


Granular Cell Tumor of the Ulnar Nerve: MR Neurography Characterization

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ABSTRACT

The authors report an unusual case of ulnar neuropathy caused by granular cell tumor. The report describes the anatomic 3 Tesla MR Neurography and functional diffusion tensor findings of the case, which was subsequently confirmed on surgical excision and histopathology.

CASE REPORT

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A 32-year-old woman working as a computer professional and spending many hours during the day typing noticed progressive and gradual weakness as well as inability to use her right fingers during fine manipulation. The symptoms gradually worsened over many months. The weakness especially involved her index finger and there was co-existent decreased grip strength. She also noticed progressive atrophy of her 1st dorsal web space muscles. There was no history of trauma involving the right upper limb. On examination, the patient had profound loss of 1st web space musculature and Froment Sign was positive. During Froment sign testing, the patient is asked to hold a flat object between her thumb and index finger and the clinician attempts to pull the object out of her hands – to evaluate the function of Adductor Pollicis. There was some sensory deficit over the middle finger, index finger and the thumb, while sensation was preserved in the small and ring fingers. She also reported weakness with adduction and abduction of her fingers. Tinel's sign (tapping on the posterior aspect of medial epicondyle that elicits a "pins and needles" sensation along the peripheral nerve distribution) was positive at the forearm just distal to the elbow and also slightly above the elbow. Electrophysiology revealed right ulnar neuropathy and localized it to possibly at the Guyon's canal or distally into the hand. There was selective denervation of first dorsal interosseus muscle without involvement of adductor digit minimi and right ulnar sensory

action potential amplitude was reduced. Mild median neuropathy was also observed.

Imaging Findings

High Resolution MR Neurography of the right wrist was ordered to rule out ulnar nerve entrapment. The patient was imaged within a month of the examination and 3 Tesla MR Neurography (MRN) protocol was followed as described in prior publication [1]. Diffusion tensor imaging was also obtained using single shot echo planar imaging with 3 diffusion moments (0, 800 and 1000 s/mm²) and 12 directions of interrogation. The examination revealed moderate T2 signal hyperintensity of the ulnar nerve in the Guyon's canal with predominant involvement of its deep branch (Fig. 1a). Distal to the Guyon's canal, there was fusiform enlargement of the deep branch with T1 isointensity and heterogeneous T2 signal intensity (Fig. 1b). The lesion measured 1.8 cm x 0.4 cm (Fig. 2). Denervation edema like T2 hyperintensity and mild atrophy was observed in the first and second intraosseous muscles. In addition, there were findings suggestive of carpal tunnel syndrome, including moderate T2 hyperintensity of the median nerve, abnormal bowing of the flexor retinaculum, effacement of the deep carpal fat pad and abnormal flattening in the carpal tunnel with proximal enlargement. On DTI, there was low apparent diffusion coefficient (ADC) in the mass lesion, measuring 0.7-0.8 x 10⁻³ mm²/s (Fig. 3). The ulnar nerve also showed low fractional anisotropy (FA) of 0.1-0.2 and the median nerve showed decreased FA 0.3-0.4. Low

fractional anisotropy have been shown to be associated with demyelination and /or axonal degeneration in various peripheral neuropathy studies. Low ADC values although seen with high cellularity tumors, can also be observed with these lesions. The differential diagnosis of ulnar nerve lesion included posttraumatic neuroma, ganglion cyst, peripheral nerve sheath tumor, lymphoma or sarcoma. Posttraumatic neuroma was however, felt unlikely due to no history of prior penetrating injury and low ADC values. There was no prior history of systemic or nerve lymphoma. Intravenous gadolinium imaging was recommended for further characterization and confirmation of the tumor. Repeat imaging was obtained within a week of initial imaging and included time resolved MR angiogram (MRA) and pre- and post-contrast 3D T1W VIBE (volume interpolated breathhold examination, Siemens, Erlangen, Germany) technique followed by subtraction imaging. MRA showed delayed and progressive enhancement of the lesion on capillary and venous phases. Subtraction images demonstrated homogeneous fusiform enhancement localized to the lesion (Fig. 4). The remaining ulnar nerve did not enhance.

