DOI: https://doi.org/10.17816/DD568545

Optimization of Magnetic Resonance Imaging of the Hand

Yuriy A. Vasilev, Dmitry S. Semenov, Alexey V. Petraikin, Andrey A. Uchevatkin, Liya R. Abuladze, Alexander V. Bazhin, Dariya E. Sharova

Research and Practical Clinical Center for Diagnostics and Telemedicine Technologies, Moscow, Russia

ABSTRACT

BACKGROUND: Magnetic resonance imaging is one of the leading imaging modalities of the musculoskeletal system. However, when imaging the hand, major problems in magnetic resonance imaging include the lack of specialized coils and reliable fixation devices for the hand, uncomfortable patient posture, motion artifacts, and small anatomical structures in the wrist. These factors inevitably lead to incorrect interpretation.

AIM: To improve the quality of magnetic resonance imaging of the hand by developing an approach to coil selection, scanning protocol, and hand positioning and fixation.

MATERIALS AND METHODS: A positioning device was developed to prevent hand movements. Two types of coils were evaluated. Magnetic resonance images were evaluated comparatively, as well as by a musculoskeletal radiologist.

RESULTS: A head coil is more appropriate when scanning the entire hand, for example, in rheumatic diseases. A knee coil is more appropriate when studying smaller anatomical structures (including the wrist) owing to a smaller field of view and higher resolution. Based on the obtained data, guidelines for the selection of scanning parameters, sequences, and coils for magnetic resonance imaging of the hand were formulated. To prevent motion artifacts, a special fixation device of the patient's hand was introduced.

CONCLUSION: Certain factors directly affect the qualitative magnetic resonance imaging study of the hand, such as safety protocols, scanning parameters, and hand fixation. The guidelines presented in this study and the use of the developed specialized fixation device may improve the quality of magnetic resonance imaging of the hand.

Keywords: magnetic resonance imaging; hand; wrist; optimization.

To cite this article:
Vasilev YuA, Semenov DS, Petraikin AV, Uchevatkin AA, Abuladze LR, Bazhin AV, Sharova DE. Optimization of magnetic resonance imaging of the hand. *Digital Diagnostics.* 2024;5(2):269–282. DOI: https://doi.org/10.17816/DD568545

Submitted: 31.10.2023 **Accepted:** 16.11.2023 **Published online:** 19.06.2024

DOI: https://doi.org/10.17816/DD568545

Магнитно-резонансная томография кисти: оптимизация сканирования

Ю.А. Васильев, Д.С. Семенов, А.В. Петряйкин, А.А. Учеваткин, Л.Р. Абуладзе, А.В. Бажин, Д.Е. Шарова

Научно-практический центр диагностики и телемедицинских технологий, Москва, Россия

АННОТАЦИЯ

Обоснование. Магнитно-резонансная томография — один из ведущих методов лучевой диагностики патологических изменений опорно-двигательного аппарата, в том числе лучезапястного сустава и кисти. Основными проблемами, с которыми встречаются рентгенолаборанты и врачи-рентгенологи при выполнении магнитно-резонансной томографии кисти, являются отсутствие специализированной катушки и надёжного фиксирующего устройства для кисти, а также неудобная поза пациента, что в итоге приводит к чрезмерной двигательной активности пациента во время исследования и снижению качества получаемых изображений. В дополнение к этому, лучезапястный сустав и кисть состоят из множества небольших анатомических структур, детальная визуализация которых требует удлинения времени сканирования, что в свою очередь является дополнительным фактором риска получения некачественных изображений из-за двигательной активности пациента, повышая вероятность некорректной интерпретации исследования врачом-рентгенологом.

Цель — улучшить качество изображений, полученных в ходе магнитно-резонансной томографии кисти, путём разработки стандартизованного подхода к выполнению исследования: выбор катушки, укладка пациента, осуществление фиксации кисти, а также выбор протокола сканирования и параметров импульсных последовательностей.

Материалы и методы. Разработана лонгета для предупреждения движений кисти и выполнены исследования с применением двух видов радиочастотных катушек. Проведена сравнительная оценка изображений по техническим параметрам, а также оценка врачом-рентгенологом, специализирующимся на скелетно-мышечной визуализации, на предмет качества изображений в зависимости от цели исследования.

Результаты. Применение катушки для исследования головы (головной катушки) более целесообразно при необходимости сканирования всей кисти (например, при ревматологических заболеваниях), применение коленной катушки — при необходимости более детальной оценки анатомических структур (в том числе запястья), ввиду меньшего поля обзора и более высокого разрешения. На основании полученных данных были сформулированы рекомендации по проведению магнитно-резонансной томографии кисти: выбор радиочастотной катушки, протокола сканирования, параметров импульсных последовательностей. Кроме того, нами предложена лонгета для фиксации кисти пациента с целью нивелирования избыточных движений и предотвращения возникновения артефактов.

Заключение. Для качественного выполнения магнитно-резонансной томографии кисти требуется учитывать ряд факторов: правила безопасности при проведении магнитно-резонансной томографии, настройка параметров сканирования, грамотная фиксация кисти в катушке. Соблюдение рекомендаций, которые предлагаются в данной работе, а также применение разработанной лонгеты позволяют улучшить качество полученных изображений при магнитно-резонансной томографии кисти.

Ключевые слова: магнитно-резонансная томография; кисть; лучезапястный сустав; оптимизация.

