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Protocol status: Working
We use this protocol and it's working

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Abstract

This protocol summarizes the MRI scans used to visualize and segment the pudendal nerve i and the CT scan used to identify the location of an implanted pudendal stimulation lead. Together these scans can be used to determine the position of the implanted lead relative to the pudendal nerve. The nerve and lead imaging is a part of a larger study mapping the effects of pudendal nerve stimulation described in a separate protocol: **dx.doi.org/10.17504/protocols.io.14egn3jezl5d/v1**

Materials

3T MRI - Ingenia 3T system, Philips
CT Scanner - DiscoverCT750 HD or Revolution scanner, GE Healthcare

Troubleshooting

MR Imaging

1 3D_T1_PRE_FMRI_CS

An anatomic 3D T1 weighted axial sequence of lower abdomen and pelvis that can be reformatted in different orthogonal planes and allows us to trace the nerve roots and branches that make up pudendal nerve.

Parameters:
EX_single_scan_id = 16825236;
SmartSelect = "yes";
Coil 1 (exclude) = "None";
Uniformity = "CLEAR";
FOV AP (mm) = 360;
RL (mm) = 360;
FH (mm) = 250;
ACQ voxel size AP (mm) = 1;
RL (mm) = 1;
FH (mm) = 1;
Recon voxel size AP (mm) = 0.75;
RL (mm) = 0.75;
FH (mm) = 0.5;
Fold-over suppression = "oversampling";
L (mm) = 40;
R (mm) = 40;
Slice oversampling = "user defined";
oversample factor = 1.29999995;
Reconstruction matrix = 480;
SENSE = "no";
CS-SENSE = "yes";
reduction = 2.5;
denoising = "system default";
k-t Acceleration = "no";
Stacks = 1;
slices = 500;
slice orientation = "transverse";
fold-over direction = "RL";
fat shift direction = "P";
Multi-chunk = "no";
O-MAR = "no";
Large table movement = "no";
PlanAlign = "no";

```
REST slabs =                0;
Interactive positioning =       "no";
External control =          "no";
Patient position =          "head first";
Patient body position =         "head first";
Patient orientation =           "supine";
Patient body orientation =      "supine";
Scan type =                 "Imaging";
Scan mode =                 "3D";
   technique =                  "SE";
Modified SE =                   "no";
Acquisition mode =              "cartesian";
Fast Imaging mode =             "TSE";
   3D VIEW =                "no";
   shot mode =                  "multishot";
TSE factor =                110;
   startup echoes =             4;
   profile order =          "linear";
   turbo direction =            "Z";
   DRIVE =                  "yes";
   ultrashort =             "ultra";
   fid reduction =          "strong";
   3D non-selective =           "yes";
Echoes =                    1;
   partial echo =           "no";
TE =                        "shortest";
Flip angle (deg) =          90;
Refocusing control =            "PSS Adv (T2-opt)";
   min. angle  (deg) =          70;
   mid. angle (deg) =           90;
   max. angle (deg) =           120;
TR =                        "user defined";
   (ms) =               2800;
Halfscan =                      "yes";
   factor Y =               0.600000024;
   factor Z =               0.800000012;
Water-fat shift =           "maximum";
RF Shims =                  "fixed";
Shim =                      "default";
mDIXON =                    "no";
Fat suppression =           "no";
Grad Rev Fat suppr =            "no";
Water suppression =             "no";
```

```
BB pulse =                "no";
MTC =                     "no";
APT =                     "no";
Custom prepulse =         "no";
MDME =                    "no";
Diffusion mode =          "no";
T1 mapping =              "no";
Transmit channels =       "both";
SAR mode =                "high";
B1 mode =                 "default";
SAR allow first level =   "no";
PNS mode =                "moderate";
Gradient mode =           "maximum";
SofTone mode =            "no";
Cardiac synchronization = "no";
Heart rate > 250 bpm =    "no";
Respiratory compensation = "no";
Navigator respiratory comp = "no";
Flow compensation =       "no";
Motion smoothing =        "no";
NSA =                     1;
MRE enable =              "no";
CENTRA =                  "no";
Manual start =            "no";
Dynamic study =           "no";
Arterial Spin labeling =  "no";
Preparation phases =      "auto";
Interactive F0 =          "no";
Quick Survey =            "default";
B0 field map =            "no";
B1 field map =            "no";
MIP/MPR =                 "no";
Images =                  "M", (3) "no";
Autoview image =          "M";
Calculated images =       (4) "no";
Reference tissue =        "Male Pelvis";
Recon compression =       "No";
Preset window contrast =  "no";
Reconstruction mode =     "immediate";
Save raw data =           "no";
Hardcopy protocol =       "no";
Image filter =            "system default";
Uniformity correction =   "no";
```