Management & Follow up

The patient subsequently underwent open carpal tunnel release with right ulnar nerve neurolysis at the Guyon's Canal. A fusiform mass with yellow firm tissue (within the fascicles) was identified as the nerve was neurolyzed distally in the palm area. The mass was dissected from within the ulnar nerve with careful preservation of motor fascicles. Histopathology revealed cells with eosinophilic "granular cytoplasm" and the tumor was found to be strongly positive for S100 protein, thus confirming the diagnosis of granular cell tumor (Fig. 5, 6). Postoperatively, mild functional improvement in ulnar nerve motor function was noted with increased hand strength over 3-month follow-up and the patient is being followed up by oncology service.

DISCUSSION

Ulnar neuropathy is most commonly caused by entrapment or trauma [2]. A granular cell tumor (GrCT) arising in the ulnar nerve is extremely rare and the radiologist should be vigilant in differentiating such a tumor from the more commonly occurring mass like lesions of the nerve, such as post traumatic neuroma.

Etiology

Granular cell tumor (GrCT) is an uncommon neoplasm with predilection towards skin, soft tissue, and the upper aerodigestive tract, especially involving the tongue and vocal cords. It has a slight preponderance towards premenopausal women. The exact histogenesis of this tumor is unclear, although ultrastructural and immunohistochemical studies suggest that these lesions may originate from the Schwann Cells, showing reactivity with S100 protein, inhibin, neuron-specific enolase, and myelin-specific protein as in this case [3,4]. The tumors are solitary and appear gray-white to yellow in cross-section. They have a characteristic histological appearance composed of cells showing PAS positivity and abundant lysosome rich eosinophilic "granular" cytoplasm

(hence the name Granular Cell Tumor) [5]. Though the tumor is considered to be of Schwann cell origin, it very rarely involves the major peripheral nerves. Only four cases of GrCT of the peripheral nerves have been reported. Three arose in the ulnar nerve, and one in the tibial nerve [6-8]. Similar to our case, all of them presented with features of mononeuropathy.

Imaging Findings

On conventional MR Imaging, GrCT is T1 iso to hyperintense, round or oval in shape, superficially located, well defined, and less than 4 cm in size. These lesions may demonstrate peripheral T2 hyperintensity with/without central isointensity. Post contrast studies show uniform enhancement following administration of gadolinium. Both benign and malignant variants of these lesions have been described and larger size >4cm, heterogeneous signal intensity / enhancement and local invasive features may suggest malignancy [9]. In the present case, the lesion was small but heterogeneous. Anatomic MR Neurography confirmed neuropathies of deep branch of ulnar and median nerves and associated regional muscle denervation changes supporting the clinical and electrophysiology findings. Additionally, tumor involvement of the deep branch of the ulnar nerve was detected, later confirmed on surgery. The mass lesion could be prospectively differentiated from post-traumatic neuroma as there was post-contrast enhancement of the lesions (whereas neuromas show no enhancement) and from a peripheral nerve sheath tumor, such as schwannoma or neurofibroma due to lack of classic radiologic signs, such as target sign and fascicular sign [10]. The more common ganglion cyst shows hypointensity on T1 weighted images and no or little peripheral post-contrast enhancement, and thus could be excluded [11]

DTI also confirmed ulnar and median neuropathy suggested by anatomic imaging findings and low FA values [12,13]. Although, there was delayed enhancement in the lesion reflecting lack of neoangiogenesis, malignancy could not be excluded, especially in the presence of low ADC values [12]. Low ADC was also contrary to the findings seen in other benign peripheral nerve sheath tumors that exhibit higher ADC values of more than $1.1-1.2 \times 10^{-3} \text{mm}^2/\text{s}$.

Treatment & Prognosis

Lack et al had reported 110 cases of GrCTs and observed an 8% recurrence rate in the patients who underwent resection of the tumor, but these cases involved organs other than major peripheral nerves, such as skin and breast [14]. Thus, the recurrence rate after excision of these tumors is unknown for peripheral nerves and it is believed that macroscopic excision and nerve grafting is most appropriate treatment [7]. Our case received nerve preserving tumor excision and no grafting was needed. The patient showed motor functional improvement during short-term follow-up at 12 weeks.

