

Upper Extremity Ultra-High Field MR Imaging of Bilateral Hand Transplant Patient: Case Report(VCA)

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INTRODUCTION: Reconstructive transplantation is a clinical reality with more than a dozen countries across the world performing unilateral and bilateral transplantation [1]. Statistics indicate that (i) upper extremity (UE) trauma constitutes 39% of combat injuries [2-4] ii) As of 2005, 1.6 million civilians with limb-loss (34000 major-UE-loss[2]) in the US alone and expected to go up-to 3.6million by 2050 [1-2]. If only 1% of this population qualifies to undergo transplant surgery, that mandates the need for additional transplant infrastructure (including pre and post-surgery monitoring and evaluation methods). Commercially ($\leq 3T$) available MR lacks the capability to provide critical anatomical resolution compare to UHF scanners ($\geq 7T$) which enable significantly superior signal-to-noise ratio (SNR), higher image resolution, and reduced scan time [5]. To our knowledge, the current study is the first ever report of 7T UET imaging 4 years after surgery as part of post-transplant clinical MR assessment.

METHODS: A 7T Siemens Magnetom scanner was used under an IRB approved consent protocol to acquire in-vivo images utilizing custom built UE coil. 3D T1VIBE, T2DESS, TOF(non-contrast) MRI, SWI, and DTI were optimized (this paper focuses on first three sequences) to utilize the multi-planar capabilities for evaluating and identifying the size, location, and 3Dcontextual anatomy of interest. Optimization of T1VIBE provides high-anatomic resolution; T2DESS improves CNR/SNR in nerve and vessels; TOFMR angiography technique utilizes the advantage of longer T1-relaxation constant at 7TMRI.

RESULTS:T1VIBE shows exquisite high resolution anatomy for assessing phalangeal, metacarpal and carpal bone edema, erosion, cartilage, tendon and other soft tissue anatomy in patients, as well as neurovascular anatomy [proper palmar digital (PPD) arteries] and its branches (including capillaries on finger pulps (b,d,e)). T2DESS shows much more contrast in identifying the vessels and nerves. TOF images ([g, h]: Right Hand, [k, l, p]: Left hand, Volunteer: [t, u]) clearly shows not only digital arteries but its branches and capillary bed all the way towards finger tips. The PPD mean diameter comparisons: Ringfinger: $2\pm 0.6\text{mm(V)}, 1\pm 0.4\text{mm(P)}$, MiddleFinger[fig.2m]: $2.6\pm 0.6\text{mm(V)}, 1.55\pm 0.4\text{mm(P)}$, Indexfinger[Fig.2i]: $1.4\pm 0.4\text{mm(V)}, 0.97\pm 0.4\text{mm(P)}$, Babyfinger: $1.55\pm 0.6\text{mm(V)}, 1.23\pm 0.4\text{mm(P)}$.

CONCLUSION: This study shows a potential of not only using UHF-MRI in post-transplant evaluation after UET but more importantly could be implemented to great value in hand surgery practice in diagnosis and interpretation of scaphoid fractures, avascular necrosis, carpal dislocations, triangular cartilage tears and multiple other vascular abnormalities, connective tissue disorders or micro-vascular disease conditions.

REFERENCES:

- [1] Petruzzo P. The international registry on hand and composite tissue transplantation. Transplantation 2008; 86: 487–9
- [2] Ziegler-GK, et al. Estimating the prevalence of limb loss in the US: 2005 to 2050. Arch Phys Med Rehab 2008; 89:422–9.
- [3] Dougherty AL. Battlefield extremity injuries in Operation Iraqi Freedom. Injury 2009;40(7):772
- [4] Gorantla VS. Favoring the Risk– Benefit Balance for UET- The Pittsburgh Protocol Hand Clin 27 (2011) 511–520.
- [5] Vaughan JT, 7 T Whole Body Imaging: Preliminary Results, MRM. 2009 Jan., 244–248 2.

