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Diagnostic accuracy of three-dimensional CT reconstruction and cephalometry for lateral skull base tumors

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Abstract. – OBJECTIVE: To explore the diagnostic accuracy of three-dimensional CT reconstruction and cephalometry in lateral skull base tumors.

PATIENTS AND METHODS: Fifty-eight patients with lateral skull base tumors were randomly divided into control group (n = 29, examined with conventional diagnostic technique) or study group (n = 29, examined with three-dimensional CT reconstruction and cephalometry). The diagnostic accuracy, tumor distribution and image characteristics were compared between both patient groups.

RESULTS: In control group, preoperative tumor diagnosis was consistent with intraoperative diagnosis in 20 patients, similar in 7 patients and discrepant in 2 patients. In study group, there were 24 consistent, 4 similar, and 1 discrepant diagnoses ($p < 0.05$ *vs*. control group). Frequency of individual tumor types, as revealed by either diagnostic method, was comparable. The images obtained with three-dimensional CT reconstruction were clearer, facilitating an accurate demonstration of the tumor, including tumor size and location.

CONCLUSIONS: Three-dimensional CT reconstruction and cephalometry provides accurate diagnosis of lateral skull base tumors, which is helpful for subsequent surgical treatment.

Key Words:
Three-dimensional CT reconstruction, Cephalometry, Lateral skull base tumor.

Introduction

Lateral skull is a delta-shaped region[1-3]. Its location is deep in the skull, and the anatomical structure is complicated. It is adjacent to brain tissue and is parallel to many important vessels and nerves. Therefore, the diagnosis of lateral skull base disease is difficult[4-6]. The common tumors of the lateral skull base are nasopharyngeal carcinoma, middle ear carcinoma, meningioma, glomus jugulare tumors, facial nerve neurilemma, and some others. Of those, diagnostics of glomus jugulare tumor is the most complicated[7-9].

In the past, the surgical approach to lateral skull base disease was through the side of the neck. This required the mandible to be transversely cut off or the mandibular ramus to be longitudinally cut off at high or low level. However, the resulting surgical trauma was substantial, leading to postoperative sequelae[10-12]. With the development of modern surgical techniques for lateral skull base disease, three-dimensional imaging became crucial[13-15]. In the present work, we assessed the diagnostic accuracy of three-dimensional CT reconstruction and cephalometry in patients with lateral skull base tumor in order to provide a clinical reference.

Patients and Methods

Patients

Fifty-eight patients with lateral skull base tumors admitted to our Hospital between March 2011 and March 2014 were randomly divided into two groups, with 29 patients per group. In study group, patients were pre-surgically examined by three-dimensional CT reconstruction and cephalometry. The group included 15 male and 14 female patients whose average age was (mean ± SD) 42.8 ± 9.5 (range 23-65) years. Patients in control group (14 male and 15 female patients aged 43.2 ± 10.3[24-67] years) were diagnosed using conventional diagnostic technique.

The age and gender distribution were comparable between both patient groups.

The tumors manifested as neck or temporal mass, accompanied by headache, dizziness, and facial numbness.

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Diagnostic Techniques

The patients in study group were diagnosed using three-dimensional CT reconstruction and cephalometry. The scanning equipment was GE Discovery CT750 HD and GE LightSpeed Ultra (16-layer spiral CT; GE Medical Systems, Wuxi, China). Scanning method was the following. The patients were in supine position, and head support was used to fix the head. The orbitomeatal line was set as baseline and patients were subjected to CT scanning. The scanning parameters were: layer thickness 1 mm, current of bulb tube 225 mA, voltage 120 kV, threshold value 150-200 Hu, matrix 512 × 512. Bone window was set, and no-interval scanning was applied. The scanning data were transferred to the three-dimensional CT reconstruction workstation (3D-Display). The surface shaded display was used for three-dimensional image reconstruction, and three-dimensional effect was established by shades of gray. Incisions and rotations were used to observe the skull base and deep structure, bone mark points were marked and measuring tools of the workstation were used to measure the meridians of important structures.

The patients of control group were diagnosed using conventional diagnostic technique with axial scanning. If patient condition was severe, the patient underwent coronal and sagittal scannings; both layer thickness and interval were set to 3-6 mm, and the patient was scanned with the lesion in the center of the scan.

