

Percutaneous Injection of Intradiscal and Paraspinal Space with O₂-O₃ Mixture to Treat Lumbar Disc Herniation

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SUMMARY - To evaluate the therapeutic effect and safety for the treatment of lumbar disc herniation using injection of intradiscal and paraspinal space with O₂-O₃ mixture. 258 patients were selected in the present study. All patients presented the symptoms of sciatica and low back pain. The diagnosis of the lumbar disc herniation including 70 bulging, 184 protrusion and 4 extrusion was verified by CT or MR imaging. O₂-O₃ mixture at 30-40 µg/mL and 19~21G puncture needles were prepared. The injection was conducted through the puncture of intradiscal and paraspinal space. For each herniated disc treatment, 4~6 mL O₂-O₃ mixture were injected into intradiscal space and 10-15 ml into paraspinal space. The patients were followed up from 3 to 28 months after treatment. The therapeutic effect showed that 160 patients (62%) had excellent recovery, and 39 cases (15.1%) had significant relief of symptoms, and 59 patients (22.9%) got failure in treatment. No any serious complication occurred. The therapeutic method developed by using O₂-O₃ mixture injection in lumbar intradiscal and paraspinal space was a safe and effective one for the treatment of the lumbar disc herniation.

Introduction

Ozone (O₃, MW=48) is a potent oxidant. It has more specific gravity, smell, color and easily dissolved in water comparing to oxygen. Ozone is decomposed into O₂ and O within twenty minutes in the room temperature. In 1988, Verga, an Italian physician, first injected O₂-O₃ mixture into paraspinal space to treat lumbar disc herniation. Then, Muto modified the technology and injected O₂-O₃ mixture into intradiscal space to treat the same disease in 1998¹. Continuously, the technology has been extensively applied in clinic in most European countries including Italy, France, Germany and so on. The therapeutic effectiveness has been certainly recognized and accepted by physicians. In 2000, we collaborated with Ospedale Bellaria Hospital in Italy and set up this project at our hospital in China. At the same year, we completed animal tests and reported this results with its methodology in the Journal of Zhong Hua Radiology^{2,3}. In the present paper, we will report the technology used and experience through summarizing 258 cases treated by ozone injection therapy at our hospital in recent years.

Methods

Clinical Data: Between November 2000 and April 2003, 258 patients with diagnostically confirmed lumbar disc herniation to enter the study. Their average age was 44.6 years old (ranging from 19 to 82 years old) and patients included 152 male and 106 female cases. All patients complained sciatica and low back pains which existed 3 months to 17 years. In physical examination, all patients showed Leasgue Sign positive reaction. Diagnostic verification by CT and MRI exhibited the disc herniation or protrusion with nerve root or thecal sac compression. Based on the CT or MRI images, the patients could be classified into three subgroups which are Bulding (70 cases), protrusion (184 cases), and extrusion (4 cases)^{4,6}. The disc lesions in all patients occurred between L4 to L5 and L5 to S1.

Instrument and facilities: One set of X-Ray machine with C arm was utilized in the study. The ozone generator (TOG C2) made in Switzerland was adopted. Pure Oxygen was supplied from our hospital. 19~21G chiba needles or 21G needle with multi side-hole were chosen as the injection needle.

Treatment Procedure: The patients lay down on the negative side with a pillow under their waist. The patient's negative side leg was kept in stretching position and positive side leg in flection. The anchoring point could be located in the positive side 7 to 9 cm away from middle line at the level of herniated disc space. Local anesthesia was done by injection of 2% Lidocain. The puncture was conducted via the posterior-outer side with 45-degree angle to reach the lesion lumbar disc space. When the position of the needle tip was verified, four to six ml of O₂-O₃ mixture with 30-40 µg/ml was injected into the inside of lessened disc. The O₂-O₃ mixture could be seen disperse into intradiscal space. If the patient had non-container herniated disk, the mixture gas was spread into the anterior epidural space. On the imaging vision, the needle was moved backward into intraforaminal space. Thereafter, fifteen ml of O₂-O₃ mixture and then fifty mg prednisolone were injected into this space. Drawing the needle out of the skin, we completed the procedure. Generally, the diskgraphy was not carried out in our routine procedure as it will increase the intradiscal pressure. During the injection of O₂-O₃ mixture, some patients felt local hot and mild pains but relieved in a short of time. The patient must be kept in bed for at least one day, and in home rest for two weeks. Antibiotic and cortisone intravenous injections were taken for three days. About sixty percent of patients accepted second injection of O₂-O₃ mixture during the period of one week to ten days. It's necessary that the patients avoid acute activities and heavy burden for six months.

