

Application of intrapulmonary wire combined with intrapleural fibrin glue in preoperative localization of small pulmonary nodules

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Abstract

Objective: This study aims to investigate the accuracy of the preoperative localization of small nodules by computerized tomography (CT)-guided placing wire and intrapleural fibrin glue near the nodules at 3 days before the operation.

Methods: From October 2015 to December 2017, a total of 79 patients, who received preoperative localization of small pulmonary nodules and surgical treatment in the Department of Thoracic Surgery of Hohhot First Hospital, were enrolled into this study. These patients were randomly divided into 2 groups: methylene blue localization group ($n=47$), and modified localization group ($n=32$), where the patients received preoperative localization of the small nodules by CT-guided placing wire and intrapleural fibrin glue near the nodule at 3 days before the operation. Localization accuracy, operation time and difficulty in postoperative seeking for pathological specimens were compared between these 2 groups.

Results: In the methylene blue localization group, 3 patients had localization failure due to the intrathoracic diffusion of methylene blue, and the success rate was 93.61%. In the modified localization group, all 32 patients succeeded in the localization, and the success rate was 100%. Operation time and difficulty of finding the specimen was significantly lower in the modified localization group than in the methylene blue localization group ($P < .05$).

Conclusion: The application of preoperative localization of small nodules by placing wire and intrapleural fibrin glue improves the success rate of resection, reduces operation time and the risk of the operation, and lowers the difficulty of finding pathological specimens after the operation. Hence this operative procedure is worthy of popularization.

Abbreviations: CT = computerized tomography, SD = standard deviation.

Keywords: fibrin glue, intrapleural, localization, placement, small nodule, wire

1. Introduction

With the extensive application of low-dose spiral computerized tomography (CT) in regular physical examinations, the detection rate of small pulmonary nodules has gradually increased. For nodules with small diameters, deep position, or light density, localization is very difficult during an operation, which accordingly affects the surgical procedure and prolongs opera-

tion time. This brings about difficulties for surgeons during an operation^[1] and for pathologists in finding specimens after the operation, and increases unnecessary pains to the patient.^[2] The incidence of thoracotomy due to failure of localization in thoracoscopic surgery is 46%.^[3] Therefore, the accuracy of preoperative localization is closely correlated to the success rate of the operation.^[4] Determining how to accurately localize small pulmonary nodules is a new opportunity and challenge for thoracic surgeons. In the present study, 2 years of follow-up for the application of preoperative localization of small nodules by CT-guided placing wire and intrathoracic glue near the nodule at 3 days before the operation was carried out on 32 patients. A good result was achieved, and its safety and effectiveness were fully confirmed. The report is presented below.

2. Information and methods

This study was conducted in accordance with the declaration of Helsinki. This study was conducted with approval from the Ethics Committee of our hospital. Written informed consent was obtained from the participants.

2.1. General information

From October 2015 to December 2017, a total of 79 patients, who underwent preoperative localization of small pulmonary nodules and surgical treatment in the Department of Thoracic Surgery of Hohhot First Hospital, were enrolled in the present

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Table 1**General data of the patients in the 2 groups.**

Groups	Cases (n)	Sex		Average age	Average diameter	The location of the growth					The distance to the pleura
		Male	Female			Upper right	Middle right	Lower right	Upper left	Lower left	
Methylene blue localization group	47	24	23	62.4	10.2	7	3	15	13	9	25.8±3.4
Modified localization group	32	17	15	64.7	11.1	6	2	9	10	4	29.4±4.1
<i>P</i> value				<.05	<.05						<.05

study. These patients were randomly divided into 2 groups: methylene blue localization group ($n=47$), and modified localization group ($n=32$), where the patients underwent preoperative localization of small nodules by CT-guided placing wire and intrapleural fibrin glue near the nodule at 3 days before the operation. The details are presented in Table 1.

All lesions were diagnosed as small nodules that were difficult to localize during the operation by clinical thoracic surgeons. Inclusion criteria: the location of the nodule was relatively near to the middle-lateral side of the surgical field; the diameter of the nodule was within 8 to 15 mm; there were no important tissues, such as major trachea and blood vessels around the nodules.

2.2. Surgical equipment and instruments

A 64-slice spiral CT scanner (CT, Siemens), a video-assisted thoracoscopic system (Olympus), an endoscopic incision suture (Johnson), and other conventional surgical instruments were used.

2.3. Implantation steps

A puncture needle (Japan Hakko, 12G×100 mm or 12G×150 mm), metal wires (0.7 mm in diameter and 0.5 cm in length, remade from metal nails used in a disposable skin stitching device, Changzhou Locman, LMPF-35W), and medical glue cyanoacrylate (Beijing Compont, 1.5 ml/bottle) were used. First, the chest enhanced CT scan images were analyzed, and the position of the patient in the localization, the depth and the angle of the needle were determined. After disinfection, local layer-by-layer infiltration anesthesia was performed until the parietal pleura were carried out with 2% lidocaine. With the anesthetic needle as a reference, a local scan with a gap of 1.25 mm was performed, the angle and depth of the needle was confirmed, and important organs such as cardiac large blood vessels, trachea and liver were dodged. Then, the shortest puncture approach was selected, and the needle was punctured into the lung tissue and placed after reaching approximately 5 mm around the nodule. The local scan was repeatedly performed. After confirmation and there was no blood at pumpback, 3 to 5 wires with a diameter of 0.7 mm and a length of 0.5-cm were implanted around the nodules. After the needle core was pulled out, a 1-ml skin test syringe received the medical glue cyanoacrylate. During the withdrawal of the needles, a small amount of medical glue cyanoacrylate was injected until the parietal pleura, and the needles were pulled out one at a time. The needle holes were sterilely ensnawed.