Statistical Analysis

The SPSS 17.0 (IBM Corporation, Chicago, IL, USA) statistical software was used to analyze the data. Quantitative data were presented as mean ± SD and tested for differences using the *t*-test. Qualitative data were analyzed by the chi-square test. A p of < 0.05 was considered as statistically significant.

Results

Diagnostic Accuracy of Tested Imaging Techniques

We compared the agreement between the preoperative (i.e., made by either conventional or three-dimensional CT reconstruction + cephalometry imaging techniques) and intraoperative diagnoses. Among 29 patients assessed using conventional diagnostic technique, preoperative and intraoperative diagnoses were consistent in 20 patients, similar in 7 patients and discrepant in 2 patients (Table I). In study group (three-dimensional CT reconstruction and cephalometry), there were 24 consistent, 4 similar, and 1 discrepant diagnoses. Thus, there were significantly more cases with accurate diagnosis with the use of three-dimensional CT reconstruction and cephalometry ($p < 0.05$ *vs.* conventional technique; Table I).

Histological Distribution of Tumors

The three-dimensional CT reconstruction and cephalometry imaging revealed sarcoenchondroma (n = 5), chordoma (n = 4), osteosarcoma (n = 4), neuroblastoma (n = 3), meningioma (n = 3), nasopharyngeal rhabdomyosarcoma (n = 2), and neurilemma (n = 2). Thus, tumor distributions were similar between this and conventional technique (Table II).

Imaging Characteristics of Tumours

On three-dimensional CT, chordoma manifested as bone destruction of skull base and clear high density shadows of soft tissue (Table III). Neuroblastoma and rhabdomyosarcoma were seen as soft tissue shadows of similar or enhanced intensity (Table III). Meningioma showed clear border; 60% to 75% and 25% to 30% had, respectively, even or equivalent density with partial calcification (Table III). Images of neurilemma are shown in Figures 1 and 2. These tumors

Table I. Pre-surgery diagnostic accuracy of tested imaging techniques.

	Conventional diagnostic technique		Three-dimensional CT reconstruction and cephalometry	
	Absolute number	%	Absolute number	%
Consistent with intraoperative diagnosis	20	69.0	24	82.8*
Similar to intraoperative diagnosis	7	24.1	4	13.8*
Discrepant from intraoperative diagnosis	2	6.9	1	3.4*

Footnote: *p < 0.05 vs. conventional diagnostic technique.

Table II. Distribution of lateral skull base tumours in patient groups.

Tumour type	Diagnosed by conventional diagnostic technique		Diagnosed by three-dimensional CT reconstruction and cephalometry	
	Absolute number	%	Absolute number	%
Chordoma	5	17.2	4	13.8
Nasopharyngeal rhabdomyosarcoma	2	6.9	2	6.9
Neuroblastoma	4	13.8	3	10.3
Meningioma	4	13.8	3	10.3
Neurilemma	1	3.4	2	6.9
Osteosarcoma	4	13.8	4	13.8
Chondrosarcoma	4	13.8	5	17.2
Other	5	17.2	6	20.7

Table III. Three-dimensional CT characteristics of lateral skull base tumours.

Tumour type	Absolute number	Characteristics
Chordoma	4	The skull base bone is damaged, the soft tissue shadow of prepontine cistern is clear and markedly enhanced
Neuroblastoma	3	Nasal pharynx shows an equivalent density soft tissue shadow with apparent enhancement
Nasopharyngeal rhabdomyosarcoma	2	Nasal pharynx shows an equivalent density soft tissue shadow with apparent enhancement
Neurilemma	2	Large space occupying lesion shadow in the side tempora and basal ganglia region, marked shadow enhancement
Meningioma	3	Clear border, even density of the tumour, some patients showed even equivalent density shadow and marked shadow enhancement