Results

Evaluation of the therapeutic effectiveness was in accordance with the modified MacNab method which classified the effectiveness into success and failure categories (Please see the details from Muto and Avella in reference 1). We followed up all patients treated by O₂-O₃ mixture for three to twenty eight months after their therapeutic injection. Based on the modified MacNab criteria¹, the clinical effectiveness was evaluated for 258 cases in the present report. In the success group, 160 (62,0%) of 258 cases obtained complete recovery, and 39 cases achieved (15,1%) significant relief of symptoms. In failure group, 59 cases (22,9%) didn't gain any improvement (table 1). The effectiveness has been also evaluated according to classifications of lumbar disk herniation (table 2). 61 (87,2%) of 70 cases gained significant effectiveness in the group of patients suffered with bulging disc, and 132 (71,8%) of 184 cases in protrusion group, as well as 1 (25,0%) of 4 cases in extrusion group. The best response to the therapy can be seen in the group suffered with bulging disc herniation, and second level response from protrusion disc and extrusion disc with the lowest relief rate. The results showed that the therapeutic responses were related to the age. There was no difference between the groups of the young and the middle aged. The patients over 60 years got better

therapeutic response comparing to the other groups (table 3). 135 patients selected at random were followed up by CT and /or MRI three months after the intradiscal injection. Five cases showed a reduction in the size of the herniated disc (figure 1-6). Side reverse effects have been evaluated in this report. No any serious complication such as disc infection, spinal cord injury and large vessel damage occurred.

Discussion

Possible mechanism using O₂-O₃ mixture to treat the lumbar disk herniation: there exist uncertainty about the mechanism using the local injection of O₂-O₃ mixture into intradiscal space directly. Bocci, a physiologist in the Siena University in Italy hypothesized a mechanism⁷. Based on the hypothesis combining the results from our animal tests and human studies, we suppose the following possibilities on the mechanism using the local injection of O₂-O₃ mixture into intradiscal space.

Oxidation of proteoglycan in the nucleus pulposus: Ozone is a potent oxidant with half-life span of twenty minutes in normal temperature. The oxidation process finishes in a very short time. Ozone causes oxidation of proteoglycan in disc nucleus pulposus and makes its water loss, and then decreases the osmotic pressure of disc tissue. The disc nucleus exhibited dry up, degeneration, necrosis and atrophy, which lightened the compression of nerve root. In our animal experiments, this mechanism was verified by the dog disc nucleus appeared dry up, lost elastic features and became rough one month later after ozone injection in the intradiscal space. The degeneration, necrosis and atrophy of the dog disc nucleus were observed two to three months later, but there was no any disc change in the contrast group which received pure oxygen injection only^{2,3}.

Table 1 Evaluation of therapeutic effectiveness from 258 cases treated by injection of O₂-O₃ mixture into intradiscal space based on MacNab's criteria

Complete Recovery	Significant Relief	No improvement
160	39	59
62,0%	15,1%	22,9%

Anti-inflammatory action: The back pains and sciatica are caused not only by mechanical compression of herniated disc to the nerve root, but also by non-bacterial inflammation induced by local never root edema and effusion resulting from local venous circulation blockage. Meanwhile, the inflammatory factors such as histamine, β-protein and glycoproteins releasing from damaged discal tissue could stimulate the nerve root to cause the pains. It is possible for ozone injection into in-

Table 2 Evaluation of therapeutic effectiveness from 258 cases treated by injection of O_2-O_3 mixture into intradiscal space based on the classification of lumbar disc lesion

Disc Damage Types	Success/Total Cases	Percentage
Bulging Disc	61/70	87,2%
Protrusion Disc	132/184	71,8%
Extrusion Disc	1/4	25,0%

tradiscal and paraspinal spaces to relief the pains by blocking the release of inflammatory factors and directly expanding the blood vessels to improve local circulation, reduce local never root edema and conglutination.