2.4. Surgical methods (Fig. 1)

The single-hole or double-hole operation guided by the video-assisted thoracic surgery system was adopted. During the exploration, wrinkle marks on the surface of the lung tissue

were found, which was induced by the medical glue cyanoacrylate. Then, a relatively larger and more easily recognizable hard node caused by artificial manipulation was palpated using a finger or instrument. Next, the location of the lesion and scope of the resection were confirmed. The specific surgical methods were in accordance with the requirements of the guidelines.

3. Observation of curative effect

The accuracy of localization (from the beginning of the operation to the frozen-section pathology of the tumor) and the difficulty of postoperative finding of pathological specimens were compared between these 2 groups. The specific observation indexes were as follows: finding lesion through hand touch, 0 point; finding the lesion by cutting the local segments of lung tissues into slices, 1 point; finding the lesion by cutting the lung tissues (lung lobe) into slices, 2 points; finding the lesion by cutting the lung tissues into filiform, 3 points; finding the lesion by re-localization guided by X-ray, 4 points.

4. Statistics analysis

Count data were compared using Chi-square test. Measurement data were expressed as mean±standard deviation ($\bar{x}\pm SD$), and compared using *t* test. $P<.05$ was considered statistically significant.

5. Results

After the operation, the patients in both groups exhibited good effects, recovered smoothly, and had no severe complications, and there were no surgical deaths. Differences in average age, average diameter, growth location and the distance to the pleura between the 2 groups were not statistically significant ($P>.05$). In the methylene blue localization group, 3 patients had localization failure due to the intrathoracic diffusion of methylene blue, and the success rate was 93.61%. In the modified localization group, all 32 patients succeeded in the localization, and the success rate was 100%. Operative time (from the beginning of the operation to the time of frozen-section pathology of the tumor) was significantly lower in the modified localization group than in the methylene blue localization group ($P<.05$). Furthermore, failure rate and postoperative pathological finding difficulty was significantly lower in the modified localization group than in the methylene blue localization group ($P<.05$, Table 2).

6. Discussion

For the past 10 years, with the improvement of the resolution of CT scanning, more and smaller pulmonary nodules have been found. As a consequence, some lesions could not be seen by the naked eye and cannot be clearly touched during an operation,

Before location



In the process of location



After location



Figure 1. The single-hole or double-hole operation guided by the video-assisted thoracic surgery system.

Table 2

Comparison of the indexes in the 2 groups.

Groups	Success rate of localization	Operation time	Difficult degree of finding pathological specimen after operation
Methylene blue localization group	100%	20 ± 6.55	68 ± 29.5
Modified localization group	93.61%	28 ± 16.47	128 ± 38.4
P value	<.05	<.05	<.05

bringing about a number of unexpected difficulties during an operation.^[4,5] Some patients even turned to thoracotomy or extension of the scope of resection. In addition, even when the scope of resection is extended, it was also suspected that the lesion for testing can be found in the specimen.^[6] The above choices are all unsatisfactory for both the patient and operator. Therefore, it is particularly important to accurately localize small pulmonary nodules before the operation.

At present, various preoperative localization methods have been reported. However, any localization method may fail.^[7] A literature revealed that 3 to 8% of preoperative localization can present displacement or even unhooking.^[8] No unified localization technology has been widely applied in clinical practice. Furthermore, the advantages and disadvantages of various methods have been confirmed by various clinical practices.^[9] However, the hook-wire localization method is relatively widely used and has a high success rate, which has advantages of simple operation, short operation time, and reduction of surgical trauma.^[10–12] However, this approach still has many disadvantages: large damage to lung tissues,^[13] high incidence of displacement or even falling off,^[14,15] failure of identifying the surgical margins after displacement, and high probability of miscutting lesions or the lack of surgical margins;^[16] having a blind area for placement, especially prone to failure of localization of small nodules at deeper positions that are difficult to palpate, easily leads to pneumothorax, hemothorax and pain,^[17–19] and death from gas embolism.^[20,21,4] At present, in order to more accurately find these nodules, a chest surgeon would place the positioning device near a nodule in the thoracic cavity for a short period of time. It is necessary to completely remove the needle track and the positioning device during the operation,^[22–24] in order to ensure that the surgical margins are negative and more normal lung tissues are reserved.^[25,26] However, due to the limitations of the anatomical structure, the needle track may be relatively long, and there is an unnecessary loss of normal lung tissue during the resection.^[27] Therefore, in the present study, the investigators preoperatively localized small nodules by CT-guided placing wire and intrapleural fibrin glue near the nodules at 3 days before the operation. Three days later, due to the stimulation of the foreign body of the wire, reactive hyperplasia occurred in the surrounding tissue, forming a relatively larger hard nodule,^[28] without altering the properties the nodule.^[29] In the surgical exploration, the approximate position of the nodule was 1st found based on the crinkle marks of the medical glue cyanoacrylate on the surface of the lung tissues. Then, a relatively larger and more easily recognizable hard node caused by artificial manipulation was palpated using a finger or instrument, thereby confirming the location of the lesion and scope of the resection.

In summary, this method is simpler and easier to operate, compared to the previous localization methods. Furthermore, this approach has a high success rate in positioning, and presents with a relatively good localization of the nodules in deeper parts of the lungs, which is more beneficial for large and obese patients. Moreover, it greatly lowers the difficulty of finding pathological specimens after an operation, and is more suitable for primary hospitals.

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