Geometry correction = "none";
Elliptical k-space shutter = "default";
Stack Offc. AP (P=+mm) = 10.0683002;
RL (L=+mm) = -0.0122832758;
FH (H=+mm) = -32.6540947;
Ang. AP (deg) = 0;
RL (deg) = -0;
FH (deg) = -0;
Free rotatable = "no";
IF_info_seperator = 1634755923;
Extended Function. Opt. = "6";
Total scan duration = "11:12.0";
Rel. SNR = 1.87513769;
Act. TR (ms) = "2800";
Act. TE (ms) = "178";
ACQ matrix M x P = "360 × 360";
ACQ voxel MPS (mm) = "1.00 / 1.00 / 1.00";
REC voxel MPS (mm) = "0.75 / 0.75 / 0.50";
Scan percentage (%) = 100;
Act. slice gap (mm) = -0.5;
WFS (pix) / BW (Hz) = "0.582 / 746.7";
TSE es / shot (ms) = "3.7 / 435";
TEeff / TEequiv (ms) = "178 / 117 ";
Min. TR (ms) = "1734";
Local torso SAR = "< 39 %";
Whole body SAR / level = "< 1.2 W/kg / normal";
SED = "< 0.8 kJ/kg";
Coil Power = "37 %";
Max B1+rms = "1.42 uT";
PNS / level = "80 % / normal";
dB/dt = "102.5 T/s";
Sound Pressure Level (dB) = 28.1958218;

2 OPT_CS_Ax_T2_3D_1mm

An anatomic 3D T2 weighted axial sequence of lower abdomen and pelvis that can be reformatted in different orthogonal planes. The goal is of making nerves stand out from the surrounding tissue.

Parameters:
EX_single_scan_id = 20666869;
SmartSelect = "yes";
Coil 1 (exclude) = "None";
Uniformity = "CLEAR";

```
FOV         AP (mm) =          220;
            RL (mm) =       220;
            FH (mm) =       200;
ACQ voxel size   AP (mm) =  0.649999976;
            RL (mm) =       0.65180105;
            FH (mm) =       1;
Recon voxel size AP (mm) = 0.491071433;
            RL (mm) =       0.491071433;
            FH (mm) =       1;
Fold-over suppression =             "oversampling";
   L (mm) =                 80;
   R (mm) =                 80;
Slice oversampling =          "user defined";
   oversample factor =      2;
Reconstruction matrix =             448;
SENSE =                  "no";
CS-SENSE =               "yes";
   reduction =           6;
   denoising =                "system default";
k-t Acceleration =       "no";
Stacks =             1;
   slices =              200;
   slice orientation =        "transverse";
   fold-over direction = "RL";
   fat shift direction =  "P";
Multi-chunk =                "no";
O-MAR =                      "no";
Large table movement =             "no";
PlanAlign =              "no";
REST slabs =             0;
Interactive positioning =    "no";
External control =       "no";
Patient position =       "head first";
Patient body position =      "head first";
Patient orientation =        "supine";
Patient body orientation =   "supine";
Scan type =              "Imaging";
Scan mode =              "3D";
   technique =               "SE";
Modified SE =                "no";
Acquisition mode =           "cartesian";
Fast Imaging mode =          "TSE";
   3D VIEW =             "no";
```

```
    shot mode =                 "multishot";
TSE factor =                60;
    startup echoes =            4;
    profile order =         "linear";
    turbo direction =           "Y";
    DRIVE =                 "yes";
    ultrashort =            "no";
    fid reduction =         "strong";
    3D non-selective =          "yes";
Echoes =                    1;
    partial echo =          "no";
TE =                        "shortest";
Flip angle (deg) =          90;
Refocusing control =            "constant";
    angle (deg) =           45;
    bright fat reduction =      "no";
TR =                        "user defined";
    (ms) =              1800;
Halfscan =                  "no";
Water-fat shift =           "maximum";
RF Shims =                  "fixed";
Shim =                      "default";
mDIXON =                    "no";
Fat suppression =           "no";
Grad Rev Fat suppr =            "no";
Water suppression =             "no";
BB pulse =                  "no";
MTC =                       "no";
APT =                       "no";
Custom prepulse =               "no";
MDME =                      "no";
Diffusion mode =            "no";
T1 mapping =                "no";
Transmit channels =             "both";
SAR mode =                  "high";
B1 mode =                   "default";
SAR allow first level =         "no";
PNS mode =                  "high";
Gradient mode =                 "maximum";
SofTone mode =                  "no";
Cardiac synchronization =   "no";
Heart rate > 250 bpm =              "no";
Respiratory compensation = "no";
```

```
Navigator respiratory comp =      "no";
Flow compensation =               "no";
Motion smoothing =                "no";
NSA =                        1;
MRE enable =                 "no";
CENTRA =                     "no";
Manual start =                    "no";
Dynamic study =                   "no";
Arterial Spin labeling =     "no";
Preparation phases =              "auto";
Interactive F0 =             "no";
Quick Survey =                    "default";
B0 field map =                    "no";
B1 field map =                    "no";
MIP/MPR =                    "no";
Images =                     "M", (3) "no";
Autoview image =             "M";
Calculated images =               (4) "no";
Reference tissue =           "Grey matter";
Recon compression =               "No";
Preset window contrast =     "soft";
Reconstruction mode =             "real time";
Save raw data =                   "yes";
Hardcopy protocol =               "no";
Image filter =               "system default";
Uniformity correction =           "no";
Geometry correction =             "default";
Elliptical k-space shutter =      "default";
Stack Offc. AP (P=+mm) =     10.0683002;
        RL (L=+mm) =         -0.0122832758;
        FH (H=+mm) =         -11.8124113;
    Ang.  AP (deg) =                  0;
        RL (deg) =           -0;
        FH (deg) =           -0;
    Free rotatable =                  "no";
IF_info_seperator =               1634755923;
Total scan duration =             "16:13.8";
Rel. SNR =                   1.39131403;
Act. TR (ms) =                    "1800";
Act. TE (ms) =                    "291";
ACQ matrix M x P =                "340 × 337";
ACQ voxel MPS (mm) =              "0.65 / 0.65 / 1.00";
REC voxel MPS (mm) =              "0.49 / 0.49 / 1.00";
```