FIGURE LEGENDS:

Figure 1: 7T MRI of double amputee arm transplant patient: Right Hand data: T1VIBE [a(axial), b, d, e (coronal)], MIP image [c], T2DESS [f], and TOF [g, h]: Left Hand data: T1VIBE [l,j], T2DESS [m, n, o], and TOF [k, l, p]

Figure 2: Healthy Volunteer 7T MRI: T1VIBE [q, r, s] (L: ligaments, T; tendons, V: vessels), and TOF [t, u], [l, m]: Vessel dia. Comparison for patient and volunteer

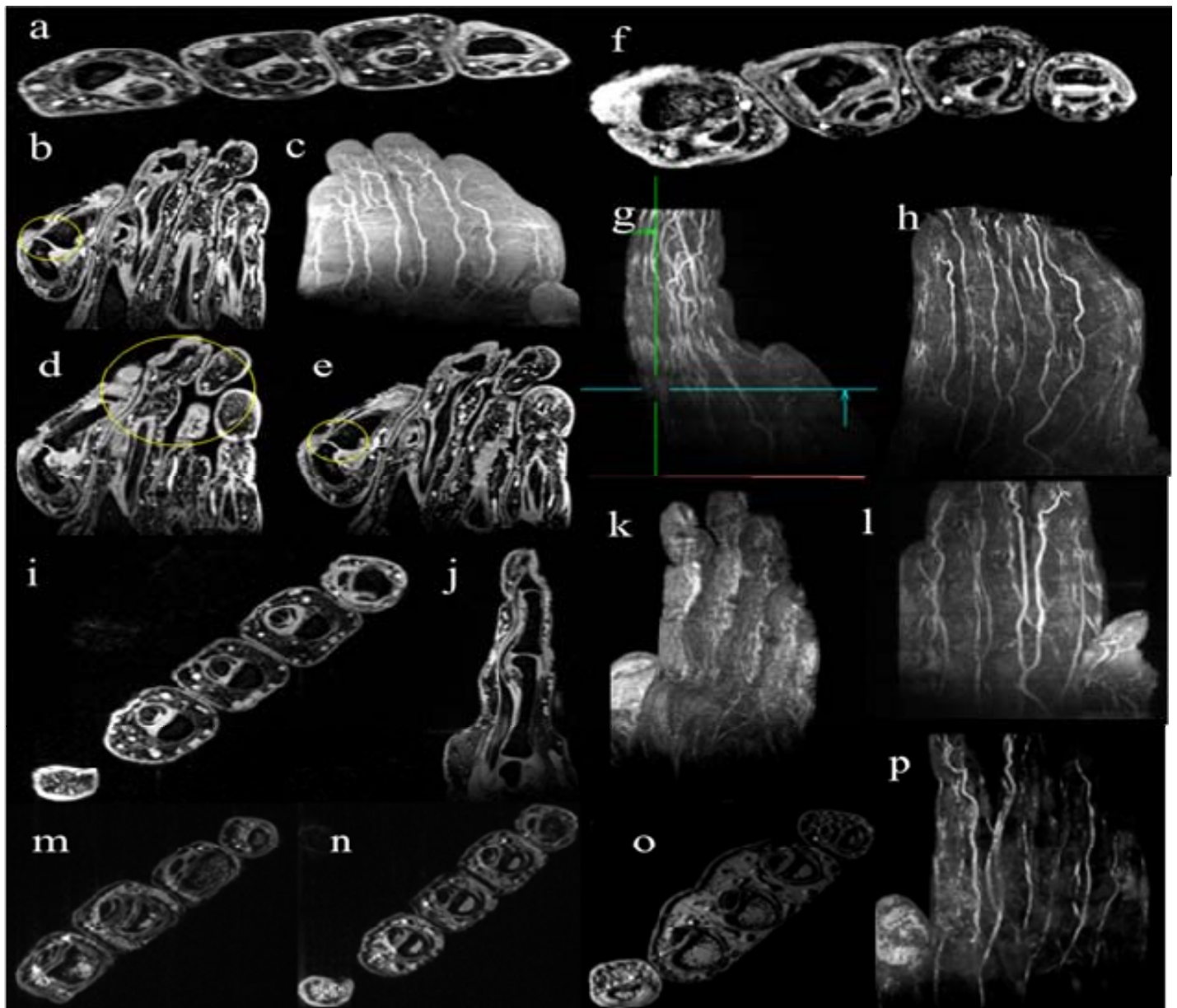


Figure 1: 7T MRI of double-amputee arm transplant patient: Right Hand data: T1 VIBE [a (axial), b, d, e (coronal)], MIP image [c], T2DESS [f], and TOF [g, h]; Left hand data: T1VIBE [i, j], T2DESS [m, n, o], and TOF [k, l, p].

