

Original Article

The application of MRI in preoperative localization of glomus tumors of the fingertip

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Abstract: Objective: This study was designed to prospectively evaluate the utility of preoperative MRI with micro-coil localization of glomus tumors of the fingertip to facilitate tumor removal and to reduce recurrence rate. Methods: During a 5-year period, 15 patients clinically diagnosed with glomus tumors of the fingertip were examined with micro-coil MRI. The tumor size (diameter: D1) was estimated by MRI and statistically compared with the diameter (D2) of the actual tumors resected postoperatively using paired t-test. Patients were followed up for 1 to 3 years. Postoperative complications and recurrence were documented. Results: MRI revealed nodular glomus tumors with clear margins. Nine patients had a lesion located at subungual region, 4 presented with a paraungual lesion, and 2 in the pulp. The lesions showed low or slightly low signal in T1WI and high signal in T2WI. Complete resection of glomus tumors was performed in 15 patients by preoperative MRI localization. The diameter of the glomus tumors shown in the MRI was D1 (3.4±1.09) mm and the actual diameter was D2 (3.3±1.1) mm with no statistical significance ($P>0.05$). During postoperative follow-up, 12 cases had alleviated symptoms, no significant complications or tumor recurrence. Conclusion: MRI has great advantages in accurately identifying the location and size of the glomus tumors preoperatively, which facilitates complete excision of glomus tumors and reduces the incidence of postoperative recurrence and complications.

Keywords: Glomus tumor, fingertip, MRI, surgical treatment

Introduction

Glomus tumor is a rare benign neoplasm arising from the glomus body [1] and 75% of glomus tumors occur in the hand [2], mainly found in the fingertip, especially 65% under the fingernail [3] including nail bed and onychostroma. Partial glomus masses are located at paraungual region and finger pulp. Glomus tumor is typically characterized with triad: intermittent pain, tenderness and the pain is reproduced when the lesion is placed in the cold water. The underlying pathogenesis is still elusive. It mainly occurs in young female subjects. Most glomus tumors are benign and malignant cases are extremely rarely noted. The incidence of glomus tumor is low and it is likely to make a misdiagnosis [4]. Surgical resection is the only option in clinical settings. It is extremely challenging to thoroughly remove the tumors of small size if the accurate location of the lesion

were lacking. MRI yields high resolution in identifying soft tissue tumors, which applies to accurately locate the glomus tumors and evaluate the size and morphology of the lesion before surgery.

Materials and methods

General data

Fifteen patients with glomus tumors of the fingertip admitted to the first affiliated hospital of Sun Yat-sen University between 2009 and 2014 were enrolled, including 3 male and 12 female, aged 23-56 years, 39 years on average, course of diseases ranging from 8 months to 25 years, 5 years on average. Sites of glomus tumors: 9 cases had a lesion in subungual region, 4 in paraungual region and 2 in finger pulp. All 15 patients were manifested as typical triad: intermittent pain, tenderness and pain

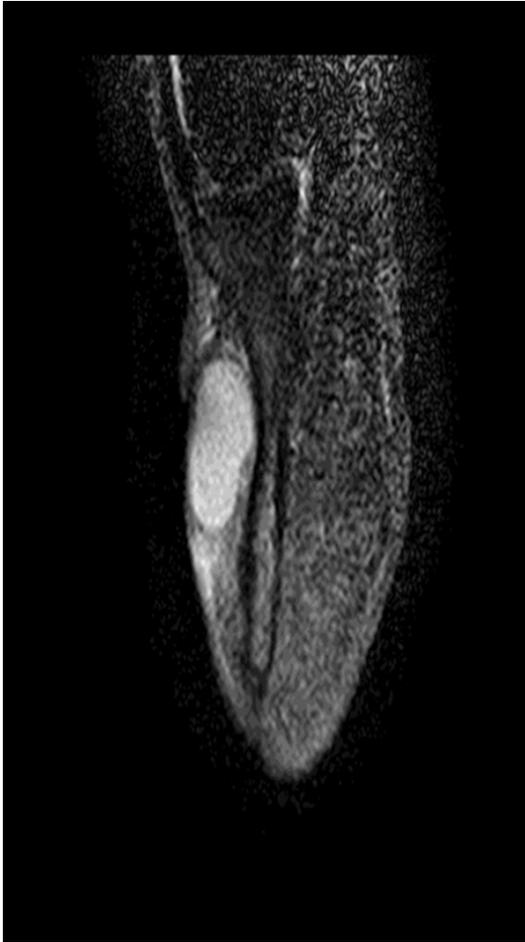


Figure 1. Nodular glomus tumor reveals a significant high signal on T2WI and FLASH sequence.