Как цитировать:
Васильев Ю.А., Семенов Д.С., Петряйкин А.В., Учеваткин А.А., Абуладзе Л.Р., Бажин А.В., Шарова Д.Е. Магнитно-резонансная томография кисти: оптимизация сканирования // Digital Diagnostics. 2024. Т. 5, № 2. С. 269–282. DOI: https://doi.org/10.17816/DD568545

Рукопись получена: 31.10.2023 **Рукопись одобрена:** 16.11.2023 **Опубликована online:** 19.06.2024

DOI: https://doi.org/10.17816/DD568545

手部磁共振成像：扫描优化

Yuriy A. Vasilev, Dmitry S. Semenov, Alexey V. Petraikin, Andrey A. Uchevatkin, Liya R. Abuladze, Alexander V. Bazhin, Dariya E. Sharova

Research and Practical Clinical Center for Diagnostics and Telemedicine Technologies, Moscow, Russia

摘要

论证。磁共振成像是对包括腕关节和手部在内的肌肉骨骼系统病变进行放射诊断的主要方法之一。放射技师和放射科医生在进行手部磁共振成像时遇到的主要问题是缺乏专用线圈和可靠的手部固定装置，以及病人的姿势不舒适。这最终会导致患者在检查过程中过度移动，并降低所获图像的质量。此外，腕关节和手部由许多细小的解剖结构组成，对这些结构的详细观察需要更长的扫描时间。反过来，由于患者的运动活动，这也是造成图像质量差的一个额外风险因素。这就增加了放射科医生对检查做出错误解释的可能性。

目的是通过制定标准化的检查方法，提高手部磁共振成像的图像质量：线圈选择、患者定位、手部固定以及扫描方案和脉冲序列参数的选择。

材料和方法。开发了一种防止手部运动的绷带，并使用两种射频线圈进行了检查。一名专门从事肌肉骨骼成像的放射科医生对图像的技术参数进行了比较评估，并根据研究目的对图像质量进行了评估。

结果。当需要扫描整个手部（如风湿病）时，头部线圈更为合适。膝部线圈的视野较小，分辨率较高，可用于对解剖结构（包括腕部）进行更详细的评估。根据获得的数据，我们制定了手部磁共振成像的建议：选择射频线圈、扫描方案和脉冲序列参数。此外，我们还提出了固定患者手部的绷带，以平缓过度运动和防止伪影。

结论。要保证手部磁共振成像的质量，需要考虑以下几个因素：磁共振成像过程中的安全规则、扫描参数的调整以及手部在线圈中的正确固定。遵守本文提出的建议以及使用开发的绷带可以提高手部磁共振成像的质量。

关键词：磁共振成像；手部；腕关节；优化。

引用本文：
Vasilev YuA, Semenov DS, Petraikin AV, Uchevatkin AA, Abuladze LR, Bazhin AV, Sharova DE. 手部磁共振成像：扫描优化. *Digital Diagnostics.* 2024;5(2):269–282. DOI: https://doi.org/10.17816/DD568545

收到： 31.10.2023 **接受：** 16.11.2023 **发布日期：** 19.06.2024

BACKGROUND

Magnetic resonance imaging (MRI) is a crucial imaging modality for diagnosing abnormalities in human musculoskeletal structures. It is widely used owing to the absence of radiation exposure and high contrast enhancement of soft tissues. MRI has a high diagnostic accuracy in evaluating lesions of cartilage, ligaments, mass lesions, and bone marrow [1]. However, to evaluate the small structures of the hand and obtain high-quality MRI scans, several conditions should be met: the radiologist should follow general MRI precautions [2], use correct sequences, and use special radiofrequency (RF) coils and accessories to fix the hand position. The disadvantages of MRI include its limited availability [3] and high cost [4].

For radiologists, one of the challenging aspects in interpreting hand MRI is that the hand is composed of small structures; thus, imaging and interpretation of pathological changes in the hand tissues is directly dependent on the skill and expertise of the radiologist and on the quality of the image [5]. For example, radiologists with expertise in diagnosing musculoskeletal disorders were shown to provide more detailed interpretations than those with less experience [1]. For patients, the key factors for obtaining high-quality images are proper positioning and fixation of the patient's hand and minimizing motor activity throughout the examination. Motion is a common source of MRI artifacts. Artifacts appear as blurred margins of structures and thus reduce the informational value of the examination [6]. Two types of motion can cause artifacts: internal, caused by physiological processes (e.g., blood flow in the vessels), and external, which are directly related to the patient's active or passive movements during the examination. Flow artifacts are less significant owing to the small vessel caliber. They can be mitigated by using special saturation pulses applied distal and proximal to the area being scanned and by changing the direction of the phase encoding gradient. The patient's movements can be minimized by choosing a comfortable position for the hand and fixing it securely [6].

STUDY AIM

This study aimed to improve the quality of hand MRI by standardizing coil selection, patient positioning, hand fixation, scan protocol, and sequence parameters.

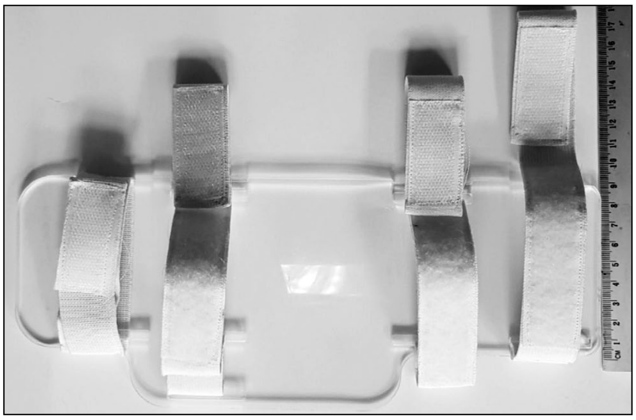

Fig. 1. A device (splint) for positioning the patient's hand.

MATERIALS AND METHODS

Currently, various problems in performing hand MRI have been identified. Healthcare facilities of the Moscow City Health Department are no exception to these issues, including lack of a special coil, uncomfortable patient position, motion artifacts, and small anatomical structures that require increased scanning time for detailed imaging. The lack of reliable hand fixing device in the coil is another crucial problem. Therefore, an immobilizing splint was developed and evaluated in studies using different RF coils (head and knee) to compare quality and provide recommendations for MRI scanning based on the data obtained, depending on the purpose of the examination.

The present study included a healthy volunteer using Excelart Vantage 1.5T (Toshiba, Japan), a commonly used MR scanner model in healthcare facilities of the Moscow City Health Department at the time of the study.

A splint made of polymethyl methacrylate (organic glass) with four textile fasteners on elastic straps was developed to immobilize the hand (Fig. 1). The splint had the dimensions 30 × 12 cm and thickness of 0.5 cm. A pad for the distal forearm (Fig. 2*b*) and disposable covers (gloves, sleeves) were also provided.