Scan percentage (%) = 99.1765747;
Act. slice gap (mm) = 0;
WFS (pix) / BW (Hz) = "2.021 / 215.0";
TSE es / shot (ms) = "8.4 / 548";
TEeff / TEequiv (ms) = "291 / 132 ";
Min. TR (ms) = "556";
Local torso SAR = "< 8 %";
Whole body SAR / level = "< 0.3 W/kg / normal";
SED = "< 0.3 kJ/kg";
Coil Power = "8 %";
Max B1+rms = "0.66 uT";
PNS / level = "76 % / normal";
dB/dt = "104.6 T/s";
Sound Pressure Level (dB) = 23.9341621;

3 CS_COR_T2_3D

An anatomic 3D T2 weighted sequence of lower abdomen and pelvis obtained in coronal plane, that can be reformatted in different orthogonal planes and allows us to trace the peripheral nerves, including nerve roots and branches that make up pudendal nerve.

Parameters:
EX_single_scan_id = 63403658;
SmartSelect = "yes";
Coil 1 (exclude) = "None";
Uniformity = "CLEAR";
FOV FH (mm) = 220;
RL (mm) = 220;
AP (mm) = 148;
ACQ voxel size FH (mm) = 0.649999976;
RL (mm) = 0.651851833;
AP (mm) = 2;
Recon voxel size FH (mm) = 0.491071433;
RL (mm) = 0.491071433;
AP (mm) = 2;
Fold-over suppression = "oversampling";
L (mm) = 110;
R (mm) = 110;
Slice oversampling = "user defined";
oversample factor = 2;
Reconstruction matrix = 448;
SENSE = "no";
CS-SENSE = "yes";

```
    reduction =             6;
    denoising =                 "system default";
k-t Acceleration =          "no";
Stacks =            1;
    slices =                74;
    slice orientation =         "coronal";
    fold-over direction =   "RL";
    fat shift direction =   "F";
Multi-chunk =               "no";
O-MAR =                     "no";
Large table movement =          "no";
PlanAlign =             "no";
REST slabs =            0;
Interactive positioning =   "no";
External control =          "no";
Patient position =          "head first";
Patient body position =     "head first";
Patient orientation =       "supine";
Patient body orientation =  "supine";
Scan type =             "Imaging";
Scan mode =             "3D";
    technique =             "SE";
Modified SE =               "no";
Acquisition mode =          "cartesian";
Fast Imaging mode =         "TSE";
    3D VIEW =           "no";
    shot mode =             "multishot";
TSE factor =            60;
    startup echoes =        4;
    profile order =         "linear";
    turbo direction =       "Y";
    DRIVE =             "yes";
    ultrashort =            "no";
    fid reduction =         "strong";
    3D non-selective =      "yes";
Echoes =                1;
    partial echo =          "no";
TE =                    "shortest";
Flip angle (deg) =          90;
Refocusing control =        "constant";
    angle (deg) =           45;
    bright fat reduction =  "no";
TR =                    "user defined";
```

```
    (ms) =              1800;
Halfscan =              "no";
Water-fat shift =       "maximum";
RF Shims =              "fixed";
Shim =                  "default";
mDIXON =                "no";
Fat suppression =       "no";
Grad Rev Fat suppr =        "no";