Analgesic action: One hypothesis from acupuncture therapy of low back pain and sciatica believes that the acupuncture of fine needle into intradiscal and paraspinal spaces stimulate the inhibiting interneurons to produce enkaphalin-like substances which play an important role in the relief of pain. They called the acupuncture therapy as a "chemical acupuncture". The ozone therapy could relief

Table 3 Evaluation of therapeutic effectiveness from 258 cases treated by injection of O_2-O_3 mixture into intradiscal space based on the classification of patients' age

Age	Success/Total Cases	Percentage
Young (20 to 39 yrs)	61/70	76,2%
Middle (40 to 59 yrs)	132/184	73,0%
Old (more than 60 yrs)	1/4	82,6%

the pain within one to three days. It might be partially related to this pain relief pathway.

Evaluation of therapeutic effectiveness and achievement of better therapeutic responses: According to MacNab's evaluation criteria, the success rate was 75.9% in the present report which was equivalent to the success rates reported by Muto and Avella¹, Bocci⁷. About 26% cases gained symptom relief within 3 days after the therapeutic procedure. The therapeutic effectiveness shows that the therapeutic method creates minimum trauma, no side reverse effect, and proves to be very economical, and with high success rate (more than 70%). In order to

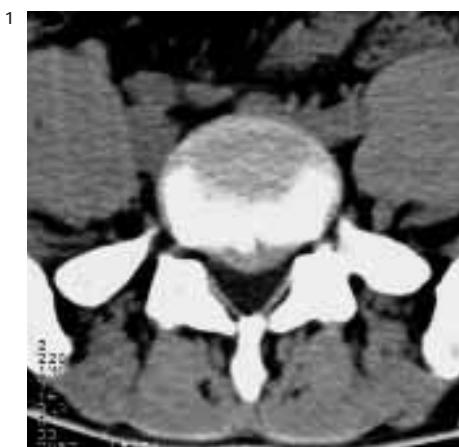


Figure 1 and 2 CT axial scans before (figure 1) and after (figure 2) intradiscal O_2-O_3 mixture injection in a 32 year-old male patient and suffering sciatica on the left for 2 years. The patient showed the Leasegue sign positive reaction in his physical examination, and lumbar disk protrusion in L5-S1 (figure 1). The patient gained complete relief of sciatica 3 months after therapeutic injection, and a reduction in the size of the herniated lumbar disk (figure 2).

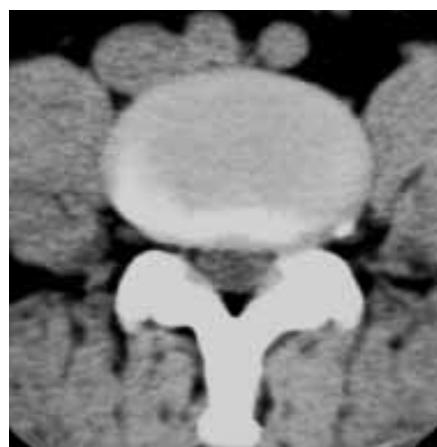
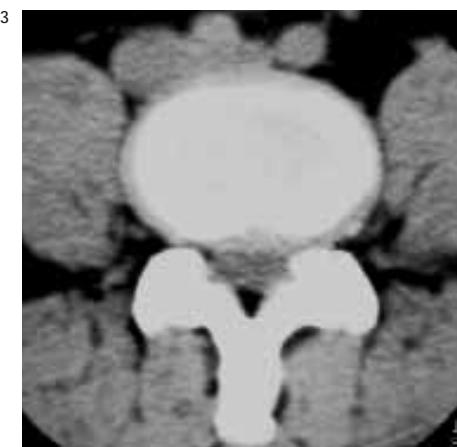


