

Magnetic Resonance Spectrum Technique in the Follow-up of an Ulnar Nerve Injured Patient

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Summary: A 49-year-old Chinese man sustained laceration of the right forearm by a dagger, with his right ulnar nerve completely transected. Four months postinjury, he underwent surgery to repair the nerve. He was examined by electromyogram, nerve conduction velocity, magnetic resonance imaging, and proton magnetic resonance spectroscopy (¹H-MRS) 6, 12, 18, and 24 months after the injury. Before surgery, intramyocellular lipid (IMCL)/creatinine (Cr) and extramyocellular lipid (EMCL)/Cr were observed to be higher than those of the uninjured side. During the recovery, IMCL/Cr and EMCL/Cr became lower and closer to the uninjured side. This case demonstrates that the change of IMCL/Cr and EMCL/Cr may be related to the recovery of peripheral nerve. (*Plast Reconstr Surg Glob Open* 2015;3:e403; doi: 10.1097/GOX.0000000000000368; Published online 20 May 2015.)

In personal injury cases, ulnar nerve injury is a common comorbidity resulting from the defense wound of upper extremity, which leads to a drastic loss of hand function. Currently, electrophysiological tools serve as one of the most frequently used methods to assess the reinnervation of hand intrinsic muscle during recovery. One of the disadvantages is its invasiveness and painfulness, with a small but definite risk of direct injury to nerves, blood vessels, and vital structures.¹ In the present study, we report the utility of magnetic resonance spectroscopy (MRS), as a new noninvasive technique to aid the evaluation of hand muscle reinnervation, by detecting various metabolite concentrations of hand muscles, includ-

ing creatine (Cr), intramyocellular lipid (IMCL), and extramyocellular lipid (EMCL).

CASE REPORT

A 49-year-old man sustained laceration of the right forearm by a dagger. He was diagnosed with ulnar nerve rupture. Four months postinjury, he underwent surgery to repair the nerve. His hand demonstrated a “claw-hand” like abnormal position. He was examined by electromyogram (EMG), nerve conduction velocity (NCV), magnetic resonance imaging (MRI), and MRS 6, 12, 18, and 24 months after injury.

Two months after surgery, he came to hospital for postoperation follow-up. EMG indicated that the fibrillation potential and positive sharp waves had been alleviated, the recruitment response had increased, and the pathologic spontaneous activities had been reduced. Motor nerve conduction study of his injured ulnar nerve revealed a prolonged latency and low amplitude at the abductor digiti minimi and at the fourth interosseous muscle. Sensory nerve conduction study demonstrated a slightly prolonged latency and low amplitude on the fourth finger; sensory conduction was absent on the fifth finger. During the follow-up, sensory conduction tests showed

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that latency and amplitude of the fifth finger were still absent. Simultaneously, the latency of the fourth finger was longer, and the amplitude of the finger was significantly higher (Table 1).

MRI showed that the interossei muscles were atrophied at first test and that proliferation fibrous tissue was present. During follow-up, the muscles regained fullness and the muscle fibers became thicker (Fig. 1). The volume of the first dorsal interosseous muscle became larger (Table 2).

The concentration of metabolites was defined as the integral value of metabolite peaks detected by MRS. IMCL/Cr and EMCL/Cr of the injury side were much higher than those of the uninjured side at first test. During the follow-up, we found that the data of IMCL/Cr began to decrease and came to approach that of the uninjured side at 14 months after surgery. The trend of EMCL/Cr was also decreasing back toward normal (Table 2).

DISCUSSION

Almost all ulnar nerve injury cases were diagnosed with clinical, neurological, and electrophysi-

ological findings. Peripheral nerves, including ulnar nerve, have the capacity to regenerate after injury. But there is no surgical repair technique that can assure recovery of tactile discrimination in the hand of an adult patient following nerve repair.² Because ulnar nerve serves as a major nerve innervating the distal fine intrinsic hand muscles, the injury repair outcomes for ulnar nerve were drastically inferior than those for median and radial nerves.³

The rapid growth spurt of nerve regeneration was 15 days to 6 months after injury. This patient's ulnar nerve was repaired 4 months after injury. In addition, he followed his surgeon's advice to carry out rehabilitation training. At his last visit, he reported a partial recovery of motor function, as manifested by a better utilization of the injured hand in daily life. Contrarily, we have not found any recovery of tactile or temperature sensation on the pulp of his fifth finger. Through the results of several EMG and NCV tests, we found that the results accorded with clinical manifestation—his sensory nerve was still not yet recovered. MRI showed that his interosseous muscles obviously became larger.