The splint was placed to keep the hand close to the body, and the wrist was comfortably positioned on a special pad. Then, the splint was secured with four textile fasteners on elastic straps (Fig. 2). The patient was put in the prone position, with the arm extended forward (the superman position) and the splint fixed to the hand (Fig. 3).

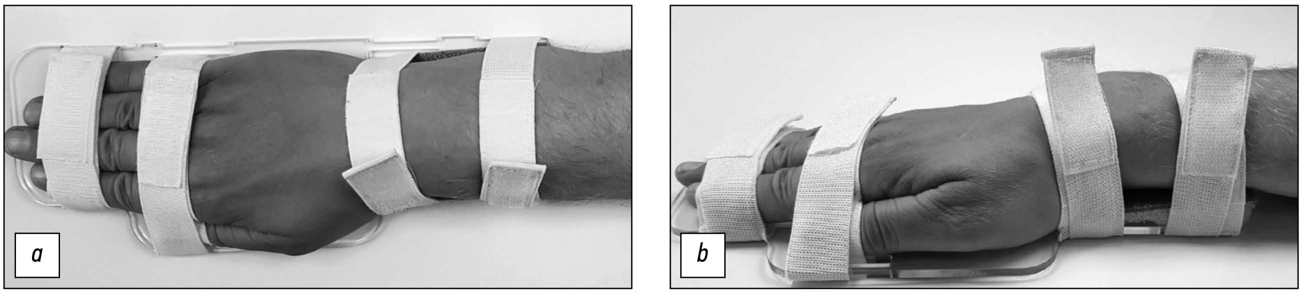

Fig. 2. Fixing a splint to immobilize the patient's hand; (*a*) top view; (*b*) side view.

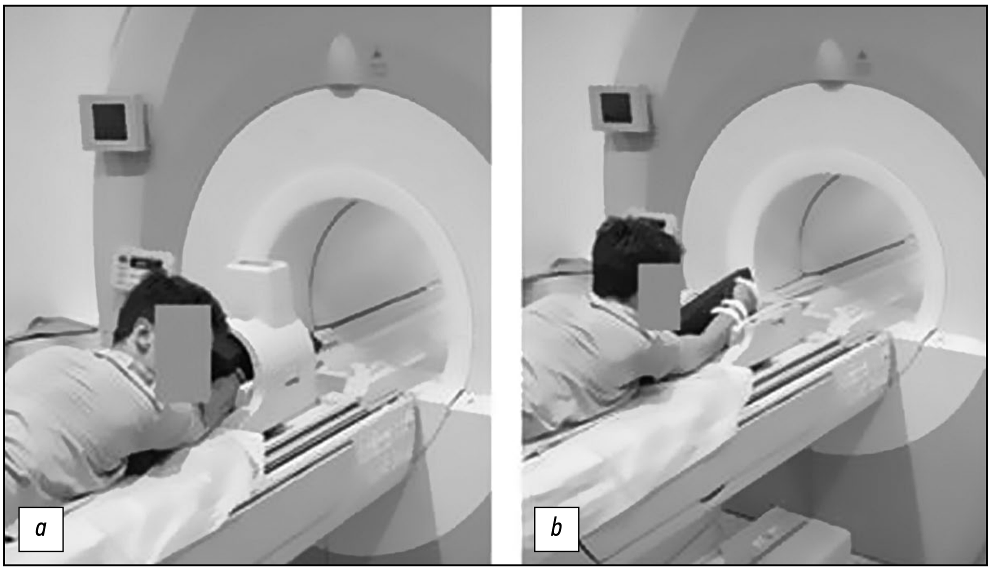

Fig. 3. Patient in the prone position with the arm extended forward (the superman position) and the hand placed on a splint for immobilization; (*a*) positioning of the device in the assembled radiofrequency coil; (*b*) positioning of the device in the volume radiofrequency coil with the upper part open.

Signal-to-noise ratio (SNR) is a crucial parameter of MRI quality; the higher the SNR, the better the anatomical structures are visualized. Therefore, the first step was to evaluate the images by SNR, depending on the scanning region. Two methods were used to calculate the SNR for the head and knee coils.

The first method calculated the ratio of the thenar muscle signal and the standard deviation (SD) of the background (formula (1)):

$$SNR = \frac{\text{Thenar Signal}}{\text{Background SD}} \quad (1)$$

The second method uses the ratio of the thenar signal to the background signal (formula (2)):

$$SNR = \frac{\text{Thenar Signal}}{\text{Background Signal}} \quad (2)$$

The signal was determined for the thenar as the muscle signal was not suppressed by the short tau inversion recovery (STIR) and fat suppression (FS) modes; hence, the obtained data for different scan modes were averaged. The SNR was calculated for three main pulse sequences: T1-weighted (WI) images, STIR, and proton-density weighted images with fat suppression (PD-WI FS). Furthermore, the presence of vascular artifacts, the possibility of vertical and horizontal placement, the need for scan program adjustments, and patient comfort were evaluated. The images were interpreted by a radiologist with 10 years of experience.

RESULTS

Table 1 shows the SNR comparison data for the head and knee coils. When using the knee coil, the SNR was higher for both calculation methods. This is more clearly seen when presented as the mean SNR, which was 1.39 times higher when using formula (1) and 5.3 times higher when using formula (2).

Table 2 presents data comparing head and knee coils. Fig. 4 and 5 display images obtained with the head and knee RF coils. When using the head coil (Fig. 4), the SNR was lower; however, the signal intensity was more evenly distributed, allowing evaluation of the entire hand. However,

Table 1. Signal-to-noise ratio comparison for head and knee coils

	SNR with formula (1)			SNR with formula (2)		
	T1-WI	**STIR**	**PD FS**	**T1-WI**	**STIR**	**PD FS**
Head coil	6.62	11.51	30.81	1.67	1.65	4.08
Knee coil	10.13	15.54	39.97	11.29	7.16	20.39
SNR	1.53	1.35	1.30	6.76	4.34	5.00
Mean		1.39			5.3	

Note: WI, weighted images; PD FS, proton density with fat suppression; SNR, signal-to-noise ratio; STIR, short tau inversion recovery. SNR is calculated using the following formula: knee coil SNR / head coil SNR.