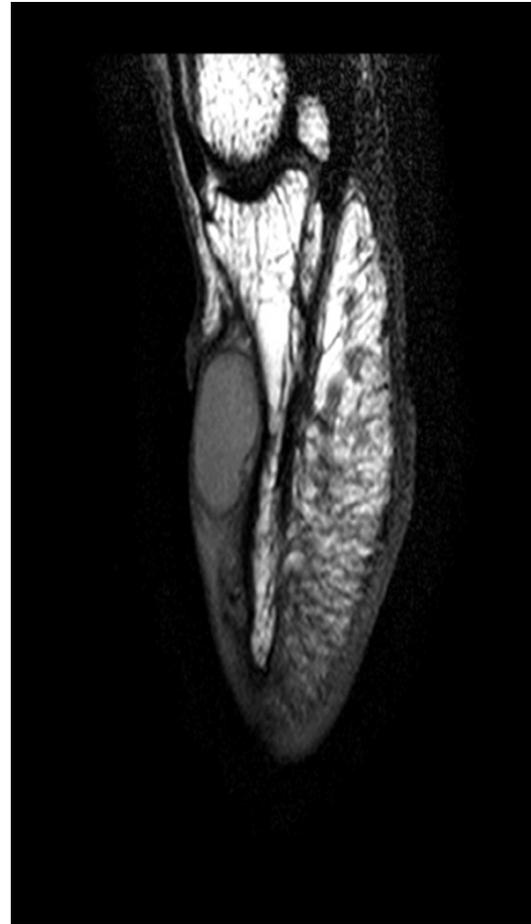


Figure 2. nodular glomus tumor in the finger pulp of the distal phalanx of ring finger reveals a slightly low T1WI signal.

irritated by cold water. They suffered from different degrees of pain and their daily life was negative affected. Certain patients had acute pain radiating to the affected finger. Emotional changes did not significantly affect the pain. All 15 cases presented with finger pain and tenderness. Punctate bluish discoloration in the subungual glomus tumors, and nail thickening and deformation were noted in 5 cases. Light greenish discoloration in the extraungual glomus tumors of 3 patients. The position, size and morphology of the lesion could not be accurately detected in the remaining 7 cases. Love test was 100% sensitive and cold sensitivity test was positive for 15 cases. Hildreth's test was positive for 11 patients and transillumination test revealed 10 positive cases. The affected nails were examined by plain X-ray (anterior and lateral view) and MRI scans prior to surgery.

MRI scan

MRI data of the affected fingers were acquired on a 1.5 T Philips Achieva Nova Dual MR scanner (Achieva Nova Dual, Philips, Netherlands) with micro-coil with an inner diameter of 23 mm. Micro-coil imaging parameters: field of view (FOV) = (25-30) mm × 30 mm~25 mm × 15 mm, NEX 4-6, slice thickness = 1.50 mm, slice interval = 0.15 mm, voxel = (0.15-0.25) mm × (0.15-0.25) mm × 1.50 mm. Scan sequence: T1WI-TSE sagittal and coronal planes (TR = 350 ms, TE = 34 ms), T2WI-TSE sagittal plane, cross section (TSE TR = 1500 ms, TE = 88 ms), T2WI-TSE-SPiR sagittal plane (TR = 1700 ms, TE = 75 ms), 3D-WATSc sequence sagittal and coronal planes (TSE-TR = 30 ms, TE = 11 ms). MR imaging software was utilized to measure the maximum diameter of the lesion on each slice and the maximum value was defined as DI.

