US vs. Blind Needle Insertion/Anatomic Localization

ULTRASOUND VS. ANATOMIC TECHNIQUES: WHAT’S THE EVIDENCE
GENERAL STUDIES ON US GUIDANCE
Guided interventions in MSK US:
J. Davidson, S. Jayaraman Clinical Radiology 66(2011) 140-152

• **Review Article**: US guided interventions, injections, adults
  – *included BoNT injections*

• Reported little evidence regarding efficacy of infection control methods
  – Practice: clean site with alcohol
  – Sterile saline used as coupling agent.
  – Probe cleaned (using alcohol directly may damage probe)
  – Probe covers used only for deep injections
  – Audited injection rates: 0 in > 2000 injections
Guided interventions in MSK US:
J. Davidson, S. Jayaraman Clinical Radiology 66(2011) 140-152

• Categories of Us guided procedures
  – Guided intervention: Lavage, dry needling, Brisement, electro coagulation, cryotherapy
  – Injections: LA, corticosteroid, autologous substances, sclerosants, Prolo, BoNT
  – Future Direction: Mesenchymal stem cells for tendon repair
Guided interventions: what’s the evidence?
J. Davidson, S. Jayaraman Clinical Radiology 66(2011) 140-152
Continued

• *Evidence for better results with US guided interventions:*
  – Anecdotal: Dry Needling
  – Prospective, non randomized
    • Brisement: 1 study, 30 patients improvement in symptoms following injection LA, steroid
    • Electrocoagulation: 1 study 11 patients, Achilles T: symptomatic relief
  – Cochrane reviews: Numerous for steroid injections
    – RCT: BoNT: several for psoas spasticity, plantar fascitis, lateral Epicondylosis
  – Numerous studies: Sclerosants: + outcome US guided injections of stump neuromata, Achilles and patellar tendinosis
  – Small studies: Prolotherapy, autologous substances, enocyte like cells
Berweck and Heinen: Movement Disorders Supplement 2004

• US guided BoNT injections (20,000 injections)
  – Precise, real-time, visually guided injection into the center of every targeted muscle belly in lower/upper extremity is possible

• US enables differential target selection.
  – Precisely choose injection: adductor longus gracilis
    • Based on US/clinical evaluation
      – Observe for adductor spasm with knee flexion or extension.
Berweck and Heinen: Movement Disorders Supplement 2004

• Conclusions
  – US prevents:
    • Accidental sub-Q or intravascular injections
    • Mis-directed injection in deep or atrophied muscles
  – Compared to conventional methods US surpasses other imaging techniques
  – As an add-on procedure it demands little additional time and avoids X-ray exposure
  – US images may be stored electronically or printed for documentation
ULTRASOUND PROSPECTIVE STUDIES
US-guided BoNT-A injection Iliopsoas Muscle in Children with CP
Depedhbi et al. NeuroRehabilitation 2008

• Prospective study:
  – 18 patients, CP
  – Multilevel BTX-A injections
  – Dose of 15 U/kg

• Assessments:
  – Before, weeks 5 and 12 post-injection:
    • Thomas test, Duncan-Ely test, PROM, distance between knee (DBK), Selective Motor Control (SMC) scale, MAS modified Physician rating scale (mPRS)
  – Before and week 12: GMFM, WeeFIM
US-guided BoNTA injection iliopsoas Children, CP
Depedhbi et al NeuroRehabilitation 2008

• Results
  – Wk 5: significant improvements
    • Spasticity (p < 0.01)
    • mPRS and PROM,
    • No improvement in SMC
• Week 12: Improved
  – GMFM (p< 0.001)
  – WeeFIM (p< 0.001).
  – Improved PROM, mPRS (p< 0.01)

• Improvement not lasting to week 12
  – MAS (p > 0.05)
  – Tardieu (adductors) (p > 0.05)

• Conclusion:
  • BoNTA enhanced function/motor abilities
  • US facilitated muscle localization
Boon A et al: Cadaver Study, Blind Needle Placement vs. US Guided Placement

• 14 lower limb muscles, 2 fresh frozen cadavers
  – Fine wire placed using standard manual needle placement
  – Fine wire placed under US guidance

• 2 clinicians
  – Experienced EMG Attending
  – Resident with 6 months EMG experience

• Fine Wire placement checked by CT

ULTRASOUND VS. ANATOMIC LOCALIZATION
Boon et al, Blind Needle Placement vs. US

• Accurate placement = in target muscle or ≤ 5mm deep to muscle
• Location of needle relative to vital structures was also noted (≤ 5mm)
• For inaccurate placement, trajectory of the wire was recorded i.e. correct or not
• Overall Accuracy
  – Blind placement: 39%
  – US Guided: 96%
Boon et al, Blind Needle Placement vs. US

• Blind placement, range of accuracy
  – 0% : FDI, Semi T, Semi M, Rectus fem
    • US Guidance: 100% for these muscles
  – 100%  Tib, Ant, Short head biceps femoris
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• Does experience matter?
  – No statistical difference between the more experienced and less experienced clinician
  – **Experienced clinician** had a more accurate trajectory (82% vs. 50%)

- Prospective study: 272 injections, 39 children
- Injection site selected by anatomic landmarks
- Needle site checked by second clinician using ultrasound
- Accuracy of injection
  - 64% lateral gastrocnemius
    - Accuracy lower in younger/smaller patients
  - 92% medial gastrocnemius
- Conclusion: landmark based injection guidance not acceptable for lateral gastrocnemius
Conclusions: Even in a relatively superficial, large muscle US is superior to anatomic localization

