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Percutaneous laser microdiscectomy in the treatment of thoracic intervertebral disc protrusions

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One of the causes of thoracalgia is a protrusion of the thoracic intervertebral discs (IVD). Treatment of these protrusions is often ineffective.

Objective: To improve the outcomes of treatment of thoracalgia caused by protrusions of the thoracic IVD, using the method of puncture laser microdiscectomy (PLM).

Materials and methods. A retrospective analysis of treatment outcomes of 64 patients with thoracalgia at the "Endoscopic Neurosurgery" Medical Center in the period from 2000 to 2023 was carried out. The patients ranged in age from 24 to 67 years. There were 48 (75.5%) men, 16 (24.5%) women. Puncture laser microdiscectomy was performed in 42 patients under the control of a C-Arm operating fluoroscope (Philips, the Netherlands), 22 - under CT-assisted method (Toshiba, Japan).

Results. In 10 cases, PLM was performed on two IVDs. The rate of positive results of treatment of thoracic IVD by the PLM method is 89%. The rate of excellent results was 71.4% in the group of operations under operating fluoroscope control, in the operations group under CT assisted method - 72.7%. Complications were registered only in 3 patients operated on under the fluoroscope control.

Conclusions. Puncture laser microdiscectomy in case of thoracic IVD protrusions is an effective method for treatment of persistent thoracalgia. Performing PLM under CT assisted method does not increase the efficacy of the surgery, but it allows avoiding complications.

Keywords: thoracalgia; thoracic intervertebral discs; laser microdiscectomy

Thoracic intervertebral disc protrusions (IVD) are common, but they are mostly asymptomatic. Rarely, they are accompanied by symptoms of thoracalgia (any painful symptoms in the thoracic spine) - a common polyetiological disease. A distinction is made between reflex and radicular pain syndromes. Reflex syndromes (thoracalgia with muscle-tonic, degenerative-dystrophic and vegetative-visceral manifestations) occur most often [1]. One of the causes is the protrusions of the IVD, for which the pain can be persistent and poorly tolerated by medication and physiotherapy. Radicular syndromes are often associated with IVD herniations. The prevalence of hernias does not exceed 1 case per 1 million population [2]. Attempts to surgically treat hernias [3–5], rather than protrusions, are increasingly mentioned in the literature. There are few cases of successful treatment of thoracic IVD protrusions by the puncture method. Chemonucleolysis, radiofrequency thermocoagulation, and cold plasma coagulation have been used for treatment [6–8]. Most often, the literature mentions the puncture laser effect on thoracic IVD [9–13]. However, puncture of thoracic IVDs is associated with great technical difficulties. On the one hand, it is not always possible to penetrate a specific IVD with a needle through the heads of ribs, on the other hand, there is a danger of needle damage to the lung or spinal

canal. Therefore, few doctors perform the following operations. If the cause of pain is correctly identified, and the puncture laser microdiscectomy (PLM) is performed technically correctly, then this minimally invasive operation can be effective. According to the literature, there are no clear indications for PLM in case of protrusions of thoracic IVD and no elaborated techniques for performing PLM, no analysis of possible complications, and no treatment methods have been developed.

Objective: to improve the treatment outcomes of thoracalgia caused by thoracic intervertebral discs protrusions using the puncture laser microdiscectomy method.

Materials and methods

Study participants

Results of treatment of 64 patients with thoracalgia in the Medical Center of Endoscopic Neurosurgery in the period from 2000 to 2023 were analyzed.

The age of the patients was from 24 to 67 years. There were 48 (75.5%) men, 16 (24.5%) women, i.e., men to women ratio was 3:1.

Informed and voluntary written consent to participate in the study was obtained from all patients.



The study was approved by the committee on ethics and bioethics of Dnipro State Medical University (Minutes № 8 dated February 26, 2023).

Inclusion criteria

Patients with thoracalgia caused by protrusions of the thoracic IVD, who were treated by the PLM method, were included in the study.

Characteristics of the group

All patients had pain in the thoracic spine as their main complaint. The pain was often constant and increased with exertion (57%) or when lying down (43%). The duration of the pain was from 3 months to several years. Medicinal and physiotherapeutic methods of treatment were ineffective. Some patients (32) resorted to manual therapy, but the effect was short-lived. Most often, the pain was localized only in the area of the spine without lateralization (78%). Only 22% of the patients had the pain predominantly on one side, and in 8 of them it had a girdle character. The intensity of the pain syndrome according to the visual analogue scale ranged from 4 to 7 points, on average - (5.67±1.23) points. Muscle-tonic syndrome of varying severity was registered in 38% of patients, vegetative-irritating manifestations - in 23%. Pain was localized in the upper thoracic region (Th1–Th4) in 15% of patients, in the mid-thoracic region (Th5–Th8) in 56%, in the lower thoracic region (Th9–Th12) in 29% (**Table 1**).