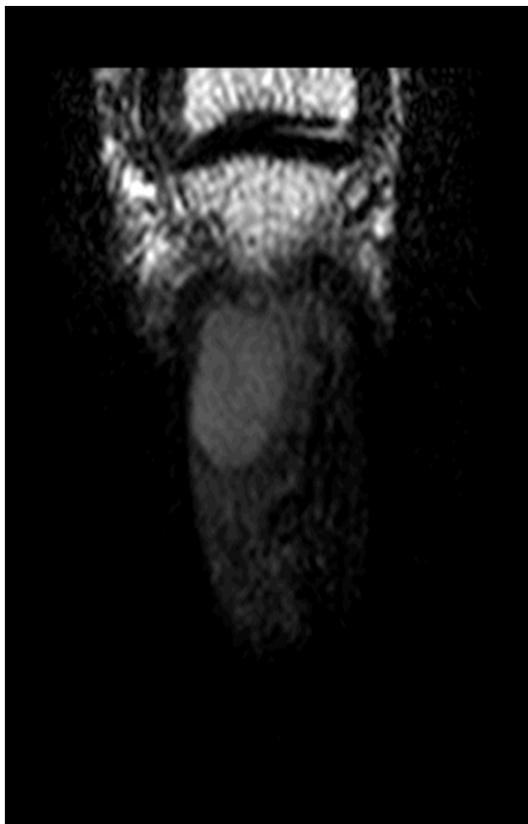


Figure 3. Coronal MRI reveals the position of the lesion in the fingertip and radioulnar anatomical relationship.

Surgical approach

All surgeries were performed under brachial plexus nerve blocking anesthesia. The patients wore pneumatic tourniquet in the upper arm. Assisted by the operating loupe, the microanatomy was performed. Prior to surgery, MRI data combined with tenderness test using a pin were adopted to locate and mark the lesion. The subungual glomus tumors were resected by excising the nail and then closed by 5-0 Vicryl suture. The paraungual glomus tumors were exposed and resected by creating lateral subperiosteum incision. The glomus tumors of the finger pulp were subject to longitudinal incision to expose and remove the tumors using preoperative mark as the center. Intraoperatively, the actual diameter of the resected glomus tumors was measured by the single physician. The tumor specimen was prepared for subsequent pathological examination.

Statistical analysis

SPSS 19.0 statistical software was used for data analysis. The D1 estimated by MRI mea-

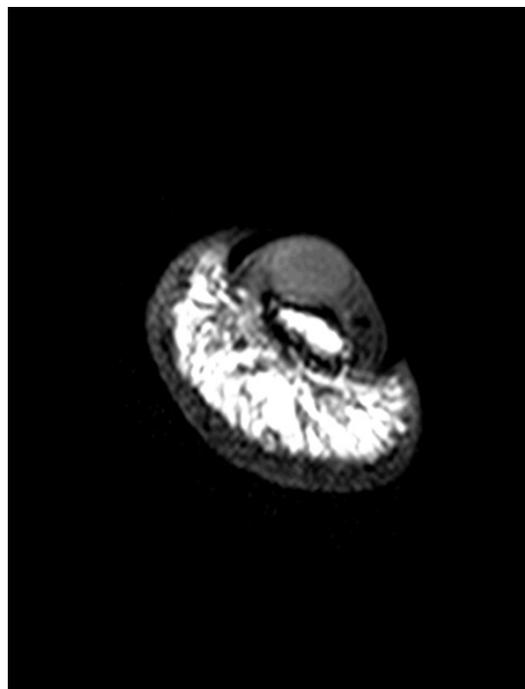


Figure 4. Axial MRI reveals the anatomical relationship between the lesion and hand palm and dorsa.

surement and D2 of the resected tumors were statistically compared by paired t-test. All data were expressed as mean \pm standard deviation ($\bar{x} \pm s$). $P < 0.05$ was considered as statistical significance.