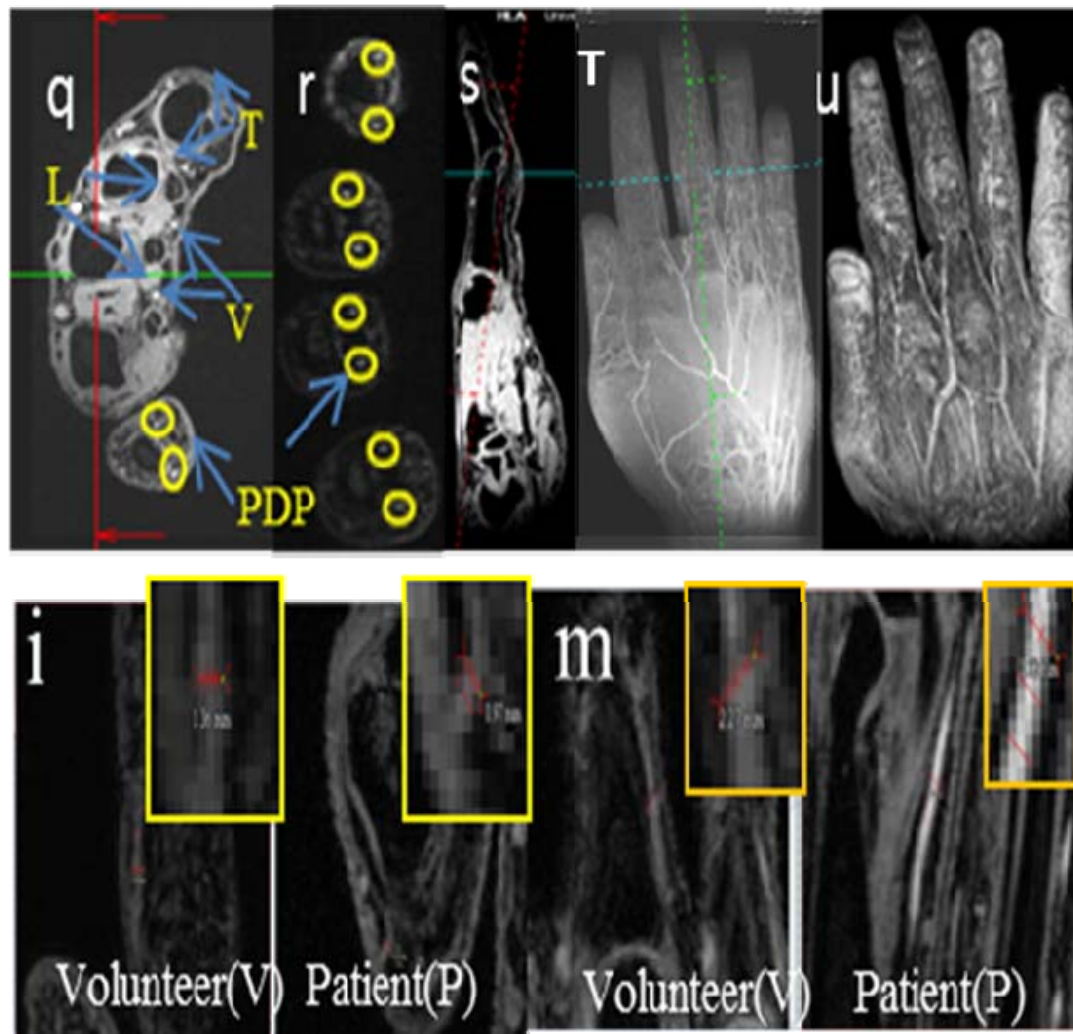


Figure 2: Healthy Volunteer 7T MRI: T1VIBE [q, r, s] (L: ligaments, T: tendons, V: vessels), and TOF [t, u], [i, m]: Vessel dia. comparison for patient and volunteer

Table 1: The following Acquisition Parameters were utilized.

Sequence	FOV(mm)	TR/TE (ms)
T2DESS	(294x448) 105x160	13/5.2
T1VIBE	(304x512) 95x160	12/4.5
TOF	(236x640) 85x208	12/4.5