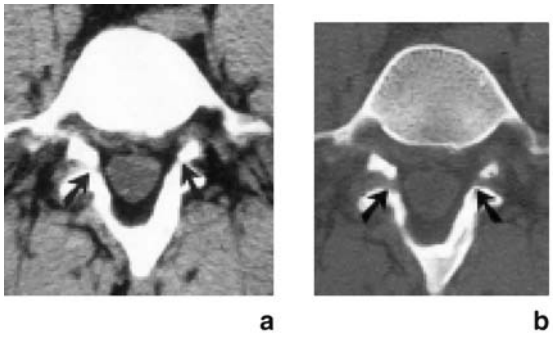

Fig. 3(a,b). CT diagnosis of isthmic spondylolysis (arrows) (a) standard reconstruction algorithm; (b) bone reconstruction algorithm

Results

Treatment outcome was assessed by a modified version of MacNab's method with clinical follow-up at one, three and six months after treatment as follows (table):

a) excellent: resolution of pain and return to normal working activity carried out before pain onset
b) good or satisfactory: more than 50% reduction of pain
c) mediocre or poor: partial reduction of pain below 70%.

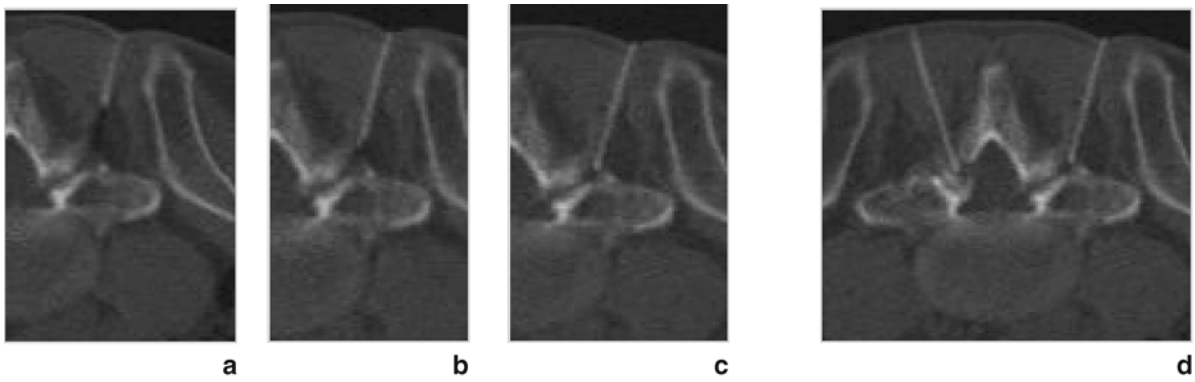

Fig. 4(a–d). Needle penetration to the lysis points under CT guidance (a–c) and correct needle placement (d) (arrowheads)

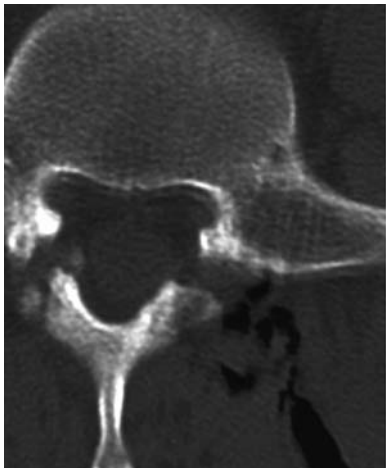

Fig. 5. CT image showing distribution of the gas mixture in the lysis points (arrowhead)

Of the 18 patients treated, 15 (83.3%) had a complete remission of pain immediately after treatment (Figs. 6, 7) subsequently confirmed at clinical follow-up one, three and six months later, whereas two patients (11.1%) had only a slight clinical improvement and one patient failed to benefit from O_2-O_3 administration. Of the 15 patients with excellent clinical outcome, two subsequently complained of sporadic episodes of ''bar-like'' back pain, but it was well tolerated and relieved by non-steroidal anti-inflammatory drugs when required. All the patients in the study were advised to consult a physiatrist/rehabilitation specialist to devise a programme of postural exercises for the purposes of treatment and prevention.

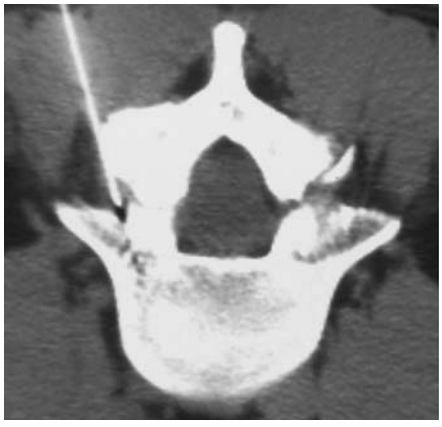

Fig. 6. A 31-year-old man was referred to us with several years' history of bilateral back pain and sciatica mainly on the right caused by Meyerding's first grade spondylolisthesis and bilateral isthmic lysis demonstrated on multiple radiograms (standard x-rays, CT and MR scans) which also disclosed accompanying marked concentric protrusion of the intervertebral disc with involvement of both root canals. No sensory or motor deficit was evident and for this reason none of the specialists consulted by the patient had proposed stabilizing surgery by means of intersomatic arthrodesis with interpedicular osteosynthesis.