Table 2. Comparison of hand magnetic resonance imaging parameters for the head and knee coils

Parameter	Head coil	Knee coil
Type	Multichannel	Quadrature
Signal-to-noise ratio (SNR)	Higher position for the knee coil relative to the head coil	
Scan region	Evenly distributed Convenient scanning of the entire hand (rheumatology)	Locally high (up to 150 mm) Convenient scanning, two regions (radiocarpal region and wrist/metacarpal bones and finger phalanges [traumatology])
Vascular artifacts	Mild	Significant, to be suppressed in some programs
Vertical and horizontal positions are possible	Yes	Yes
Scanning programs	Setup required	Setup required
Patient comfort	Comfortable	Relatively comfortable

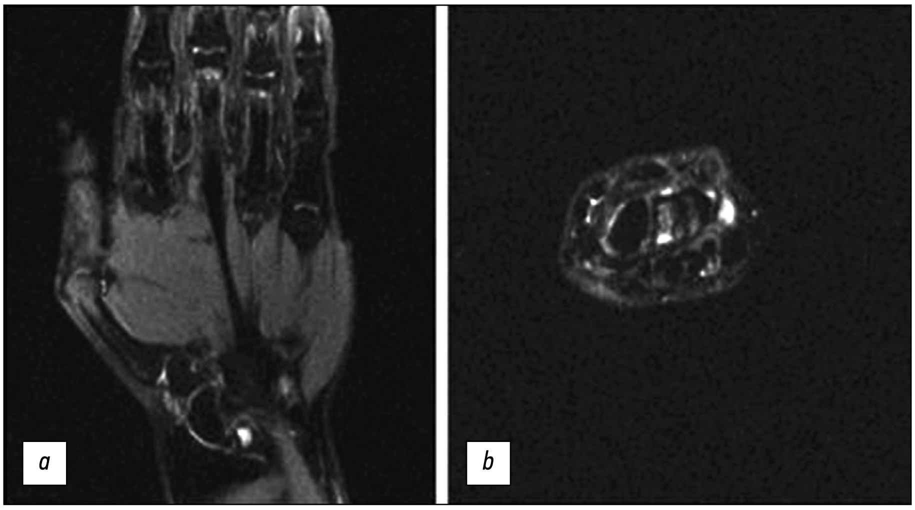

Fig. 4. Magnetic resonance imaging of the hand using a head radiofrequency coil, with a splint to immobilize the hand. PD-weighted images with fat suppression; (*a*) coronal plane; (*b*) axial plane.

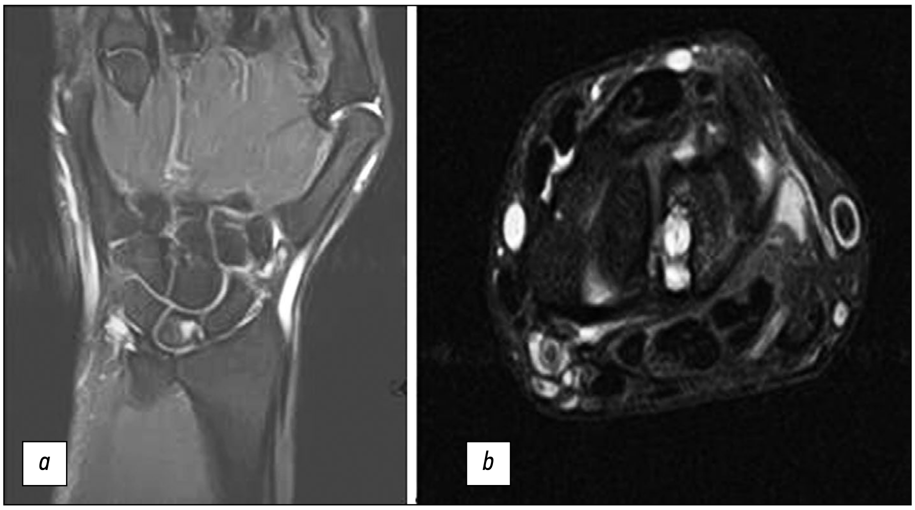

Fig. 5. Magnetic resonance imaging of the hand using a knee radiofrequency coil, with a splint to immobilize the hand. PD-weighted images with fat suppression; (*a*) coronal plane; (*b*) axial plane.

when the knee coil was used (Fig. 5), the SNR was higher locally, allowing assessment of smaller wrist structures. This was because the knee RF coil was quadrature, not multichannel, and the working field of view was smaller. A survey showed that the head coil was more comfortable for the patient.

Therefore, a head coil is preferred when the entire hand needs to be scanned, such as in rheumatic diseases, whereas a knee coil is more appropriate when small wrist structures need to be examined, for example, in hyaline cartilage lesions, stress and pathologic fractures, triangular fibrocartilage complex (TFCC) lesions, and tunnel syndrome.

Recommendations for clinicians and X-ray technicians have been developed based on these data:

1. Ensure that there are no metal objects that could cause artifacts and patient injury.
2. Select an RF coil appropriate for the clinical task: a volume knee RF coil is recommended for thorough evaluation of local anatomical structures (e.g., wrist, TFCC, etc.); a head RF coil is recommended to scan the entire hand.
3. Fix the patient's hand firmly to the splint, placing the wrist on a special pad for comfortable hand positioning and securing with four textile fasteners on elastic straps (Fig. 2*a, b*).
4. Place the patient in the prone position, with one arm extended forward (the superman position) (Fig. 3). It is not always possible to place the patient's arm along the central axis of the scanner bore with the hand exactly isocentered; hence, the hand is often rotated and/or moved to the edge of the bore. Additionally, the choice of coil matters. Some manufacturers attach a coil rigidly to the patient table, whereas others allow enough space for movement to position the hand precisely in the isocenter.
5. Use the following scan protocol [7–10]:
   a) For the entire hand scan, e.g., in rheumatic diseases (Table 3):
   - Pre-scan to set up and position the slices
   - PD-WI FS in the sagittal plane
   - PD-WI FS in the coronal plane
   - PD-WI FS in the axial plane
   - STIR in the coronal plane
   - T1-WI in the coronal plane