TEACHING POINT

Magnetic Resonance Neurography with Diffusion Tensor Imaging is an excellent technique for detection of neuropathic changes in peripheral nerves and regional muscles, and prudently aids in the preoperative diagnosis, localization, and

characterization of tumors and tumor like lesions of the peripheral nerves. Granular cell tumor characteristically shows iso-to-hyperintensity on T1W images, hyperintensity on T2W images, post-contrast delayed enhancement and low Apparent Diffusion Coefficient (ADC) values on Diffusion Tensor Imaging.

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FIGURES

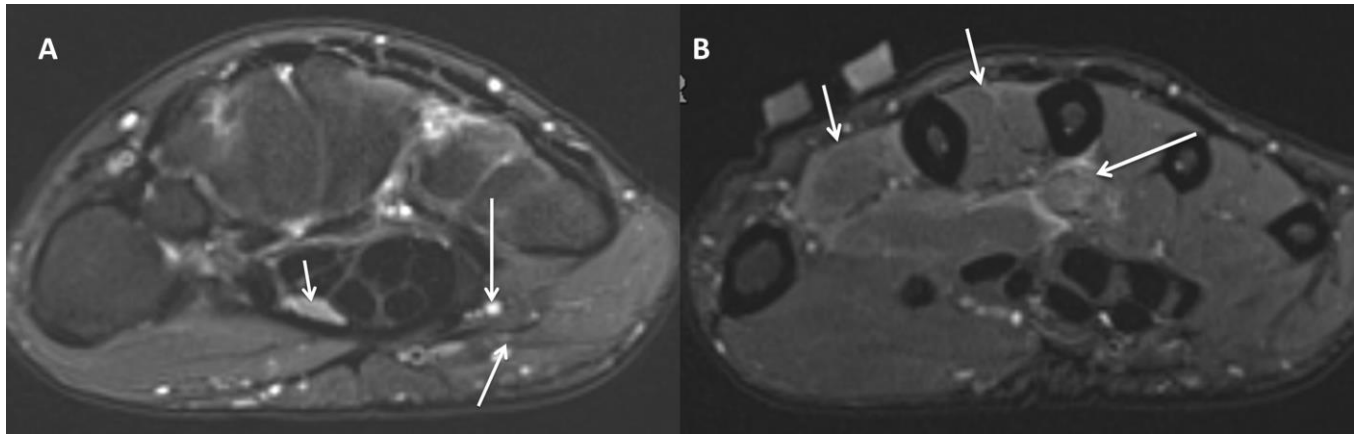


Figure 1: A 32 year old female with Granular Cell Tumor of the right Ulnar Nerve. Axial T2 SPAIR (spectral adiabatic inversion recovery) image (A) through the carpal tunnel shows moderately hyperintense and flattened median nerve (small arrow) with bowing of the flexor retinaculum in keeping with carpal tunnel syndrome. Note moderate hyperintensity and mild enlargement of the deep branch of the ulnar nerve (large arrow) and normal isointense sensory branch (medium arrow). Distally in palm (B), there is heterogeneous lesion of the deep branch of ulnar nerve (large arrow) and notice denervation edema in the 1st and 2nd interossei muscles (small arrows). (Protocol: 3 Tesla magnet strength, 3 mm slice thickness, TR: 4000ms, TE: 68ms)



Figure 2 (left): A 32 year old female with Granular Cell Tumor of the right Ulnar Nerve. Coronal 3D PSIF (diffusion weighted reversed steady state in free precession) image with maximum intensity projection shows uniform fat suppression and vascular signal suppression. Notice diffusely hyperintense ulnar nerve (medium arrows) with normal sensory nerve (small arrow) and fusiform mass lesion of the deep branch (large arrow). (Protocol: 3 Tesla magnet strength, 3D 1.1 mm isotropic imaging, TR: 10 ms, TE: 4 ms, diffusion moment- 80 s/mm²)