Lateral Gastrocnemius  
Medial Gastrocnemius
Henzel et al 2010

UPPER LIMB MUSCLES
Surface vs US Localization to Identify Forearm Flexor Muscles for BoNT
Henzel, Munin et al PMR 2010

• 18 Patients, problematic upper limb spasticity
  – Excluded patients with: severe contractures or trauma

• Anatomic localization techniques:
  • Delagi: FPL, FCR, PT,
  • Bickerton: FDS individual fascicles
  – Method:
    • Proximal-distal: reference line: medial epicondyle-psiform.
      – Relative prox:distal distances calculated, expressed as % length
    • Medial-lateral coordinated: perpendicular to above line
      – Measured in mm lateral (radial) to reference line
Surface vs US Localization Forearm Flexor Muscles for BoNT: continued
Henzel et al PMR 2010

• US localization technique
  – Coordinates as above
    • Proximal- Distal,
    • Medial -lateral
• Localization methods compared by
  – Wilcoxon signed rank test
  – 1 Sample T Test

• Results:
• Optimal site for injection were expressed as
  – % LL
  – Lateral coordinates (mm)
Surface vs US Localization Forearm Flexor Muscles for BoNT: continued
Henzel et al PMR 2010

• Results: Significant differences in optimal site:
  – Proximal-Distal site:
    • FPL (p.042)
    • PT (p .003)
    • Trend FCR (.066).
  – Lateral distance from reference line:
    • FDS3 (.011)
    • FCR (.023)
    • Trend in FDS2 (.052), FDS4 (.088)
Surface vs US Localization Forearm Flexor Muscles for BoNT: continued
Henzel et al PMR 2010

• Conclusion:

• **US localization revealed significant differences in optimal muscle injection site compared to surface guided recommendations**
  – May be due to many factors
    • Cadaver specimens used for surface references
    • Patient size
    • Positioning patients with spasticity for surface techniques
    • 3D distortion from spasticity
Why Use Ultrasound Guidance: Is There Evidence to Support Increased Accuracy?
Prospective Study: Efficacy BoNT

- Lower limbs, children with CP according to:
  - Age, dose, dilution, injection site
  - Needle placement technique (manual vs. US)
  - Patient Selection: All children /CP over 1 year who received BoNTA (add, HS, gastroc/soleus) could be included
Py AG et al continued

Methods

• 54 patients participated
  – 30 received BoNT with US guidance
• Pre-/post- BoNT evaluations were done
  – Clinical examination
  – GMFM-88.
• RESULTS: Overall clinical effectiveness for 51% of children
• Efficacy significantly higher for children < 6 or > 12
Py AG et al continued

**Efficacy**

Higher when:
- Doses > 0.8 UI/kg/muscle Botox
- When the injected muscles were hamstrings or gastrocnemius,
- When the injections were guided by ultrasound
- Dilution had no effect on clinical effectiveness.

**Functional Outcome**

- At 1 month improved in 24%
- Improvement significantly better for
  - < 6 years old
  - Injections under ultrasound
- CONCLUSIONS: study confirmed effectiveness of BoNT was
  - Higher in younger children
  - With injected doses higher than 0.8 UI/kg per muscle Botox
  - Injections guided by ultrasound.
US VS. E-STIM
BoNT Calf Muscles, Equinus in CP: Controlled Trial Comparing US and E-Stim:
Kwon Am J Phys Med Rehab 2010

- 32 children CP, equinus gait
  - Enrolled in separate categories based on GMFCS
- 2 groups: US and E-Stim
- Gastrocnemius (n 30)
  - Equal dose BoNT, 4-6 sites, 30 children
- Injection guidance: 14 E-Stim 16 US
- Evaluation: baseline, 1, 3 months post injection
  - MAS, M-Tardieu, selective motor control, PRS-gait

• Results
  – US Group: significantly improved PRS subscales
    • Gait pattern
    • Hindfoot position
    • Maximum foot/floor contact during stance

• No statistical differences noted
  – MAS
  – M-Tardieu Scale
  – Selective Motor Control.
OTHER RELEVANT STUDIES
In Ho Lee, et al
AJR:192, April 2009

Experience with Imaging Guided BoNT in Cervical Dystonia (CD)

• 2005-2008, 14 patients with idiopathic cervical dystonia
• Evaluated clinically, with EMG, PET and CT
• 8 Patients had BoNT injections performed under US (5) or CT (1), both (2)
• 13 Sessions
  – 7 US, 6 CT

Results

• After CT or US guided IM BTX injections, all 8 pts had markedly reduced pain/neck by Tsui and TWSTRS subscale
• Conclusion: Imaging guidance mandatory for injections into deep neck muscles or those with focal area of high SUV by CT
• Imaging provides accurate targeting, avoids injury to important structures including carotid vessels
Case Report: Vasogenic TOS

- Vascular TOS
  - Reduced BF measured in radial artery
  - 3 x increased velocity across stenotic area of subclavian artery with arm hyper-abducted
- Tx: 15 Units OnabotulinumtoxinA injected into anterior scalene, US guided
- Post injection
  - Improved blood flow in provocative position
  - Decreased symptoms


Pre OnabotulinumtoxinA

Post BotulinumtoxinA