   Position the locator sequences, i.e., low-resolution images, in three planes obtained in less than 25 seconds:
   - Axial plane: the resulting slices should cover the entire hand for three slices above the carpometacarpal joint and three slices below the distal radioulnar joint.
   - Coronal plane: the resulting slices should cover the entire hand from the dorsal surface to the palmar surface.
   - Sagittal plane: the resulting slices should cover the entire hand from the medial surface to the lateral surface of the wrist joint area.

   b) For a hand scan, e.g., in case of an injury (Table 4):
   - Pre-scan to set up and position the slices
   - T1-WI in the coronal plane
   - T2-WI in the coronal plane
   - PD FS in the axial plane

Table 3. Recommended parameters for hand scan (Toshiba scanner, head radiofrequency coil)

Sequence	TR	TE	Slice thickness (mm)	FOV (cm)	ETL	Matrix
PD-WI FS, sag	2050	36	3	15×20	7	320x224
PD-WI FS, cor	2700	36	3	15×15	7	320x224
PD-WI FS, ax	2700	36	3	15×15	7	320x224
STIR, cor	3632	36	3	15×15	7	320×224
T1-WI, cor	646	15	3	15×15	1	320x224

Note: ax/cor/sag, axial, coronal, and sagittal planes; WI, weighted images; ETL, echo train length; FOV, field of view; PD FS, proton density with fat suppression; STIR, short tau inversion recovery; TE, echo time; TR, repetition time. The gap between slices is 10% of the slice thickness. STRI time: 130 msec.

Table 4. Recommended parameters for hand scan (Toshiba scanner, knee radiofrequency coil)

	TR	TE	Slice thickness (mm)	FOV (cm)	ETL	Matrix
T1-WI, cor	273	10	3	20×16	1	368×240
T2-WI, cor	3,660	45	3	12×12	7	320×256
PD FS, ax	3,630	36	3	12×12	7	256×224
PD FS, cor	2,116	45	3	18×16	7	256×256
STIR, sag	2,464	12	3	15×15	7	320×224

Note: ax/cor/sag, axial, coronal, and sagittal planes; WI, weighted images; ETL, echo train length; FOV, field of view; PD FS, proton density with fat suppression; STIR, short tau inversion recovery; TE, echo time; TR, repetition time. The gap between slices is 10% of the slice thickness. STRI time: 130 msec.

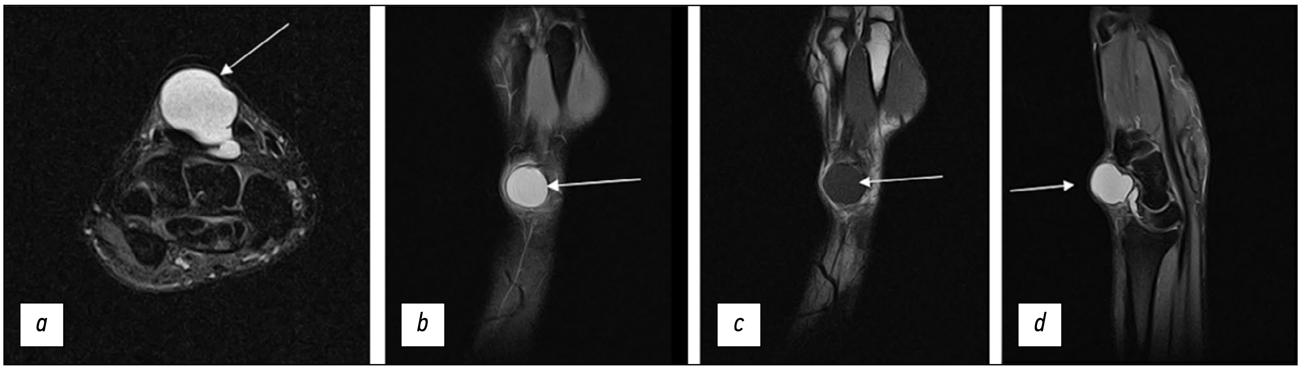

Fig. 6. Large encapsulated ganglion cyst of the dorsal hand with neck-like connection to the wrist cavity; (*a*) PD-weighted images with fat suppression in the axial plane; (*b*) PD-weighted images with fat suppression in the coronal plane; (*c*) T1-weighted images in the coronal plane; (*d*) PD-weighted images with fat suppression in the sagittal plane.

- PD FS in the coronal plane
- STIR in the sagittal plane
- 3D WET in the coronal plane (optional)

Position the locator sequences, i.e., low-resolution images, in three planes obtained in less than 25 seconds:

- Axial plane: the resulting slices should cover the entire area of the hand from the distal phalanges to the level of the distal radioulnar joint.
- Coronal plane: the resulting slices should cover the entire hand from the dorsal surface to the palmar surface.
- Sagittal plane: the resulting slices should cover the entire hand from digit 1 to digit 5.

For survey scans, such as for the diagnosis of rheumatic processes, STIR is recommended as this sequence allows a comprehensive volumetric assessment of inflammatory lesions, whereas PD-WI FS is more selective and provides higher spatial resolution, which is critical in evaluating smaller structures.

The limitations of the proposed fixation method include the potential inability to use the described splint in patients with contractures or large-space-occupying masses resulting in gross deformation of the contours (Fig. 6). However, in this case, the remaining recommendations should be followed regardless.

DISCUSSION

The hand is the distal part of the upper extremity, which includes the bones of the wrist, metacarpal bones, and phalanges, as well as ligaments, vessels, and nerves. The wrist consists of two rows of bones: the proximal row, consisting of the scaphoid (os scaphoideum), lunate (os lunatum), triquetrum (os triquetrum), and pisiform (os pisiforme) bones, and the distal row, consisting of the trapezium (os trapezium), trapezoid (os trapezoideum), capitate (os capitatum), and hamate (os hamatum) bones [11] (Fig. 7).

