**Scientific paper session 1: OBPL general**  
*Introduced and moderated by Alain Gilbert and Howard Clarke*

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1.1 The natural history of recovery of elbow flexion after obstetric brachial plexus injury managed without nerve repair

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We report the outcome for spontaneous recovery of elbow flexion in obstetric brachial plexus injury (OBPI) managed without nerve reconstruction.

Before 2008 our unit did not routinely offer nerve exploration and reconstruction. Children born before 2008 were identified from our database. 232 children had been assessed for OBPI. 80 had full early recovery, leaving 152 with a persisting deficit. These cases are followed up until skeletal maturity. The Narakas group was known for 149 children; 58 group 1, 55 group 2, 24 group 3, and 12 group 4. Five children had nerve repair. Of 147 managed without nerve exploration, only one patient had been noted to have insufficient elbow flexion to reach their mouth. Elbow flexion started to recover clinically at a mean age of 4 months for Narakas group 1, 6 months for group 2, 8 months for group 3 and 12 months for group 4. The mean active range of elbow flexion, measured in 44 cases, was 138 (Range 110–160). The mean isometric elbow flexion strength, measured in 39 patients at a mean age of 12.6 years (Range 5 to 22), was 8.7Kgf, 63% (Range 23 - 100%) of the normal side, 68% for group 1 injuries, 61% group 2, 64% group 3, and 62% group 4.

It appears to be rare for elbow flexion not to recover spontaneously, although recovery occurs later in more severe injuries. It is doubtful if nerve reconstruction can improve elbow flexion beyond the likely spontaneous recovery in children with OBPI.
1.2 Exploring the Incidence of Isolated Dorsal and/or Ventral Rootlet Disruption (Avulsion) by High-Resolution MRI in Neonatal Brachial Plexus Palsy (NBPP)

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Introduction: Avulsion injury of a nerve root in NBPP generally precludes its use as a donor for nerve reconstruction. Traditional imaging, e.g. myelograms, early CT-myelograms, provided indirect evidence via the presence of pseudomeningoceles as an indicator of an avulsed nerve root. The introduction of high resolution MRI allowed direct visualization of individual rootlets and their integrity. The purpose of our study was to determine the incidence of isolated ventral and/or dorsal nerve rootlet avulsion via high resolution MRI.

Methods: We conducted a retrospective review of MRI imaging of NBPP infants from 2010-2018. A single board-certified neuro-radiologist who was blinded to the clinical presentation and later outcomes reviewed each dorsal and ventral nerve rootlet at the C5-T1 levels from the spinal cord to its exit in the neuroforamina. Descriptive statistics were used to describe the ventral intact and ventral not-intact rootlets.

Results: Sixty infants (600 nerve roots; mean age 5±2mos) were included. Only 2/600 (0.33%) nerve roots were unreadable. Surprisingly, of the total avulsed nerve roots, C7 was most commonly disrupted (31%). Overall for each “avulsed” nerve root, 31% to 40% of the ventral rootlets were deemed intact.

Conclusion: High-resolution MRI allows 99+% readability in the determination of nerve rootlet integrity. Given the increasing incidence of pan-plexopathies, conservation of potential nerve root donors for nerve reconstruction is critical. We suggest that MRI can be of assistance in the pre-operative planning of the surgical strategy by identifying certain “avulsed” nerve roots as potentially viable donors.
1.3 Exploring Tissue Viability Imaging (TiVi), Skin Temperature and Stimulated Skin Wrinkling Asymmetry as potential tools for the evaluation of Obstetric Brachial Plexus Injury (OBPI)

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Measurement of skin temperature asymmetries, stimulated skin wrinkling (SSW), otherwise known as, the ‘wrinkle test’ and visualizing microcirculation in the upper dermis using Tissue Viability Imaging (TiVi) may allow for improved early evaluation of severity of nerve injury in OBPI. TiVi, uses a digital camera equipped with polarization filters and user-friendly software for presenting the skin microvascular blood concentration in two-dimensional digital video images. Measurement of skin temperature asymmetry with a handheld infrared thermometer and SSW using EMLA cream, both provide simple, painless and cost-effective methods that could be used in conjunction with other diagnostic methods to improve decision making re the need for surgery after OBPI.

The results of a pilot cross sectional study on infants and young children with OBPI in which all three methods were administered and showed significant differences between the affected and unaffected limbs will be presented. These results will be correlated with other measures of impairment: Active Movement Scale; Narakas Classification Level, and other diagnostic tests when available. Infants and children who have had primary reconstructive nerve surgery and those who have not, will both be included in the final sample. These new methods provide innovative, efficient and perhaps easily standardized techniques of evaluation of the extent of nerve injury.
1.4 Outcome of Microsurgery for BPBI Before Versus After 6 Months of Age: Results of the Multicenter TOBI Study

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Background: The timing of nerve surgery in infants with brachial plexus birth injury (BPBI) is controversial. The Treatment and Outcomes of Brachial plexus Injuries (TOBI) study is a multi-center prospective study designed to determine the optimal timing of this surgical intervention. This study compared outcomes evaluated 18-36 months after “early” (age 6 months) versus “late” (age 6 months) microsurgery.

Methods: 118 subjects were included based on having a nerve graft and/or transfer and at least one physical examination during the interval 18 to 36 months after microsurgery but before any secondary surgery. Surgical timing was dichotomized as before or after 6 months of life. Postoperative outcomes were measured using the total Active Movement Scale (AMS) score as well as the change in AMS score. To address hand reinnervation, a hand function subscore of the AMS was used to repeat the analysis among patients with global injuries.

Results: Eighty subjects (67%) had early surgery (at a mean 4.2 months); 38 (32%) had late surgery (at a mean 10.7 months). Infants who underwent early surgery tended to enroll earlier and have more severe injuries. When controlled for severity, the difference in AMS scores between early and late surgery groups was not significant. In patients with global injuries, there was no difference in the postoperative AMS hand subscore in the early versus late groups.

Conclusions: This study suggests that earlier surgery does not lead to better outcomes in BPBI nerve surgery, including reinnervation of the hand in global injuries.
1.5 Treatment Variation in Brachial Plexus Birth Injury Across Academic Medical Centers in North America

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Purpose: There are limited consensus-based guidelines for surgical treatment of Brachial Plexus Birth Injury (BPBI). This study investigated the variation in surgical care for BPBI among centers in the United States.

Methods: Treatment and Outcomes of Brachial plexus Injuries (TOBI) is a multi-center prospective study of BPBI patients. We analyzed 781 TOBI subjects at 6 sites (site A: 43%, B: 19%, C: 13%, D: 13%, E: 10%, and F: 2%). Binary logistic regressions and chi-squared tests were used to assess variation in microsurgery and secondary shoulder procedures (SSP) (botulinum toxin injection, contracture release, and/or tendon transfers). Site A had highest enrollment and was used as the baseline for comparisons.

Results: Subjects were enrolled at a median of 3 months of age. There was significant site variation in enrollment age (0.001). 218 subjects (28%) underwent microsurgery, at a median of 6 months of age. There was site variation in the likelihood of undergoing microsurgery, with an increased odds ratio (OR) of microsurgery at sites B (OR=5.1) and site C (OR=6.2) versus site A. Of the 218 subjects who underwent microsurgery, 55% underwent SSP. Of the 563 subjects who did not undergo microsurgery, 23% underwent SSP. While there was no difference in the rate of SSP across sites, there was significant variation in the type of SSP (0.001). (Table 1).

Conclusion: Variation exists in the surgical care of BPBI among centers in the TOBI study. This variation includes the likelihood of receiving microsurgery as well as the types of SSP performed.