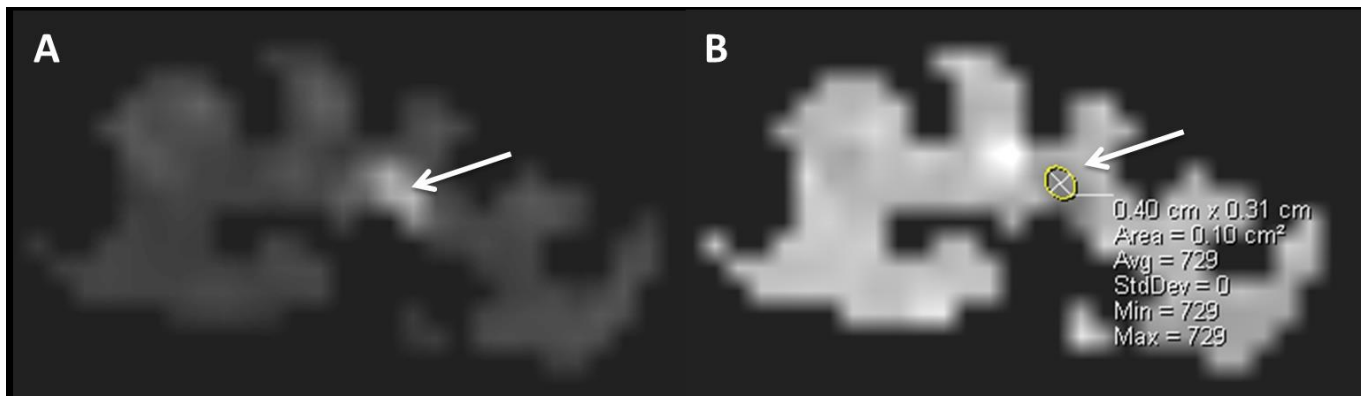


Figure 3: A 32 year old female with Granular Cell Tumor of the right Ulnar Nerve. Diffusion Tensor Imaging. Tensor map through the palm (A) shows good fat suppression and selective depiction of hyperintense mass lesion (arrow). Apparent Diffusion Coefficient (ADC) map (B) shows low ADC value in the lesion ($0.7 \times 10^{-3} \text{ mm}^2/\text{s}$). (Protocol: 3 Tesla magnet strength, $2.7 \times 2.7 \times 5 \text{ mm}$ slice thickness, TR: 3800ms, TE: 76ms, diffusion moments-0,800,1000s/mm², 12 directions of interrogations)



Figure 4: A 32 year old female with Granular Cell Tumor of the right Ulnar Nerve. Magnetic Resonance Subtraction Angiogram of wrist and hand (A,B) shows no enhancement of lesion in the arterial phase with normal ulnar and median arteries (A), and delayed and persistent enhancement of the lesion in the venous phase (arrows). Post contrast 3 Dimensional T1 volumetric interpolated breath hold examination (3D T1VIBE) (C) image shows the homogeneous enhancement in the lesion (arrow). (Protocol: 3 Tesla magnet strength, time resolved MR angiogram, VIBE: TR: 4ms, TE: 1.5ms, 3D 0.8 mm thick isotropic imaging.)

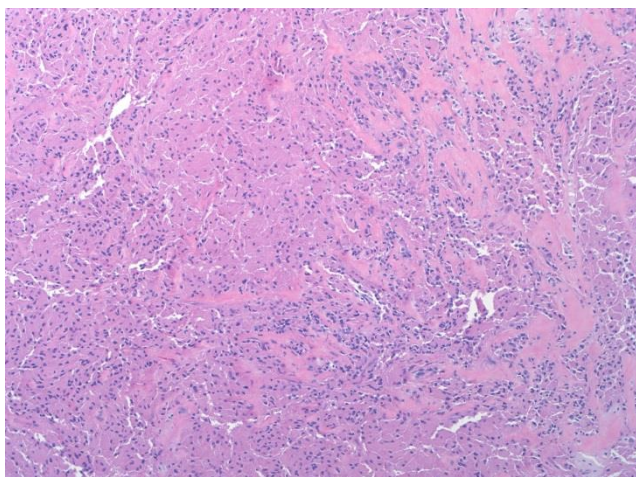


Figure 5 (left): A 32 year old female with Granular Cell Tumor of the right Ulnar Nerve. Histology Image. An ulnar nerve nodule comprised of large polygonal cells with eosinophilic cytoplasm, the background stroma is sclerosed in areas. (Magnification 40X)