MRI is a leading imaging method for evaluating hand structures; however, radiography is more commonly used for initial evaluation [12]. MRI may be used to investigate the TFCC, which is the structure that provides shock absorption, because in the neutral position, the TFCC

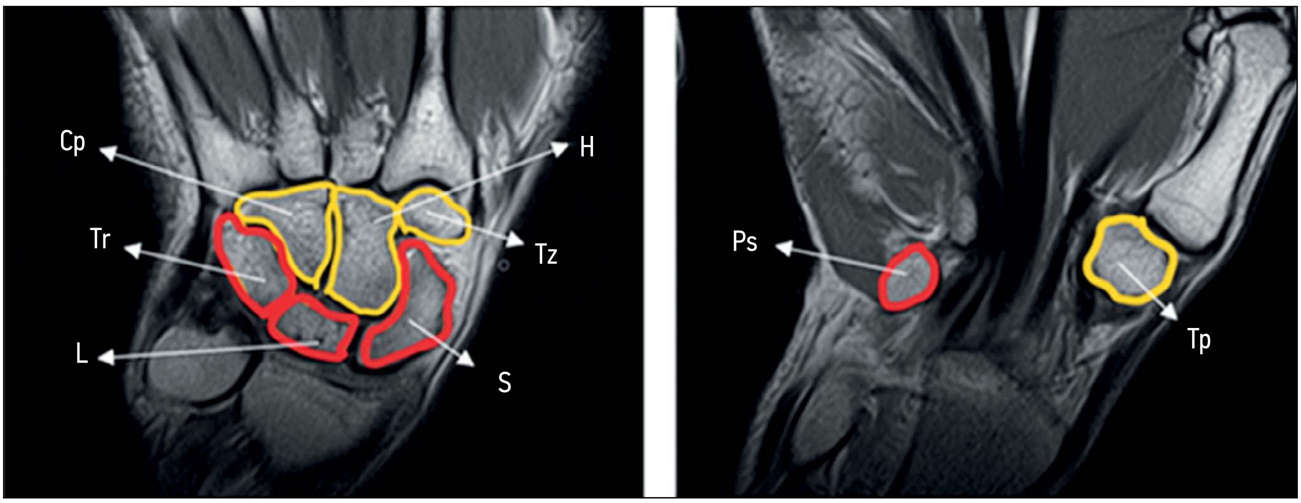

Fig. 7. Left hand, wrist bones, and magnetic resonance imaging (T1-weighted images, coronal plane). The proximal bone row is marked in red; the distal bone row is marked in yellow. S, scaphoid bone; L, lunate bone; Tr, triquetral bone; Ps, pisiform bone; Tp, trapezium bone; Tz, trapezoid bone; H, hamatum, Cp, capitate bone.

absorbs approximately 18%–20% of the axial wrist load [4]. Notably, MRI has been shown to be a useful diagnostic tool in chronic wrist pain to detect central TFCC tears and lesions at the articulation site with the radial bone, although ulnar articulation tears are often not visualized [13]. A study by El-Deek et al. compared the sensitivity, specificity, and accuracy of MRI and ultrasound (US) in the evaluation of hand pathology. US was shown to be as effective as MRI in evaluating tendon disorders and slightly more effective than MRI in diagnosing carpal tunnel syndrome and presence of foreign bodies. However, MRI is superior to US in evaluating TFCC and in assessing edema and characterizing masses [14]. A study showed that 7T MRI scanners can visualize hand structures better than 3T MRI scanners [15].

In 2018, the American College of Radiology (ACR) published guidelines for imaging modalities for chronic wrist pain (Table 5). However, recommendations regarding the technical aspects and methodology of hand MRI were few; further, a special birdcage RF coil is required for better visualization, and 3T MRI scanners should be preferred over 1.5T or lower ones [12].

Radiofrequency Coils Used for Hand Magnetic Resonance Imaging

In 2002, a published article presented a birdcage RF coil optimized for the hands. This coil improved SNR by 50%–90% [16]. This was reflected in the ACR guidelines at the time [12].

Currently, there are several RF coils for hand imaging. For example, Siemens (Germany) offers the Hand/Wrist 16 RF coil with 16 channels. The core features of this RF coil are as follows:

- Special internal design for quick and easy hand positioning
- Stabilizing pads to keep the hand in a comfortable position
- A holder to shift the center
- Easy installation in the MRI scanner [17]

Further, ScanMed (USA) offers a Hand and Wrist MRI Coil that is compatible with MRI scanners from various manufacturers, including Siemens, General Electric (USA), and Philips (the Netherlands). The manufacturer claims that this wrist, hand, and phalange imaging coil showed a significant improvement in image quality over a scan area of up to 8 cm compared to other commonly used coils (e.g., knee RF coils, quadrature extremity RF coils, wrist 4-channel RF coils, etc.). This RF coil enables the patient's arm to be positioned at the side (in the supine position) or above the head in the superman position (in the prone position). Moreover, it has two design options with two removable bases that allow scanning in craniocaudal and caudocranial directions [18].

Available Equivalents of the Proposed Splint

Peterfy et al. [19] described an equivalent of the proposed splint presented by Spire Sciences, Inc., wherein the hand is placed on a special M-shaped acrylic frame so that the thumb and the remaining four fingers are brought together and are in the same plane. Then, the hand and wrist are secured to the frame with a self-adhesive elastic bandage [19].

Patient Positioning Options

There are several ways to position a patient. In the superman position, the patient is placed in the prone position with the arm extended above the head so that the wrist is as close as possible to the isocenter of the magnetic field, which provides the highest SNR and the most uniform signal.

This is an uncomfortable position for many patients; hence, the patient can be placed in the supine position with the arms at the sides of the body. In this position, the hand is away from the magnet isocenter, resulting in a reduced signal and consequently poor and uneven fat signal suppression [20].

