OMNISCIENT NEUROTECHNOLOGY

MRI Acquisition Recommendations for Quicktome

1. Regulatory information

Quicktome (Catalogue Number: SCI0001), Neurosurgical Planning and Visualization Software
Product: Quicktome Version 1.1.0 and above
Document version: 4
Languages available: Canadian French, English, French, Italian, German, Spanish
Language of this version: English
Region of this version: Global

All critical characteristics of the medical device, as well as range and precision of all the measured or displayed values or performances can be found in the following user manuals

- UMA0011 - Quicktome Software User Guide - Quicktome version 1.1.1
- UMA0015 - Quicktome Software User Guide - Quicktome version 1.2.0 and above

Manufacturer information:

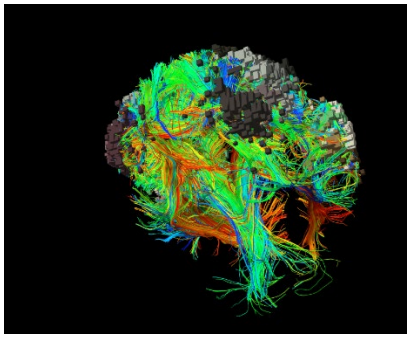
Omniscient Neurotechnology Pty Ltd
Level 10, 580 George Street
Sydney NSW 2000
Australia
support@o8t.com

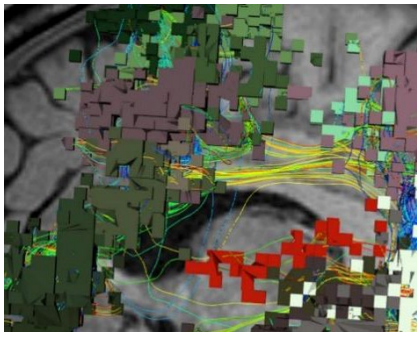
For Quicktome version 1.2.0 and above, the authorized representative within the locale can be found on the About Screen of the device or on the company website

2. Introduction

This document provides an overview of the recommended MRI acquisition protocols when obtaining scans for use with o8t's Quicktome product.

The Omniscient software utilizes standard high-resolution anatomical MRI along with high-quality diffusion acquisitions to generate connectomic maps of the brain.





The following two acquisitions must be obtained for each study in the same session:

i. DWI with high scan directions (similar to DTI)
ii. 3D or thin-slice T1 (similar to navigation scan)

3. Compatibility

Software is compatible with GE, Philips, Siemens scanners of 1.5T and 3.0T field strength. DTI must be enabled on scanner.

Software is compatible with raw DICOM files only. Pre-processed DICOM files are incompatible so should not be used.

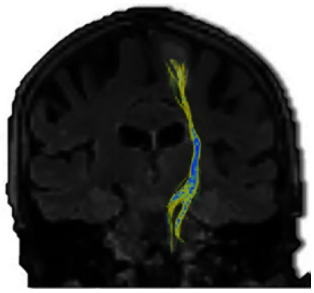
4. Patient setup

- Supine, reduce head angulation as much as possible
- Diffusion should be acquired BEFORE contrast injection

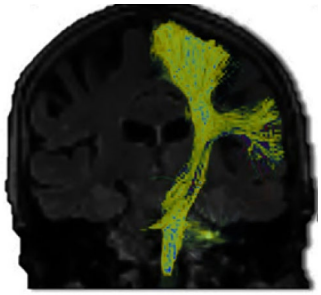
5. Diffusion scan

5.1. Background

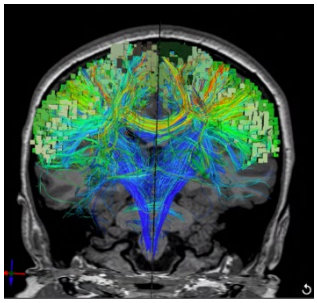
This is a high-resolution multi-scan directional diffusion scan, which is most similar to a diffusion tensor image (DTI) acquisition. From this high-direction DTI acquisition, we utilize an alternative algorithm to DTI called constrained spherical deconvolution (CSD) to generate tracts within the brain, which may improve performance in areas of crossing subcortical fibers.



Cortico-spinal tractography using standard DTI[1]



Cortico-spinal tractography using CSD[1]



Motor network generated from Omniscient Neurotechnology software

The most important aspect for this scan to allow for optimal algorithm performance is to achieve whole brain coverage with the highest number of scan directions possible in a clinically achievable time. Isotropic voxels are highly desired, and scan thickness should be as close to 2 mm as possible.