Figure 3 and 4 CT axial scans before (figure 3) and after (figure 4) intradiscal O_2-O_3 mixture injection in a 25 year-old male patient and suffering sciatica on the left for 3 months. The patient showed the Lasègue sign positive reaction in his physical examination, and lumbar disk bulging in L4-L5 (figure 3). The patient gained complete relief of sciatica in one month after therapeutic injection.

obtain better therapeutic effect, we have to pay attention to the followings.

Criteria of selecting patients: The low back pain and sciatica are very complex clinical symptoms. The compression of nerve root by lumbar disc herniation or protrusion is one of the many important factors causing low back pain and sciatica. The factors may include local non-bacteria inflammation, degeneration of tendons, turbulence of muscles, dysfunction of small joints and neurological deficits. Muto and Avella¹ selected one group of patients with herniated or protruded disc with neurological deficit to receive ozone injection therapy. The group had "failure" in all patients, in which the symptoms of seven cases improved for one month, but recurred later on. In our experience, the degree of disc herniation or protrusion is not always related to the degree of back pains and sciatica. In view of this clinical situation, we should be very careful in selecting patients to be treated by ozone injection procedure. The patient with symptoms related to nerve root compression with positive Lasegue' sign, and bulging or mild to middle extrusion are the best responsible group to the therapy. The extrusion exceeding ten mm especially with spinal canal stenosis doesn't have good therapeutic response in our practice.

Worsening clinical situation after injection: There were thirty eight cases in our reported group had different degree symptomatic relief within one to three days after injection procedure, but worse pain came back within five to seven days after first injection. Most patients in this group gained good recovery when they were given symptomatic treatment and took propriety rest. Three cases in this group got pain relief through percutaneous discectomy treatment, and one case had worse pain relief after six months. The reason to cause the worsening situation is uncertain, but we postulated that the worse pain might be related to the following factors: a) non-bacteria inflammatory reaction caused by ozone oxidation to the disc tissue resulted in the disc pressure increase; b) stimulation reaction by ozone to nerve root directly; c) impropriety operation during injection such as impropriety injection speed and impropriety injection volume of ozone; and d) the worse pain might be related to the psychological responses in some patients. To reduce the worse pain happened, the combination procedure should be set up individually by combination

of general standard therapeutic protocol according to patients' individual situation. The volume of ozone and speed of injection specifically need should be adapted to patients individually. At the same time, we need to give patients more psychological guidance and more education about the therapeutic technology before and after this procedure. The therapeutic effectiveness related to aging: Our data of successful therapeutic rate in old group (more than 60 years old) is better than in groups of young and middle aged, which is correspondent to the prior reports⁷. It seems to be more comfortable to select ozone injection procedure for old aged patients than to choose other therapeutic strategies such as chemonucleolysis and percutaneous discectomy.

Conclusion

Ozone injection therapy for herniated or protruded discs is a very wonderful therapeutic procedure that can be accepted as an alternative strategy to surgery in selected patients who went through conservative treatments and were unsuccessful for at least three to six months. To select correct patients for conducting this therapeutic ozone injection, we should see to it that clinical and neuroradiological indications and contraindications must be followed to achieve good results and to avoid complications. Low back pains and sciatica caused by lumbar disc herniation or protrusion is a very popular disease in China and the incidence of new patients per year is around two to three millions. The conventional treatments in China include Traditional Chinese Medicine, massage, acupuncture, small needle knife and surgery operation. The therapeutic effectiveness using ozone injection shows that the therapeutic method has minimum trauma, no side reverse effects and proves to be very economical, and with high success rate (more than 70%) comparing to the chemonucleolysis and percutaneous discectomy. Our results suggest trying this therapeutic strategy to treat such big population of the patients in China.

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