Table 1. Results of EMG and NCV

	EMG (The First Interosseous Muscle)		NCV			
	Relax		Motor Nerve Conduction (Abductor Digiti Minimi/The Fourth Interosseous Muscle)		Sensory Nerve Conduction (Fourth Finger/Fifth Finger)	
	Fibrillation Potential	Positive Sharp Waves	Latency (ms)	Amplitude (mV)	Latency (ms)	Amplitude (μV)
Uninjured side	–	–	3.2/2.7	13.2/10.0	2.0/2.0	14.2/12.6
2 Months after surgery	++	++	18.8/12.9	0.2/0.2	2.2/0.0	0.8/0.0
8 Months after surgery	+	++	6.2/7.0	3.4/2	2.0/0.0	3.5/0.0
14 Months after surgery	+	++	3.9/5.4	11.7/1.1	15.7/0.0	53.7/0.0
20 Months after surgery	–	+	3.0/5.0	12.8/4.0	13.6/0.0	48.3/0.0

NCV, nerve conduction velocity.

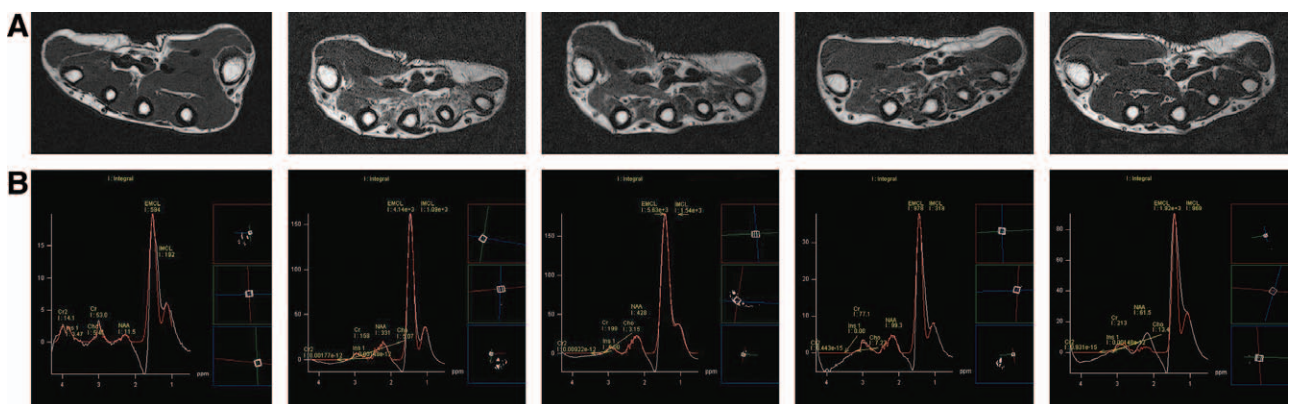


Fig. 1. A, MRI of uninjured side, 2 months after surgery, 8 months after surgery, 14 months after surgery, and 20 months after surgery. B, MRS of uninjured side, 2 months after surgery, 8 months after surgery, 14 months after surgery, and 20 months after surgery.

Table 2. The Volume of the First Dorsal Interosseous Muscle and the Peak Areas of Metabolites

	Volume (mm ³)	Cr	IMCL	EMCL	IMCL/Cr	EMCL/Cr
The uninjured side	7.28	53	192	594	3.6	3.1
2 Months after surgery	3.11	158	1090	4140	6.9	26.2
8 Months after surgery	3.3	199	1540	5630	7.7	28.3
14 Months after surgery	4.55	77	318	978	4.1	12.7
20 Months after surgery	4.81	213	969	1920	4.5	9

MRS of skeletal muscle had been applied for a long time, particularly for studies of high-energy phosphates (by ³¹P-MRS) and glycogen (by ¹³C-MRS).⁴ But we chose ¹H-MRS and observed Cr, EMCL, and IMCL. We had 2 reasons. First, hydrogen has high natural abundance and high sensitivity, which made it easier to be tested than other nuclei. Second, almost all clinical magnetic resonance scanners do not support ³¹P-MRS and ¹³C-MRS. They were mostly applied in research institutes. But ¹H-MRS can be implemented on regular clinical MR scanners successfully. Cr reflected the state of energy metabolism. Some researchers considered that Cr level was relatively stable in one's body most of the time and believed that it can be used as an inner reference to compare relative content of IMCL and EMCL.⁵ So, we compared the IMCL/Cr and EMCL/Cr. We supposed the changes were related with the fat and fibrous connective tissues. Before surgery, the muscles were atrophying and the fibrous connective tissues were proliferating in degenerative phase, and simultaneously, increased IMCL/Cr and EMCL/Cr were observed. After surgery, the muscles thickened, and decreased IMCL/Cr and EMCL/Cr were observed in regenerative phase. Before this case, our other research of healthy volunteers showed the average of IMCL/Cr and EMCL/Cr as 1.5 and 3.9.⁶ At his last visit, the IMCL/Cr and EMCL/Cr close to those of his uninjured side and to healthy volunteers' average.

In this case, some correlations were found among the electrophysiology, muscle morphology, MRS results, and clinical functional recovery. The noninvasion of MRS was a great advantage. To apply our findings in clinical diagnosis and prognosis evaluation, further experiments and more cases are needed.

CONCLUSION

MRS can be used as a noninvasive tool for evaluating peripheral nerve injury and may be a promising diagnostic tool.

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We confirm that we have adhered to the tenets of the Declaration of Helsinki.

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