Results

Sites of glomus tumors detected by MRI: subungual region in 9 patients, paraungual region in 4 and finger pulp in 2. Nodular lesions showed an equivalent or slightly low T1WI signal whereas an even and high T2WI and FLASH signal (**Figures 1, 2**). The explicit anatomical structure of the glomus tumors and surrounding tissues could be obtained by 3D scanning (**Figures 3, 4**). X-ray examination detected tumor depression and sclerosis in the phalanx of 2 patients. Intraoperatively, a majority of glomus tumors were seen in round shape and pink or purple red in color with clear margins. Intact tumor envelope was detected in 3 patients and no intact envelope was observed in the remaining 15 cases. Preoperatively, the estimated D1 by MRI was (3.4 ± 1.09) mm and the actual D2 measured intraoperatively was (3.3 ± 1.1) mm with no statistical significance between two measurements ($P > 0.05$) (**Table 1**). All patients had stage I wound healing after the surgery and no incidence of infection. The pain of the affect-

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Table 1. Comparison of clinical data of D1 and D2 of the glomus tumor

Affected finger	D1	D2
1	2.1	2.0
2	2.3	2.2
3	2.4	2.4
4	2.0	2.0
5	2.6	2.5
6	3.0	2.9
7	3.1	3.0
8	3.4	3.4
9	3.6	3.5
10	6.0	6.0
11	4.5	4.5
12	4.2	4.1
13	4.1	4.0
14	4.4	4.4
15	3.4	3.3

ed fingers was completely alleviated in all cases at postoperative 2 weeks. The diagnosis was confirmed by pathological examination of the resected tumor samples. Thirteen patients were followed up after the surgery, 26 months on average. During the follow-up, all preoperative symptoms were fully recovered and normal function of the fingers was obtained. Nail malnutrition was noted in merely 2 patients. No tumor recurrence was found.

Discussion

Glomus tumor is clinically manifested with triad including finger pain, tenderness and cold-irritated pain. However, the accurate position, size and shape of can not be understood by palpation. Subungual glomus tumor merely presents with nail discoloration. Tenderness test using a pin is adopted to localize the lesion during surgical removal. It is extremely difficult to precisely localize the paraungual tumor with small size before surgery. It is more challenging to detect the glomus tumor in the finger pulp preoperatively. Inaccurate localization is likely to cause wrong incision. Extended incision and excision probably aggravate nail injury and lead to unguual deformity. Meantime, it may cause incomplete removal of the tumor and enhance the recurrence rate after the surgery. Previous studies reported the postoperative recurrence rate of glomus tumor exceeded 4% [5]. Consequently, it is necessary to explore an effective

method for localizing the tumor preoperatively. MRI and ultrasound examinations play a vital role in preoperative localization of the glomus tumor.

High-frequency ultrasound examination is utilized to detect the lesion with a diameter >3 mm as low echo masses, whereas this method fails to identify the tiny tumors and platy tumors [6]. In addition, ultrasound physicians should be professional and proficient. Different physicians may yield varying findings on the same patient. It is of significance in diagnosing the paraungual and finger pulp glomus tumors. As a noninvasive approach, MRI scan yields contrast imaging between the cancer and normal tissues, thereby precisely pinpointing the position of the tumor and display the shape and size of the lesion.

Micro-coil MRI scan yields more explicit images. Micro-coil is a type of surface coil and its volume is significantly smaller than those currently used in clinical practice. It can be categorized into the large (inner diameter = 47 mm) and small coil (inner diameter: 23 mm). Commonly applied scan sequences can be adopted. Both 2D and 3D coronal, transverse and sagittal scans can be chosen according to the individual situation. Compared with conventional MR scan, it has smaller voxel decreased to 0.08 mm × 0.10 mm × 1.00 mm-0.25 mm × 0.25 mm × 1.00 mm and higher spatial resolution [7]. In the invariable main magnetic field strength, the smaller coil receives lower noise and smaller voxel guarantees the signal-to-noise ratio of the images, contributing to generating images with higher resolution [8]. In this study, micro-coil MRI scan yields high-resolution images and the glomus tumors with a diameter of 2 mm could be explicitly displayed, which serves as a more reliable method for preoperative localization of the glomus tumor.

MRI with micro-coil is an effective approach for the diagnosis and preoperative localization of glomus tumors of the fingertip. Understanding the position, size and morphology of the glomus tumor contributes to complete removal of the glomus tumor, thereby decreasing postoperative recurrence rate. The findings in this study demonstrate that MRI with micro-coil is of significance in preoperative localization of small glomus tumors, especially paraungual and finger pulp lesions.

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Disclosure of conflict of interest

None.

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