Table 1. Distribution of patients according to the level of protrusion localization

| Level | Number of patients | |
|-----------|--------------------|--------|
| | Abs. | % |
| Th1-Th2 | 1 | 1,56 |
| Th2-Th3 | 2 | 3,13 |
| Th3-Th4 | 3 | 4,69 |
| Th4-Th5 | 3 | 4,69 |
| Th5-Th6 | 11 | 17,19 |
| Th6-Th7 | 12 | 18,75 |
| Th7-Th8 | 11 | 17,19 |
| Th8-Th9 | 7 | 10,94 |
| Th9-Th10 | 8 | 12,50 |
| Th10-Th11 | 3 | 4,69 |
| Th11-Th12 | 2 | 3,13 |
| Th12-L1 | 1 | 1,56 |
| Total | 64 | 100,00 |

Study design

The study design is a retrospective, single-center, uncontrolled study.

Patients underwent a neurological examination (64), spondylography (39), computed tomography (CT) (34), magnetic resonance imaging (MRI) (48). Both CT and MRI were performed on 20 patients. Puncture laser microdiscectomy was performed in 42 patients under

the control of a C-Arm operating fluoroscope (Philips, the Netherlands), 22 - under CT-assistance (Toshiba, Japan). Medilas - Fibertom 4060 (Dornier, Germany) neodymium medical laser (Dornier, Germany) was used in 35 cases, and Surgilas (Germany) diode laser was used in 33 cases. Laser beam load was 15 J, total load was 350–500 J, duration was 0.3 s.

Statistical analysis

Statistical analysis of the obtained data was performed using the Statistica v.6.1 software according to the recommendations for processing the results of medical and biological research. Samples with alternative characteristics were compared using the χ^2 criterion. The results were considered statistically significant at a significance level (p) < 0.05.

Results and discussion

More often, the localization of pain corresponded to such a protrusion of the IVD, but when the IVD protrusion was localized in the lower thoracic region in 10 patients, the pain radiated to the renal area. According to the data of spiral CT and MRI, patients had predominantly IVD protrusions at one (35%) or several levels (43%). The indication for PLM was a prolonged pain syndrome that was not amenable to treatment by other non-surgical methods. The localization of the pain had to be consistent with that of the affected one or two IVD, and disc hydration had to be preserved. Contraindications to PLM are the presence of signs of ossifying ligamentosis, hernial ossification, and a decrease in the IVD height by more than one-third of normal. In the presence of only one affected disc, it was easy to determine the level of PLM appropriate for the level of pain (56% of cases), whereas in the presence of detection of two or more affected discs, it was a difficult task. In such cases, lidocaine blockade (lidocaine test) of one of the spinal roots corresponding to the presumably affected disc was performed. Under the control of the operating fluoroscope, a 1% lidocaine solution in a dose of 1 ml was injected into the intervertebral foramen. The end of the needle should be placed in the intervertebral foramen, 5 mm laterally from the medial edge of the intervertebral joints, avoiding penetration of the anesthetic into the spinal canal. The duration of anesthesia was from 25 to 40 minutes. In cases where the level of the IVD lesion corresponded to the intervertebral foramen into which lidocaine was injected, the patient experienced a marked reduction in pain. This was indicative of the correct level chosen. Such IVD was subjected to PLM. In the absence of pain reduction after lidocaine blockade, no PLM was performed on this IVD.

Of the 28 patients in whom two or more affected IVDs were identified, lidocaine test blockade was applied in 14 cases, in the remaining cases, the level of performing the PLM was determined during palpation of the site of maximum pain. The effectiveness of PLM is shown in **Table 2**.

The lidocaine test provides more accurate determination of the level of damage to the IVD (which is related to the severity of pain) and contributes to a better effect of PLM. However, the difference was not statistically significant ($p=0.509$). In 10 cases, PLM was performed on two IVDs.