- ***Required:*** Multi-direction DWI
  - ***Required***: Axial DWI
- ***Required:***
  - 1 baseline reference scan (b0) with magnetic field strength B = 0 s/mm^2
- ***Required:*** > 30 gradient directions
  - ***Recommended:*** >40 gradient directions
  - ***Required:*** Gradient directions must be equally distributed around a sphere
  - ***Required:*** Consistent magnetic field strength B >= 1000 s/mm^2)
  - ***Note:*** "Multi-shell" acquisitions of multiple b-values are not supported
- ***Required:*** Isotropic voxels in scan plane and full brain coverage
  - ***Recommended:*** Voxel size: 2x2x2 mm (see comment regarding slice thickness)
  - ***Recommended:*** FOV = 240 mm and matrix = 120 x 120
- ***Required:*** Thin slice thickness; <= 3mm
  - ***Recommended:*** <= 2mm preferred
  - ***Recommended:*** *>= 0.5 mm to avoid long processing times*
  - ***Minimum spatial image dimensions:*** 64x64x20 (closely linked with slice thickness and voxel size settings)
  - ***Tip:*** *to achieve full brain coverage with minimal slice thickness, set scan parameters to 2 mm slice thickness and appropriate matrix and FOV size; check for full brain coverage with maximum slice count; increase TR as needed to add slices; when TR is at max, increase slice thickness*
- **Target Scan Time:** 6:30 (30 directions), 13:00 (64 directions)

1 Henderson, F., Abdullah, K. G., Verma, R., & Brem, S. (2020). Tractography and the connectome in neurosurgical treatment of gliomas: the premise, the progress, and the potential, Neurosurgical Focus FOC, 48(2), E6.

5.3. Scanner specific summary – Diffusion Scan

Scanner	Scan	Acquisition Parameters	DTI specific parameters
Siemens	In Siemens library: Head > clinical libraries > advanced applications libraries > diffusion and perfusion Select: ep2d_diff_mddw_20_p2	<u>Routine:</u> Slices: 90 (adjust for full brain) Dist. Factor: 0% Orientation: Transversal Phase enc. Dir. A>>P Phase oversampling: 0% FoV read 240 FoV phase 100.0% Slice thickness: 2.0 TR: SHORTEST TE: SHORTEST Averages: 1 <u>Resolution-Common :</u> Base resolution: 120 Phase resolution: 100% <u>Resolution-IPAT :</u> PAT mode: GRAPPA Accel. Factor PE: 2 <u>Geometry-Common:</u> Multi-Slice mode/Series : Interleaved	<u>Diff-Neuro</u> *Diffusion mode: MDDW *Directions: Select 30 or 64 *Diffusion Scheme : Bipolar Diff. weighted images: On Trace weighted images: Off Mosaic: On Diff. weightings: 2 b-Value: 0 b-Value: 1000
GE	<u>Parameters</u> Pulse Seq: Spin Echo Imaging Mode: 2D Imaging Options: EPI, DIFF, Asset	<u>Acquisition Timing</u> Freq: 120 Phase: 120 NEX: 1 Freq DIR: R/L Phase FOV: 1 <u>Scanning Range</u> FOV: 24.0 Slice Thickness: 2.0 Spacing: 0 # of Slices: 80 (adjust for full brain) Auto Shim: Auto Phase Correction: Yes <u>Scan Timing</u> TE: Min TR: 8000 (adjust to increase slices for full brain)	Number of Diffusion Directions: 40 b-value: 1000 Optimized TE : Yes Dual Spin Echo: Off Diffusion Directions: Tensor Number of T2 images: 1
Philips	EPI Single Shot <u>Contrast</u> Scan Mode: MS Technique: SE Fast imaging mode: EPI Shot mode: Single-shot	<u>Geometry</u> FOV: RL(mm): 240 AP(mm): 240 ACQ voxel size: RL(mm): 2 AP(mm): 2 FH(mm): 2 Slice Thickness (mm): 2 Reconstruction matrix: 120 Sense: yes	<u>Contrast</u> Directional resolution = High (32) ***Gradient Overplus = No** Gradient Duration = Maximum Nr of b-factors = 2 b-factor order = Ascending max b-factor = 1000 average high b = No

		Stacks: Slices: 90 (adjust for full brain) Gap: 0 Slice Orientation: Axial <u>Contrast</u> TE: Shortest TR: Shortest	