Over the years, the patient had undergone numerous treatments in an attempt to relieve pain (massotherapy, laser therapy, postural exercise, ionophoresis, acupuncture and chiropractic) with little benefit. Pain-killers were not fully effective and had given rise to side effects poorly tolerated by the patient. The patient underwent O_2-O_3 infiltration in an attempt to achieve pain relief. CT display of correct positioning of the needle in the point of isthmic lysis

Discussion – conclusions

An explanation for such fast pain relief may be the twofold action of ozone in the perganglionic region

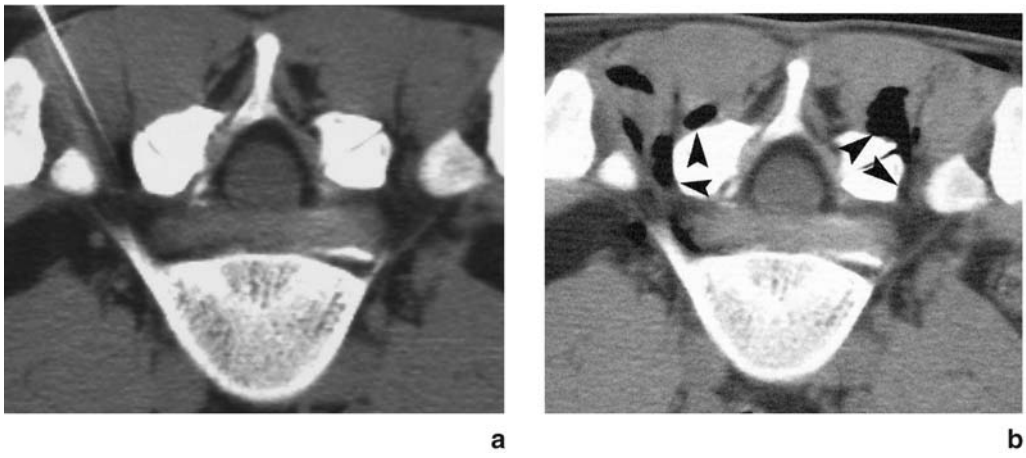

Fig. 7(a,b). (a) CT image of the needle (arrowhead) inserted into the periganglionic region, (b) distribution of the gas mixture in the periganglionic region and facet joints (arrowheads)

Table 1. *Assessment of therapeutic outcome at the time of treatment and one, three and six months later*

	Excellent	Good or satisfactory	Mediocre or poor
Immediate	15 (83.3%)		3 (16.7%)
At one month	15 (83.3%)		3 (16.7%)
At three months	13 (72.2%)	2 (11.1%)	3 (16.7%)
At six months	13 (72.2%)	2 (11.1%)	3 (16.7%)

(eutrophizing effect on the nerve roots compressed by protrusion accompanying listhesis) [16] and in the lysis points of the neural arch or pars interarticularis region innervated by Luschka's recurrent nerve.

The spine is innervated by the posterior primary branch and vertebral plexus or Luschka's recurrent nerve. The main posterior branch arises from the spinal nerve just outside the root canal: its medial branch innervates the capsule of the intertransverse joint, the dorsal muscles and the adjacent portions of the joint capsules of the metameres above and below; its lateral branch innervates the posterior skin of the trunk. Luschka's vertebral plexus, derived from the anterior part of the spinal nerve, moves medially to enter the spinal canal through the root foramen. It then exits to shunt with similar controlateral branches and those of the metameres above and below. The plexus innervates the vertebral bodies, end plates, external disc layers, posterior longitudinal ligament, dura and relative peridural tissues in particular the neural arch or pars interarticularis region (Fig. 8) [17].

Infiltration of the gas mixture directly proximal to the lysis points acts on Luschka's nerve by exploiting the well-known analgesic and anti-inflammatory effects of the oxygen-ozone mixture. Cytokine and

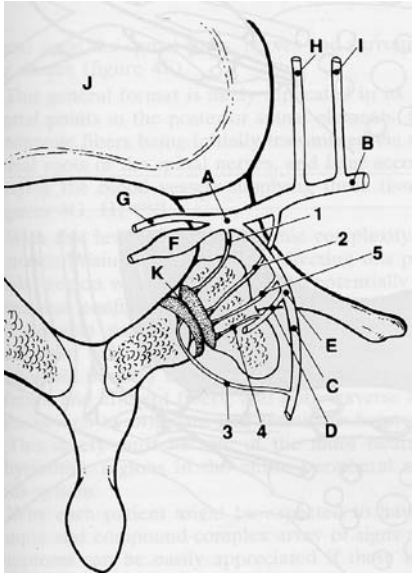

Fig. 8. Schematic diagrams outlining innervation of structures in the dorsal aspect of the spine: A) somatic-autonomic neural network innervating the dorsal spinal elements at or above the level of L2. (*1* neural fibers from the main trunk of the spinal nerve (*A*), *2* neural fibers from the ventral ramus (*B*) of the spinal nerve, *3* neural fibers from the lateral branch of the dorsal ramus (*C*), *4* neural fibers from the medial branch of the dorsal ramus (*D*), *5* neural fibers from the dorsal ramus (*E*) of the spinal nerve, (*F*) dorsal nerve root and ganglion, (*G*) ventral nerve root, (*H*) gray ramus communicans, (*I*) white ramus communicans, (*J*) intervertebral disc). From Jinkins JR "The pathoanatomic basis of somatic, autonomic and neurogenic syndromes originating in the lumbosacral spine" Rivista di Neuroradiologia 8 [Suppl 1]: 35–51, 1995

postaglandin levels are normalized with an increase in superoxide dismutase production and a reduction of reactive oxidant species [5–8]. Subsequent infiltration into the periganglionic region improves local circulation with a eutrophizing effect both adjacent to the nerve root compressed and injured by accompanying disc protrusion *and at the level of muscle spasm. The combined action accounts for the good final outcome*.

Fast pain relief without complications, relatively easy technical execution and full control of infiltration under CT guidance make oxygen-ozone administration a valid alternative to conservative treatment of first grade spondylolisthesis with spondylysis.

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