Table 2. Treatment outcomes

| Patient group | Number of patients | Number of patients without effect | Number of patients with partial effect | Number of patients with positive outcome | p |
|---------------------|--------------------|-----------------------------------|--|--|-------|
| With pre-testing | 14 | 2 | 5 | 7 | 0,509 |
| Without pre-testing | 14 | 3 | 7 | 4 | |

Table 3. Thoracalgia treatment outcomes using the PLM method according to the McNab scale, depending on the intraoperative imaging technique

| Outcome according to the MacNab scale | Operation under C-Arm | | CT guided surgery | |
|---------------------------------------|-----------------------|------|-------------------|------|
| | n | % | n | % |
| Excellent | 30 | 71,4 | 18 | 72,7 |
| Good | 5 | 11,9 | 4 | 18,2 |
| Fair | 4 | 9,5 | 2 | 9,0 |
| Poor | 3 | 7,1 | 0 | 0 |
| Total | 42 | 100 | 24 | 100 |
| p | 0,574 | | | |

The incidence of positive outcomes in the treatment of thoracic IVDs with PLM method was 89% (**Table 3**). In the group of operations under the control of the operating fluoroscope, the rate of excellent results was 71.4%, in the group of operations under CT assisted method it was 72.7%. No statistically significant difference was found between the results of different intraoperative imaging techniques ($p=0.574$). The lack of PLM effect in 9% of observations was due to various reasons. In three cases, the level of PLM was chosen incorrectly, resulting in no surgical effect. Two patients had a decrease in the height of the IVD by more than a third of the normal one, therefore PLM was ineffective.

Complications were reported only in 3 patients operated on under the control of a fluoroscope. In 2 of them it was caused by technical errors. Thus, in one patient, the needle penetrated the pleural cavity and damaged the lung. The patient did not feel anything at that moment, but after a few hours there was a pain in the chest wall from the side of the performed puncture and dyspnea. A day later, an X-ray examination was carried out, which revealed a pneumothorax. The patient was admitted to hospital. Active drainage of the pleural cavity was established. The patient's condition normalised after a week. Subsequently, the pain in the area where the PLM was performed decreased and persisted at the level of 3 points on the visual analogue scale. A needle insertion into the spinal canal was the cause of complication in two cases. No neurological symptoms were noted, but both patients developed symptoms of meningism after 24 hours. A diagnostic lumbar puncture in the cerebrospinal fluid revealed an admixture of blood as a consequence of an error during the PLM.

To avoid serious complications, the following requirements should be observed. The location of the needle puncture should be 6 cm from the midline. The patient's body weight should be taken into account. If the patient is hypersthenic, the puncture of the needle

should be located at a distance of up to 7-8 cm from the midline. Before determining the level of the affected disc, a marking is made on the skin under the control of a fluoroscope in two projections. After anaesthetising the skin and soft tissues, a needle is inserted along the planned trajectory. It is inserted very carefully: at first, in a frontal projection superficially (to a depth of 4-5 cm), without reaching 1 cm to the vertebra. In the lateral projection, the level of the needle end is determined, it should not be deeper than the root of the vertebral arch. In a frontal projection, under constant control, the needle is advanced towards the vertebra until it reaches the intervertebral joint. If the needle is not obstructed, it should not be advanced further without lateral control. This is where the needle can penetrate the spinal canal. In this case, the needle should be pulled back and inserted deeper by 1 cm. Check the position of the needle in a frontal and lateral view. Such advancements of the needle in depth can be repeated until the needle is positioned at the level of the IVD. Before puncturing the disk, also control the position of the needle in two projections. Only after that puncture the disk.

There were no complications in patients operated on under CT assisted surgery.

Protrusions and hernias of the thoracic IVD can cause persistent thoracalgia, which does not respond well to conservative treatment. Our study suggests that a properly performed PLM, at the level of the appropriate cause of pain, is highly effective. This is consistent with the findings of other authors [10-12]. However, there is a risk of complications associated with damage to the pleural cavity or spinal canal when treating thoracic IVD with PLM method [6,8]. In our observations, this was noted in three cases. There were no such complications in the group of patients who underwent PLM under CT-assisted method.

Although we do not have much experience in the treatment of thoracic IVD by the PLM method for a

definitive conclusion, the available data suggest that this method is effective. With the required experience, the number of complications can be minimised. Performing surgery under CT assisted treatment does not increase its efficiency, but it avoids complications due to technical errors.

Conclusions

1. Thoracic IVD protrusions are often the cause of persistent thoracalgia.
2. Puncture laser microdiscectomy of thoracic IVD protrusions is an effective method of treating persistent thoracalgia.
3. A lidocaine test should be performed to identify the source of pain in case of several IVD injuries.
4. Performing PLM under CT assisted surgery does not increase the efficacy of surgery but avoids complications.

Disclosure

Conflict of interest

The authors declare no conflict of interest.

Ethical approval

All procedures performed on patients during the study comply with ethical standards of institutional and national ethics committees, and the Declaration of Helsinki (1964) and its amendments or similar ethical standards.

Informed consent

Informed consent was obtained from each patient.

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