Water suppression =         "no";
BB pulse =              "no";
MTC =                   "no";
APT =                   "no";
Custom prepulse =           "no";
MDME =                  "no";
Diffusion mode =        "no";
T1 mapping =            "no";
Transmit channels =         "both";
SAR mode =              "high";
B1 mode =               "default";
SAR allow first level =     "no";
PNS mode =              "high";
Gradient mode =             "maximum";
SofTone mode =              "no";
Cardiac synchronization =   "no";
Heart rate > 250 bpm =          "no";
Respiratory compensation = "no";
Navigator respiratory comp =    "no";
Flow compensation =         "no";
Motion smoothing =          "no";
NSA =                   1;
MRE enable =            "no";
CENTRA =                "no";
Manual start =              "no";
Dynamic study =             "no";
Arterial Spin labeling =  "no";
Preparation phases =        "auto";
Interactive F0 =        "no";
Quick Survey =              "default";
B0 field map =              "no";
B1 field map =              "no";
MIP/MPR =               "no";
Images =                "M", (3) "no";
Autoview image =        "M";
```

```
Calculated images =          (4) "no";
Reference tissue =       "Grey matter";
Recon compression =          "No";
Preset window contrast =     "soft";
Reconstruction mode =        "real time";
Save raw data =              "yes";
Hardcopy protocol =          "no";
Image filter =           "system default";
Uniformity correction =      "no";
Geometry correction =        "default";
Elliptical k-space shutter = "default";
Stack Offc. AP (P=+mm) =   29.4671116;
        RL (L=+mm) =   -9.39104843;
        FH (H=+mm) =   -9.40761185;
    Ang.  AP (deg) =           0;
        RL (deg) =         -0;
        FH (deg) =         -0;
    Free rotatable =           "no";
IF_info_seperator =          1634755923;
Total scan duration =        "06:59.4";
Rel. SNR =               1.81962717;
Act. TR (ms) =               "1800";
Act. TE (ms) =               "291";
ACQ matrix M x P =           "340 × 337";
ACQ voxel MPS (mm) =         "0.65 / 0.65 / 2.00";
REC voxel MPS (mm) =         "0.49 / 0.49 / 2.00";
Scan percentage (%) =        99.1765747;
Act. slice gap (mm) =        0;
WFS (pix) / BW (Hz) =        "2.021 / 215.0";
TSE es / shot (ms) =         "8.4 / 548";
TEeff / TEequiv (ms) =       "291 / 132 ";
Min. TR (ms) =               "556";
Local torso SAR =        "<  8 %";
Whole body SAR / level =     "< 0.3 W/kg / normal";
SED =                    "< 0.1 kJ/kg";
Coil Power =             "8 %";
Max B1+rms =                 "0.66 uT";
PNS / level =            "60 % / normal";
dB/dt =                  "98.9 T/s";
Sound Pressure Level (dB) =      20.8726139;
```

4 FAT_SAT_Ax_T2_3D_1mm

An anatomic 3D T2 weighted axial sequence of lower abdomen and pelvis that takes out bright fat signal and can be reformatted in different orthogonal planes. This allows the peripheral nerves to stand out and be better appreciated.

