CT-guided needle biopsy through mandibular area for the diagnosis of nasopharyngeal carcinoma in the parapharyngeal space

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[Abstract] Background and Objective: The primary submucous type of nasopharyngeal carcinoma (NPC) or the recurrent NPC in the parapharyngeal space is difficult to be diagnosed histologically by conventional biopsy because of the obstruction of the surrounding structures. This study was performed to evaluate the needle biopsy approach through the mandibular area into the parapharyngeal space under the guidance of computed tomography (CT) for NPC. Methods: Between July 6, 2005 and October 23, 2009, a total of 6 patients were enrolled into the study. Two patients with cervical lymph node metastasis were clinically suspicious of NPC according to their clinical manifestations. However, no cancer cell could be found by repeated nasopharyngeal biopsies followed by histologic examinations. The other 4 patients were diagnosed with recurrent NPCs by magnetic resonance imaging (MRI) or and positron emission tomography (PET)-CT scan, showing tumors in the parapharyngeal spaces in 3 patients and enlarged retropharyngeal lymph node in 1 patient. The CT-guided puncture was performed through the mandibular skin and the cutting needle biopsy was taken at the parapharyngeal space focus. Results: All the cutting needle biopsies of projected locations have been performed safely. Finally, all the 7 specimens met the requirement of pathologic diagnosis and the cases were all confirmed histologically to be NPCs. The main complication was mild ache at the puncture point. No blood vessel or nerve was injured and no patient needed special treatment. Conclusions: The CT-guided puncture biopsy of the parapharyngeal space through the mandibular area is simple and feasible. It can be an additional option for routine nasopharyngeal biopsy.

Key words: Nasopharyngeal neoplasm, parapharyngeal space, puncture, biopsy, computed tomography

Nasopharyngeal carcinoma (NPC) frequently invades into the parapharyngeal space and spreads to the retropharyngeal lymph node. Recurrent NPC is also commonly seen in the parapharyngeal space, which is a difficult area for forceps biopsy. In some NPC patients with submucosal tumors, which locate in the submucosa or invade into the surrounding tissue without obvious abnormality in the nasopharyngeal mucosa, conventional nasopharyngeal biopsy is also challenging. Because of the anatomical features of nasopharynx, surgical biopsy is generally not advocated and how to get pathological diagnosis in these patients has been a thorny issue. Parapharyngeal space puncture for cytologic or pathologic diagnosis has been reported previously, mostly with the needle punctured through the facial skin or lateral oral mucosa\textsuperscript{[9-10]}. However, due to the effect and limitation by the inherent bone and vascular structures inside and surrounding the parapharyngeal space, needle biopsy requires advanced skills, and for some deep-seated lesions, especially for the enlarged retropharyngeal lymph node, inserting the needle to the right location is more difficult and riskier, and is rarely reported. In the present study, we performed needle puncture through the mandibular skin under the guidance of computed tomography (CT).
Materials and Methods