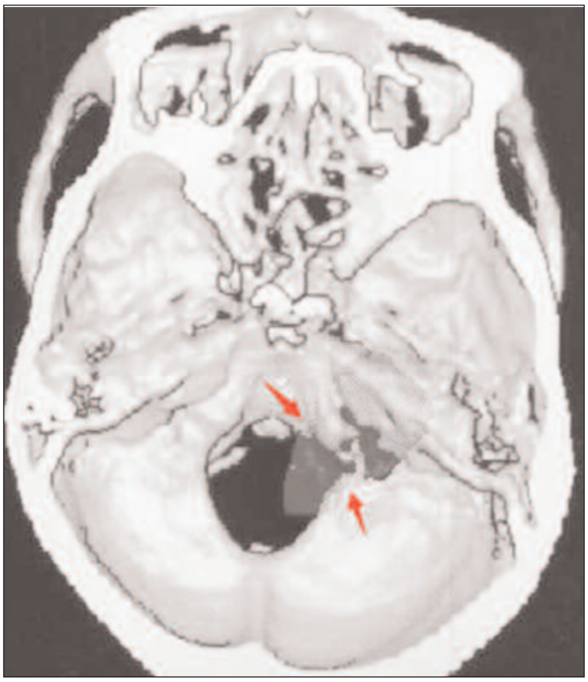

Figure 1. Internal view of neurilemma. Red arrow indicates tumor.

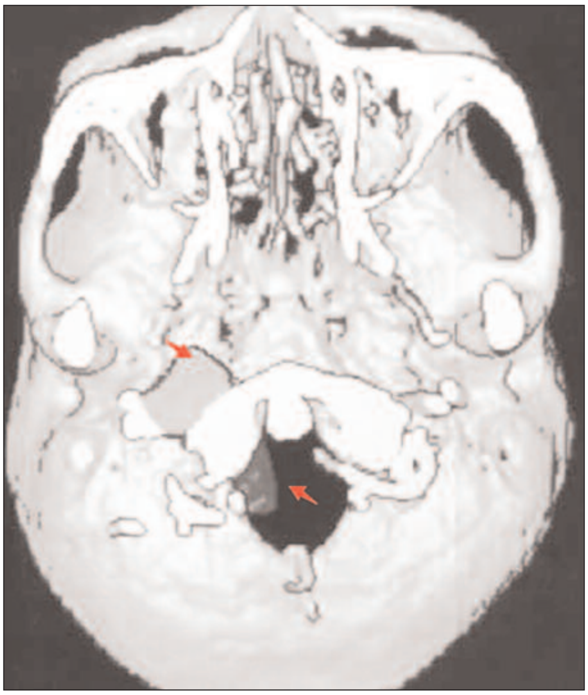

Figure 2. External view of neurilemma. Red arrow indicates tumor.

manifested as large space occupying lesions, with markedly enhanced high density shadows and clear images.

Discussion

Lesions in the lateral skull base are difficult and risky to treat surgically[4,16,17]. In recent years, there have been significant advances in magnetic resonance imaging (MRI), X-ray diffraction, and three-dimensional CT reconstruction[18-22]. The three-dimensional CT reconstruction is done by continuous non-interval thin-layer spiral CT scanning. The technique is based on conventional two-dimensional image, with scanned data subsequently transformed into three-dimensional images[23-25]. In these images, anatomical structures can be rotated and observed from multiple angles; anatomical locations are clear, which is helpful for making accurate diagnosis. It is possible to directly judge the size and location of the tumour using three-dimensional CT reconstruction and cephalometry[26]. After some processing (enhanced scanning), overlap of the tumor and bones, or tumor invasion of the bones, can be clearly displayed. Also, the relationship between affected tissue and surrounding anatomical location can be elucidated, helping to select the best surgical approach and regimen, and to reduce unnecessary trauma and surgical risk[27,28].

We used three-dimensional CT reconstruction and cephalometry to diagnose tumors of the lateral skull base and found a good agreement between preoperative and intraoperative diagnoses. Moreover, the diagnostic accuracy of this imaging technique was superior to conventional technique. The obtained images clearly show the size and location of brain tumour, and the image can be rotated to observe from different angles, which is more direct and stereoscopic. It needs to be mentioned, though, that this technique also bears some disadvantages[29], such as high radioactive exposure and high price. This should be taken into consideration when selecting this imaging technique.

Conclusions

The three-dimensional CT reconstruction and cephalometry offers an excellent diagnostic accuracy for lateral skull base tumors.

Conflict of Interest

The Authors declare that there are no conflicts of interest.

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