Parameters:
EX_single_scan_id = 61521794;
SmartSelect = "yes";
Coil 1 (exclude) = "None";
Uniformity = "CLEAR";
FOV AP (mm) = 220;
RL (mm) = 220;
FH (mm) = 175;
ACQ voxel size AP (mm) = 0.649999976;
RL (mm) = 0.65180105;
FH (mm) = 1;
Recon voxel size AP (mm) = 0.34375;
RL (mm) = 0.34375;
FH (mm) = 1;
Fold-over suppression = "oversampling";
L (mm) = 100;
R (mm) = 100;
Slice oversampling = "user defined";
oversample factor = 2;
Reconstruction matrix = 640;
SENSE = "no";
CS-SENSE = "yes";
reduction = 6;
denoising = "system default";
k-t Acceleration = "no";
Stacks = 1;
slices = 175;
slice orientation = "transverse";
fold-over direction = "RL";
fat shift direction = "P";
Multi-chunk = "no";
O-MAR = "no";
Large table movement = "no";
PlanAlign = "no";
REST slabs = 0;
Interactive positioning = "no";
External control = "no";
Patient position = "head first";

```
Patient body position =        "head first";
Patient orientation =          "supine";
Patient body orientation =     "supine";
Scan type =                    "Imaging";
Scan mode =                    "3D";
   technique =                 "SE";
Modified SE =                  "no";
Acquisition mode =             "cartesian";
Fast Imaging mode =            "TSE";
   3D VIEW =                   "no";
   shot mode =                 "multishot";
TSE factor =                   53;
   startup echoes =            4;
   profile order =             "linear";
   turbo direction =           "Y";
   DRIVE =                     "yes";
   ultrashort =                "no";
   fid reduction =             "strong";
   3D non-selective =          "yes";
Echoes =                       1;
   partial echo =              "no";
TE =                           "shortest";
Flip angle (deg) =             90;
Refocusing control =           "constant";
   angle (deg) =               45;
   bright fat reduction =      "no";
TR =                           "user defined";
   (ms) =                      1800;
Halfscan =                     "no";
Water-fat shift =              "maximum";
RF Shims =                     "fixed";
Shim =                         "default";
mDIXON =                       "no";
Fat suppression =              "SPIR";
  strength =                   "strong";
  frequency offset =           "default";
Grad Rev Fat suppr =           "no";
Water suppression =            "no";
BB pulse =                     "no";
MTC =                          "no";
APT =                          "no";
Custom prepulse =              "no";
MDME =                         "no";
```

```
Diffusion mode =          "no";
T1 mapping =              "no";
Transmit channels =           "both";
SAR mode =                "high";
B1 mode =                 "default";
SAR allow first level =       "no";
PNS mode =                "high";
Gradient mode =               "maximum";
SofTone mode =                "no";
Cardiac synchronization =     "no";
Heart rate > 250 bpm =            "no";
Respiratory compensation = "no";
Navigator respiratory comp =      "no";
Flow compensation =           "no";
Motion smoothing =            "no";
NSA =                     1;
MRE enable =              "no";
CENTRA =                  "no";
Manual start =                "no";
Dynamic study =               "no";
Arterial Spin labeling =  "no";
Preparation phases =          "auto";
Interactive F0 =          "no";
Quick Survey =                "default";
B0 field map =                "no";
B1 field map =                "no";
MIP/MPR =                 "no";
Images =                  "M", (3) "no";
Autoview image =          "M";
Calculated images =           (4) "no";
Reference tissue =        "Grey matter";
Recon compression =           "No";
Preset window contrast =      "soft";
Reconstruction mode =         "real time";
Save raw data =               "yes";
Hardcopy protocol =           "no";
Image filter =            "system default";
Uniformity correction =       "no";
Geometry correction =         "default";
Elliptical k-space shutter =  "default";
Stack Offc. AP (P=+mm) =  10.0683002;
          RL (L=+mm) =    -0.0122832758;
          FH (H=+mm) =    -11.8124113;
```

```
        Ang.  AP (deg) =        0;
            RL (deg) =      -0;
            FH (deg) =      -0;
        Free rotatable =        "no";
    IF_info_seperator =         1634755923;
    Total scan duration =       "17:43.8";
    Rel. SNR =              1.56794226;
    Act. TR (ms) =              "1800";
    Act. TE (ms) =              "261";
    ACQ matrix M x P =          "340 × 337";
    ACQ voxel MPS (mm) =        "0.65 / 0.65 / 1.00";
    REC voxel MPS (mm) =        "0.34 / 0.34 / 1.00";
    Scan percentage (%) =       99.1765747;
    Act. slice gap (mm) =       0;
    WFS (pix) / BW (Hz) =       "2.021 / 215.0";
    TSE es / shot (ms) =        "8.4 / 488";
    TEeff / TEequiv (ms) =      "261 / 121 ";
    Min. TR (ms) =              "509";
    Local torso SAR =       "<  8 %";
    Whole body SAR / level =    "< 0.3 W/kg / normal";
    SED =                   "< 0.3 kJ/kg";
    Coil Power =            "8 %";
    Max B1+rms =                "0.65 uT";
    PNS / level =           "76 % / normal";
    dB/dt =                 "104.9 T/s";
    Sound Pressure Level (dB) =     23.897604;
```

CT Imaging

5 Parameters:
Helical mode scan from L4 to proximal femur shaft
Slice thickness of 0.625 mm
Kvp = 120