Clinical data

Between July 6, 2005 and October 23, 2009, a total of 6 patients, with detailed information (Table 1), were enrolled into the study at the department of radiation oncology, Sun Yat-sen University Cancer Center. There were 4 males and 2 females with ages ranging from 36 to 65 years. The 1st and 2nd patients, 52- and 36-year-old females, Cantonese, came for treatment because of enlarged cervical lymph nodes, which were confirmed pathologically as metastatic undifferentiated carcinoma and undifferentiated non-keratinizing carcinoma respectively, with VCA-IgA ratios of 1:40 and 1:640, EA-IgA ratios of negative and 1:40, and DNA antibody rates of 32% and 54%, respectively; and both of their magnetic resonance imaging (MRI) scans showed slightly thickened mucosa in right top of the nasopharynx and tumor invasion in the right parapharyngeal space. The two patients were diagnosed with NPC based on their clinical manifestations, but cancer cells were not found by histologic examination in repeated nasopharyngeal mucosa biopsy. The 3rd, 4th, and 5th patients had suspicious recurrent NPC for more than 1 year after treatment, with parapharyngeal lesions found by image scanning but without obvious nasopharyngeal abnormality, and had repeatedly negative nasopharyngeal biopsy under electron microscope; the 5th patient had suspicious lesions in both the left pre-styloid and post-styloid spaces. The 6th patient received radiotherapy 7 years ago, with enlarged right retropharyngeal lymph nodes and increased abnormal signal and radioactivity shown by positron emission tomography (PET)-CT and MRI, but had normal nasopharyngeal mucosa under electronic microscopy, MRI and PCT-CT scanning, and cancer cells were not found by nasopharyngeal biopsy for two times. It could not be ascertained whether the retropharyngeal lymph node had recurrence or metastasis after treatment of NPC. According to the consultation of the doctors from the department of head and neck surgery and minimally invasive surgery before puncture, surgery treatment for the 5th and 6th patients was not considered because of possible adhesion since the parapharyngeal lesions showed close relationship with the carotid sheath. All patients had normal blood routine examination, liver and kidney function, chest X-ray, abdominal B ultrasound and whole bone electrical capacitance tomography (ECT) scan, with Karnofsky score equal to or larger than 70. All patients signed informed consents before puncture.

Table 1 The locations of the parapharyngeal space lesions of the 6 patients with nasopharyngeal carcinoma (NPC) and their biopsy results

<table>
<thead>
<tr>
<th>Number of patient</th>
<th>Clinical diagnosis</th>
<th>Location of lesion</th>
<th>Histologic diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Right neck lymph node metastasis from NPC</td>
<td>Right prestyloid space</td>
<td>Undifferentiated carcinoma</td>
</tr>
<tr>
<td>2</td>
<td>Left neck lymph node metastasis from NPC</td>
<td>Left prestyloid space</td>
<td>Undifferentiated nonkeratinizing carcinoma</td>
</tr>
<tr>
<td>3</td>
<td>Recurrent NPC in left parapharyngeal space</td>
<td>Left prestyloid space</td>
<td>Undifferentiated nonkeratinizing carcinoma</td>
</tr>
<tr>
<td>4</td>
<td>Recurrent NPC in right parapharyngeal space</td>
<td>Right poststyloid space</td>
<td>Undifferentiated nonkeratinizing carcinoma</td>
</tr>
<tr>
<td>5</td>
<td>Recurrent NPC in left parapharyngeal space</td>
<td>Left prestyloid space and left poststyloid space</td>
<td>Carcinoma and poorly differentiated squamous cell carcinoma</td>
</tr>
<tr>
<td>6</td>
<td>Left retropharyngeal lymph node metastasis and recurrence</td>
<td>Left retropharyngeal lymph node</td>
<td>Undifferentiated nonkeratinizing carcinoma</td>
</tr>
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Preparation of instruments for puncture biopsy

The 18G thoracic puncture needle and 14G soft tissue cutting biopsy needle provided by Harbin Medical Device Company were used. The tip of thoracic puncture needle was slightly blunt.

Method and procedure of puncture biopsy

1. Before puncture, the relationship between parapharyngeal structures and tumors was learned through MRI and PET-CT images. Needle path, direction, and biopsy point were preliminarily designed (The biopsy point was selected at the maximum section of parapharyngeal lesions as much as possible).

2. Puncture was conducted under the guidance of CT simulator. The patients were in supine position with their heads immobilized by foam pillow and straps.

3. Puncture point was selected at the ipsilateral mandibular skin above the body of hyoid bone, 1.5–2.5 cm next to the midline. After local conventional sterilization and draping towels, 0.5% procaine or 1.0% lidocaine was used for local infiltration anesthesia.

4. After making an incision of the skin for puncture
point by a sharp knife, an appropriate shortened and blunt 18G thoracic puncture needle was inserted by hand, and pushed on to the skull base direction carefully. At the same time, needle angle and direction was adjusted according to the position of tumors in the parapharyngeal space under CT guidance.