Other foreign studies described the prayer position, wherein the patient lies on his/her side with the elbow bent so that the wrist is next to the face and thus closer to the isocenter of

Table 5. Summary of the American College of Radiology recommendations for the use of radiologic modalities in chronic wrist pain

Purpose/indication	Modality
Primary diagnosis	Radiography
Radiographic results are inconclusive and the symptoms persist	Hand MRI without intravenous contrast enhancement
Diagnosis of arthritis to treat or predict course	Hand MRI with/without intravenous contrast enhancement
Kienböck's disease suspected	Radiography; for negative radiograms, hand MRI without intravenous contrast enhancement
Palpable hand mass or suspected hygroma	Hand MRI/US without intravenous contrast enhancement
Suspected occult or stress fractures of the hand	Hand MRI/CT without intravenous contrast enhancement
History of scaphoid fractures and chronic wrist pain to assess fracture complications	Hand MRI/CT without intravenous contrast enhancement
Diagnosis of tunnel syndromes	Clinical evaluation combined with electrophysiology (stimulating electroneuromyography). Further imaging is usually not needed; in some cases, a wrist US or MRI without contrast enhancement may be indicated

Note: MRI, magnetic resonance imaging; CT, computed tomography; US, ultrasound.

the magnet [20]. In the Standards of MRI, Bazhin et al. [10] revealed two similar positioning options: the prone position with the head toward the magnet bore and arms extended and raised (the superman position) and the supine position with the examined arm placed in a neutral position along the body.

Scan Protocols

In the Standards of MRI, Bazhin et al. [10] determined the following hand scan protocol:

1. T1-WI in the coronal plane
2. T2-WI in the coronal plane
3. STIR in the coronal plane
4. T1-WI in the sagittal plane
5. STIR in the sagittal plane
6. STIR in the axial plane
7. GRE in the axial plane

Nonetheless, the European Society of Skeletal Radiology Sports Subcommittee [7] recommends the following protocol, primarily for hand digits:

1. PD-WI FS in the axial plane
2. T1-WI in the axial plane
3. PD-WI FS in the coronal plane
4. PD-WI FS in the sagittal plane
5. STIR in the coronal plane

Moreover, the European Society of Skeletal Radiology Arthritis Subcommittee [8] recommends the following protocol for rheumatic diseases:

1. STIR/T2-WI FS in the coronal plane
2. T1-WI in the coronal plane
3. PD-WI FS/STIR/T2-WI FS in the axial plane
4. T1-WI in the axial plane
5. PD-WI FS in the sagittal plane
6. Contrast-enhanced T1-WI in the axial plane (optional)

Images with Artifacts

A review of hand MRI showed that MRI scans may often be of low diagnostic value, with low resolution and low contrast enhancement (low SNR), and present motion or metal artifacts in the scan field (Fig. 8–10).

The technique to be used for hand MRI to ensure maximum patient comfort and high image quality remains controversial.

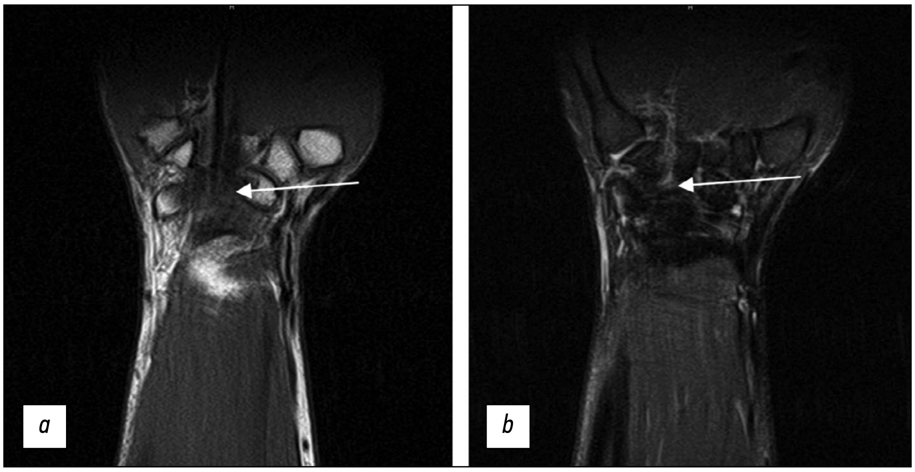

Fig. 8. Reduced imaging quality because of movement artifacts without using a splint (arrows); (*a*) T1-weighted images in the coronal plane; (*b*) STIR protocol in the coronal plane.

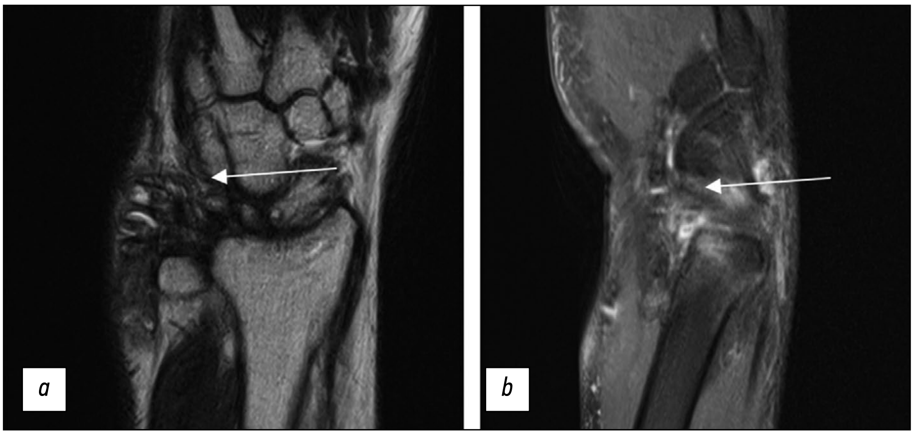

Fig. 9. Reduced imaging quality in a patient with triangular fibrocartilage complex disorder because of motion artifacts (arrows) and atypical positioning (without a splint); (*a*) T2-weighted images in the coronal plane; (*b*) PD-weighted images with fat suppression in the sagittal plane.