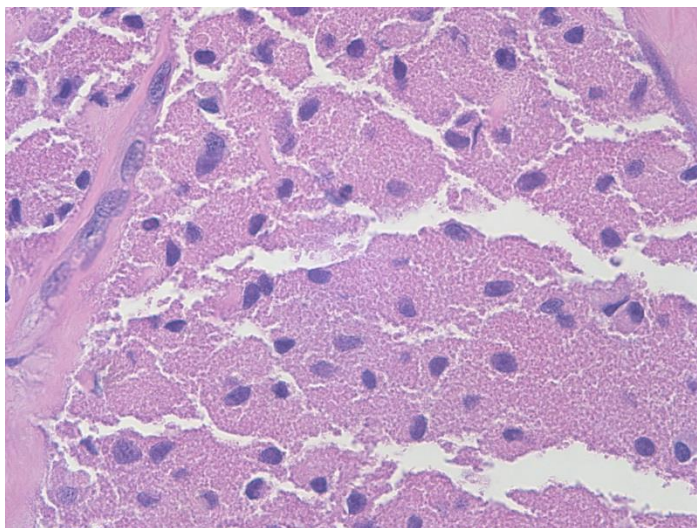


Figure 6 (left): A 32 year old female with Granular Cell Tumor of the right Ulnar Nerve. Histology Image. The cells have coarsely granular cytoplasm with rounded small centrally located nuclei, confirming the diagnosis of Granular Cell Tumor. (Magnification 260X)

Etiology	Unknown (may arise from the Schwann Cells)
Incidence	About 21 cases reported in peripheral nerves
Gender Ratio	Not Known
Age Predilection	Slight Preponderance In Premenopausal Women
Risk Factors	Not Known
Treatment	Macroscopic Excision And Nerve Grafting
Prognosis	Usually benign neoplasm; may cause local compressive symptoms and morbidity.
Imaging Findings	Magnetic Resonance Imaging (MRI) – T1W iso to hyperintense; T2W hyperintense with central isointensity; Post contrast- enhancement present Diffusion Tensor Imaging (DTI) - low Fractional Anisotropy (FA) values in the affected nerve reflecting neuropathy, low Apparent Diffusion Coefficient (ADC) Values ($<1.1 \times 10^{-3} \text{mm}^2/\text{s}$)

Table 1: Summary table for Granular Cell Tumor

	X-Ray	CT	MRI	Contrast Study
Granular Cell Tumor	No calcification or fat density	Soft tissue mass along the nerve with increasing heterogeneity if larger size	T1 - iso to hyperintense, round or oval in shape, superficially located, well defined, and less than 4 cm in size. T2 - peripheral hyperintensity with/without central isointensity.	Uniform enhancement following administration of gadolinium.
Post Traumatic Neuroma	No fat density. Rarely calcification in chronic stage	Mass along the course of the nerve as end bulb neuroma or neuroma in continuity	T1-Iso to hypointense oval shape T2- Heterogeneously hyperintense Other regional soft tissue or bony signs of injury	No appreciable enhancement
Peripheral Nerve Sheath Tumor	Soft tissue density mass. Internal calcification may be seen.	Isodense mass with enhancement on contrast imaging. Internal calcification or necrosis / cystic changes may be seen.	Classic MRI signs- tail sign, target sign, fascicular sign, split fat sign, 'bag of worms' sign.	Targetoid, diffuse, peripheral or central enhancement.
Ganglion Cyst		Cystic non-enhancing lesion of mucoid density.	Uni-or-multilocular elongated mass; hypointense on T1, hyperintense on T2W imaging.	No or peripheral enhancement following contrast administration.

Table 2: Differential diagnosis table for Granular Cell Tumor

ABBREVIATIONS

ADC - apparent diffusion coefficient
 DTI - Diffusion Tensor imaging
 FA - fractional anisotropy
 GrCt - Granular Cell Tumor
 MRA - MR angiogram
 MRN - Magnetic Resonance Neurography
 VIBE - volume interpolated breathhold examination

KEYWORDS

MR Neurography; MRN; Granular Cell Tumor; Ulnar Nerve; Sarcoma

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