(5) The core of puncture needle was pulled out when arriving at the destination point, and a 14G soft tissue cutting biopsy needle was put in through needle guard. Puncture was confirmed satisfactory under CT scan and the biopsy site was recorded (if the lesions were small or difficult to be differentiated from important structures such as peripheral vessels, enhanced CT was used to give help), and then specimen was cut and drawn at 1 cm or 2 cm stall of biopsy needle.

(6) Pull out the puncture needle and collect specimens.

(7) Press the needle puncture hole with gauze for 1–2 minutes and finish the procedure after confirming no bleeding or hematoma formation.

(8) Fix the specimens with 10% formalin and send it for histopathologic examination.

The CT images and key steps of the method are shown in Figures 1 and 2.

**Figure 1**  Puncture approach of parapharyngeal space lesion in computed tomography (CT) imaging
A, the needle was advanced from the narrower tip towards the broader bottom of the parapharyngeal space, avoiding the obstruction from those osseous structures. It is easier and safer for needle to be adjusted in angle or exposure and arrive at the biopsy destination. B–F, the needle was inserted only along the adipose tissues within the space, nearly paralleling the most of cranial nerves and blood vessels.

**Figure 2**  The main procedures of the CT-guided puncture cutting biopsy of parapharyngeal space via mandibular area
A, the blunt 18-gauge thorax-puncture-trocar was inserted to the target point of lesion, then the stylet was removed; B, the 14-gauge cutting-biopsy-needle was advanced followed by the guide cannula of trocar to obtain tissue core; C, choose 1 cm or 2 cm gear of the needle to cut the tissue. The specimens were fixed by 10% formalin for histological examination.
Results

The puncture cutting biopsies in parapharyngeal space were successfully completed in all patients, and the drawn tissues met the requirement of pathologic diagnosis. As shown in Table 1, in the 1st and 2nd patients with metastatic cervical lymph nodes, the pathologic results of parapharyngeal needle biopsies were consistent with those of cervical lymph nodes, and the patients were cured by the treatment of NPC. The three patients with suspected recurrent NPC in the parapharyngeal space after treatment all obtained positive pathologic results and recurrence was confirmed; in the 5th patient specimens were obtained at the suspected lesion in the pre-styloid space and the obvious lesion in the post-styloid space, as shown in Figure 3, cancer cells were found in specimens from both of the lesions under pathologic examination and recurrence was confirmed. In the 6th NPC patient with enlarged right retropharyngeal lymph node 7 years after radiotherapy, the biopsy result also showed non-keratinizing undifferentiated carcinoma, and the patient was diagnosed with retropharyngeal lymph node metastasis and recurrence after the treatment of NPC, whose biopsy location is shown in Figure 4.

All patients only complained slight pain when the puncture was conducted; in 2 patients the puncture point skin had a little bleeding, which was stopped after local press; there was no neurovascular injury, no internal bleeding or hematomas formation in parapharyngeal space. No complications such as local redness, swelling, heat, pain and so on occurred after operation. No special treatment was needed.