6. High-resolution anatomical scan

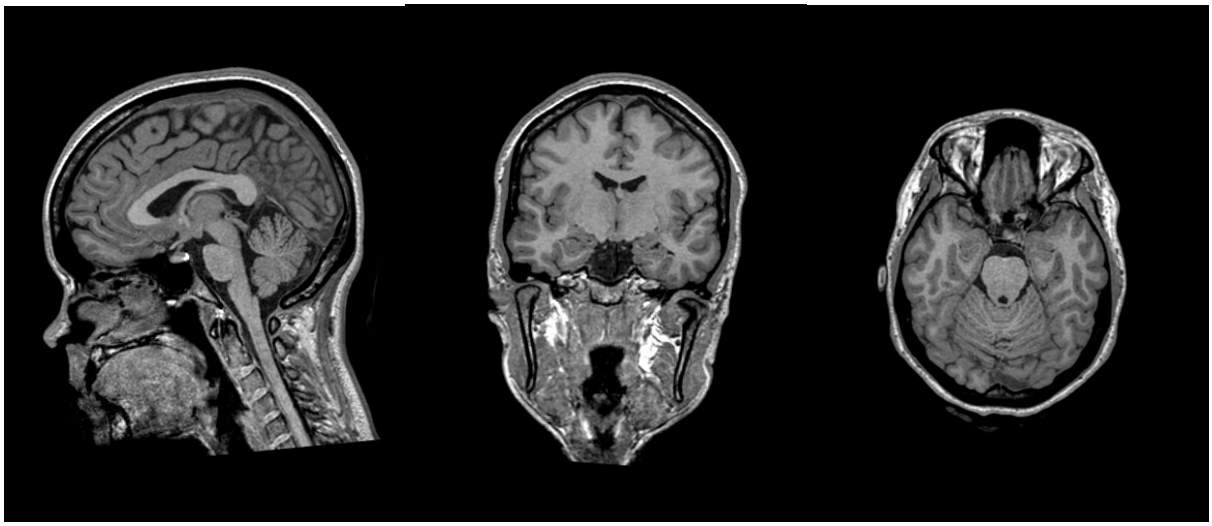


Figure 2 Example high-resolution anatomical scans

6.1. Background

This is a standard acquisition similar to navigation quality scans (Stealth scan, Brainlab scan, etc). This scan should balance high-resolution and high-tissue contrast (T1 weighting).

6.2. Summarized Checklist – Anatomical Scan

- ***Recommended:*** T1 weighting preferred, with or without contrast; T2 and FLAIR are permitted
  - ***Recommended:*** *3D volume acquisition preferred, thin-slice 2D is permitted*
  - ***Recommended:*** *Axial preferred; Sagittal and Coronal are permitted*
- ***Required:*** Thin slice thickness: <= 2 mm
  - ***Recommended:*** <= 1 mm preferred
  - ***Minimum spatial image dimensions (Primary anatomicals):*** 128x128x100 (closely linked with slice thickness and voxel size settings).
  - ***Minimum spatial image dimensions (Secondary anatomicals):*** 128x128x20 (closely linked with slice thickness and voxel size settings).
  - ***Maximum spatial image dimensions (All anatomicals): 500x500x350***(closely linked with slice thickness and voxel size settings).
- ***Required:*** FOV to cover whole head
  - ***Recommended:*** 256 x 256 matrix to achieve isotropic, other matrix sizes are permitted
  - ***Recommended:*** Isotropic voxels are preferred but not required
- ***Required:*** 0.0 mm gap/spacing between slices, no overlap between slices
- ***Required:*** 1 single acquisition, no concatenation
  - ***Recommended:*** Select for T1 weighting and optimal tissue contrast
  - **Note:**
    - DICOM MultiFrame formats are not supported
    - Limited support for DICOM Mosaic formats (isotropic in plane of acquisition required)

- ***Required:*** 1 average
  - ***Recommended:*** More if desired for higher SNR
- **Target scan time:** <6 mins

6.3. Scanner Specific Summary – Anatomical Scan

Scanner	Scan	Acquisition Parameters	Contrast Parameters	Other
Siemens	MPRAGE (3D)	Routine FoV read: 256 FoV phase: 100% Slice thickness: 1.00 Slices per slab: 190 (adjust for full head) Averages: 1 Resolution-Common Base resolution: 256 Phase resolution: 100 Slice resolution: 100	TE: SHORTEST TR: SHORTEST	Resolution-Filter Image - Distortion Corr.: On - Mode: 3D Resolution-IPAT - PAT mode: GRAPPA - Accel. Factor PE: 2
GE	BRAVO (3D) or MPRAGE (3D)	Acquisition Timing Freq: 256 Phase: 256 NEX: 1 Phase FOV: 1 Scanning Range FOV: 25.6 Slice Thickness: 1.0 Spacing: 0 # of Slices: 190 (adjust for full head)	Scan Timing TE: Min TR: Auto	Graphic RX Location per Slab : 180 (adjust for full head)
Philips	3D T1-TFE or MPRAGE (3D)	Geometry FOV: RL(mm): 256; AP(mm): 256 AC Q voxel size: RL(mm): 1; AP(mm): 1; FH(mm): 1 Reconstruction matrix: 256 Sense: yes Stacks: Slices: 190 (adjust for full head); Slice Orientation: Axial; Slice Thickness: 1.0	Contrast Scan mode: 3D Contrast enhancement: T1 TE: Shortest TR: Shortest	