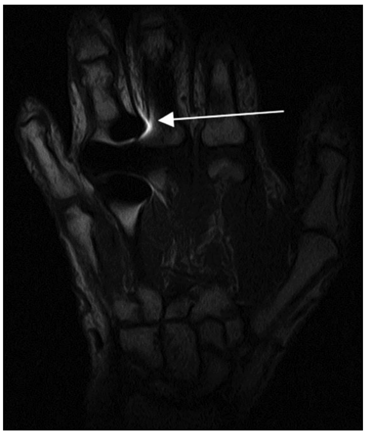

Fig. 10. Reduced imaging quality because of technical artifacts from the ring: T1-weighted images in the coronal plane.

DOI: https://doi.org/10.17816/DD568545

CONCLUSION

The hand is a complex anatomic structure. MRI is a commonly used imaging modality for evaluating the musculoskeletal system owing to the absence of radiation exposure, high contrast enhancement of soft tissues, and ability to detect radiographic abnormalities in the bone tissue. Several factors should be considered to obtain high-quality MRI scans, including general MRI precautions, scan settings, and proper hand fixation in the coil. Implementation of the proposed splint will standardize examinations and reduce motion artifacts with convenient fixation and use. Therefore, following the recommendations can improve the quality of MRI scans, reduce overall scan time, and reduce interpretation errors for hand MRI scans.

ADDITIONAL INFORMATION

Funding source. This article was prepared by a team of authors as part of the research work "Scientific support for standardization, safety and quality of magnetic resonance imaging" (No. in the Unified State Information System of Accounting: 123031500007-6) in accordance with Order dated December 21, 2022 No. 1196 "On approval of state assignments, the financial support of which is carried out from the budget of the city of Moscow to state budgetary (autonomous) institutions subordinate to the Department of Health".
Competing interests. The authors declare that they have no competing interests.
Authors' contribution. All authors made a substantial contribution to the conception of the work, acquisition, analysis, interpretation of data for the work, drafting and revising the work, final approval of the version to be published and agree to be accountable for all aspects of the work. Yu.A. Vasiliev — concept and design of the work, setting up the proposed scanning protocol, editing and approval of the final version of the manuscript, advisory support; D.S. Semenov — concept and design of the work, data analysis, writing the text of the article, setting up the proposed scanning protocol, developing the proposed splint, conducting a technical audit; A.V. Petryaykin — concept and design of the work, data analysis, writing the text of the article, setting up the proposed scanning protocol, conducting a technical audit, developing the proposed splint, approving the final version of the manuscript; A.A. Uchevatkin — concept and design of the work, data analysis, writing the text of the article, setting up the proposed scanning protocol, conducting a technical audit, editing and approving the final version of the manuscript; L.R. Abuladze — data analysis, writing the text of the article; A.V. Bazhin, D.E. Sharova — editing and approval of the final version of the manuscript, advisory support.

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AUTHORS' INFO

*** Liya R. Abuladze,** MD;
address: 24-1 Petrovka Str., Moscow, 127051, Russia;
ORCID: 0000-0001-6745-1672;
eLibrary SPIN: 8640-9989;
e-mail: drliaabuladze@gmail.com

Yuriy A. Vasilev, MD, Cand. Sci. (Medicine);
ORCID: 0000-0002-0208-5218;
eLibrary SPIN: 4458-5608;
e-mail: VasilevYA1@zdrav.mos.ru

Dmitry S. Semenov, Cand. Sci. (Engineering);
ORCID: 0000-0002-4293-2514;
eLibrary SPIN: 2278-7290;
e-mail: SemenovDS4@zdrav.mos.ru

Alexey V. Petraikin, MD, Dr. Sci. (Medicine);
ORCID: 0000-0003-1694-4682;
eLibrary SPIN: 6193-1656;
e-mail: PetryajkinAV@zdrav.mos.ru

Andrey A. Uchevatkin, MD, Cand. Sci. (Medicine);
ORCID: 0000-0001-7284-4737;
eLibrary SPIN: 5575-4511;
e-mail: UchevatkinAA@zdrav.mos.ru

Alexander V. Bazhin, MD, Cand. Sci. (Medicine);
ORCID: 0000-0003-3198-1334;
eLibrary SPIN: 6122-5786;
e-mail: BazhinAV@zdrav.mos.ru

Dariya E. Sharova, MD;
ORCID: 0000-0001-5792-3912;
eLibrary SPIN: 1811-7595;
e-mail: SharovaDE@zdrav.mos.ru

ОБ АВТОРАХ

*** Абуладзе Лия Руслановна;**
адрес: Россия, г. Москва, 127051, ул. Петровка, д. 24, стр. 1;
ORCID: 0000-0001-6745-1672;
eLibrary SPIN: 8640-9989;
e-mail: drliaabuladze@gmail.com

Васильев Юрий Александрович, канд. мед. наук;
ORCID: 0000-0002-0208-5218;
eLibrary SPIN: 4458-5608;
e-mail: VasilevYA1@zdrav.mos.ru

Семенов Дмитрий Сергеевич, канд. техн. наук;
ORCID: 0000-0002-4293-2514;
eLibrary SPIN: 2278-7290;
e-mail: SemenovDS4@zdrav.mos.ru

Петряйкин Алексей Владимирович, д-р мед. наук;
ORCID: 0000-0003-1694-4682;
eLibrary SPIN: 6193-1656;
e-mail: PetryajkinAV@zdrav.mos.ru

Учеваткин Андрей Алексеевич, канд. мед. наук;
ORCID: 0000-0001-7284-4737;
eLibrary SPIN: 5575-4511;
e-mail: UchevatkinAA@zdrav.mos.ru

Бажин Александр Владимирович, канд. мед. наук;
ORCID: 0000-0003-3198-1334;
eLibrary SPIN: 6122-5786;
e-mail: BazhinAV@zdrav.mos.ru

Шарова Дарья Евгеньевна;
ORCID: 0000-0001-5792-3912;
eLibrary SPIN: 1811-7595;
e-mail: SharovaDE@zdrav.mos.ru

* Corresponding author / Автор, ответственный за переписку