Discussions

Individual studies of CT-guided needle puncture aspiration for cytologic analysis or biopsy in the parapharyngeal space have been reported previously, and in these studies the procedures include inserting and puncturing needle through the maxillofacial skin, then proceeding through the natural clefs between maxilla and pterygoid, zygomatic arch and mandibular joint notch, mandibular ramus and the mastoid process or styloid process[14]. Because these methods are limited by osseous structures such as maxilla, pterygoid plate or mandible, the puncture approach is often narrow and difficult with limited adjustable puncture angle, and changeable needle positions due to the changes of head position or mouth movement.
More ominously, the puncture approach often runs across or through many different tissues or organs, especially the posterior approach between mandible and styloid process or mastoid process, and injures the blood vessels and nerves in carotid sheath more easily. It is more difficult and with great risk for the swollen retropharyngeal lymph nodes in front of these nerves and blood vessels. Therefore, these methods are only suitable for lesions near the outside of parapharyngeal space or shallow lesions, and the puncture biopsy of lesions in the deep parapharyngeal space is difficult to be conducted, requiring advanced skills, and the puncture biopsy of enlarged retropharyngeal lymph node is especially rare reported. In addition, the needle puncture cytology diagnostic method for parapharyngeal tumor via oral soft palate and oropharyngeal wall under the guidance of ultrasound has been reported previously [7-10]. Although the approach largely overcomes the effect of surrounding osseous structures on the ultrasonic detection, the needle point is deep and hard to be exposed with poor cooperation by patients. Oral needle point is easy to be contaminated, and cytological diagnosis has a lower certainty. Therefore, the study and exploration of an easy and safe needle biopsy method in parapharyngeal space is of great clinical significance.

The parapharyngeal space is an inverted cone-shaped latent space. The wide cone bottom extends up to the base of the skull and the narrow tip down to the level of hyoid bone and the 2nd and 3rd cervical vertebrae; the inner wall is composed of buccopharyngeal fascia and pharyngeal constrictor muscle, the outer wall is composed of the mandibular, the inner and outer pterygoid muscles, and capsule of the parotid gland, and the posterior wall is mainly composed of the cervical prevertebral fascia, the styloid process and attached muscles. The approach via the mandible into the parapharyngeal space is often used for surgical resection of parapharyngeal tumor[11]. Pan et al. [12] also reported implanting brachytherapy for parapharyngeal tumors in NPC through this approach, but the related puncture biopsy was not reported. Compared with previous puncture approaches and methods, through this approach the needle location is superficial and fully exposed, and patients can cooperate easily. Moreover, the needle approach chooses the access route from the narrow tip to the wide bottom of the parapharyngeal space, and needle angle can be adjusted greatly. The needle only passes through the adipose tissue in the parapharyngeal space, and the opportunity of other tissues and organs damage caused by puncture is reduced compared with previous methods, so the requirement of technical skill is also reduced. Under the guidance of CT, puncture biopsy can be conducted on deep-located parapharyngeal lesions. Especially for the biopsy of enlarged retropharyngeal lymph node, the previous methods cannot be completed due to the obstruction of nerves and vessels in carotid artery sheath. In this method, the needle path is basically parallel to the major blood vessels and cranial nerves in the parapharyngeal space, and the injury chance of these blood vessels and nerves by puncture is significantly decreased. A slightly blunt thoracic puncture needle is used for the import channel of cutting biopsy needle, which further lowers the risk of puncture or cutting injury on the blood vessels adjacent to the tumors located in the parapharyngeal space, and enlarged retropharyngeal lymph nodes can also be directly reached and drawn more safely under CT guidance. In the 5th and 6th patients in this study, because the post-styloid lesions were close to the carotid sheath (enlarged retropharyngeal lymph nodes are shown in Figure 4), the doctors from head and neck surgery and minimally invasive surgery departments feared blood vessel invasion or adhesion, and thought excision or biopsy could not be performed, but we obtained the specimens successfully by this method, and the patients were finally pathologically diagnosed and received appropriate treatment. From the study so far, except only minor discomfort complaint at puncture site, patients had no complications such as vascular injury and bleeding or nerve damage.

In summary, the CT-guided puncture biopsy of tumors in the parapharyngeal space through mandible approach has superficial and visualized needle position with enhanced patient compliance, avoiding the constraint of osseous structures in the parapharyngeal space. Moreover, this approach has larger adjustable angle for inserting the biopsy needle and fewer tissues involved in the whole procedure, therefore lowering down the injury risk of major blood vessels and nerves in that area. The operation is simple and easy, and is a useful alternative approach for the conventional nasopharyngeal biopsy. It can help the NPC patients with lesions confined in the parapharyngeal space to obtain histological diagnosis as early as possible, and is worthy of further clinical study and application.

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References


