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Obstetrical brachial plexus palsy: Can excision of upper trunk neuroma and nerve grafting improve function in babies with adequate elbow flexion at nine months of age?

Anne E. Argenta [a], Jack Brooker [b], Zoe MacIssac [a], Megan Natali [a], Stephanie Greene [c], Meg Stanger [d], Lorelei Grunwaldt [a,*]

[a] Department of Plastic Surgery, Children's Hospital of Pittsburgh of UPMC, USA
[b] School of Clinical Medicine, University of Cambridge, UK
[c] Department of Neurosurgery, Children's Hospital of Pittsburgh of UPMC, USA
[d] Department of Physical Therapy, Children's Hospital of Pittsburgh of UPMC, USA

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Summary Accepted indications for exploration in obstetrical brachial plexus palsy (OBPP) vary by center. Most agree that full elbow flexion against gravity at nine months of age implies high chance of spontaneous recovery and thus excludes a baby from surgical intervention. However, there are certain movements of the shoulder and forearm that may not be used frequently by the infant, but are extremely important functionally as they grow. These movements are difficult to assess in a baby and may lead to some clinicians to recommend conservative treatment, when this cohort of infants may in fact benefit substantially from surgery. A retrospective review was conducted on all infants managed surgically at the Brachial Plexus Center of a major children's hospital from 2009 to 2014. Further analysis identified five patients who had near-normal AMS scores for elbow flexion but who had weakness of shoulder abduction, flexion, external rotation, and/or forearm supination. In contrast to standard conservative management, this cohort underwent exploration, C5-6 neuroma excision, and sural nerve grafting. Data analysis was performed on this group to look for overall improvement in function. During an average follow-up period of 29 months, all patients made substantial

* Corresponding author. Children's Hospital of Pittsburgh, UPMC, One Children's Hospital Drive, 4401 Penn Ave, Faculty Pavilion, #7105, Pittsburgh, PA, 15224, USA. Tel.: +1 412 692 8650; fax: +1 412 692 8614.
E-mail address: lorelei.grunwaldt@chp.edu (L. Grunwaldt).

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gains in motor function of the shoulder and forearm, without loss of elbow flexion or extension, or worsening of overall outcome. In select infants with brachial plexus injuries but near-normal AMS scores for elbow flexion, surgical intervention may be indicated to achieve the best functional outcome.
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Introduction

Obstetrical brachial plexus injury (OBPI) represents a spectrum of upper extremity injuries that can occur during birth, due to traction on one or more nerve roots or trunks of the brachial plexus, which arises from C5-T1. While the incidence of OBPI ranges from 0.4 to 5:1000 live births, there is a wide range of injury severity and spontaneous recovery.[1,2] Although Pondaag et al. report spontaneous recovery in over 90% of patients in their series, a review of studies with the highest methodological quality demonstrate only 75% complete recovery, indicating misplaced optimism with conservative management.[1,3] Long-term disability from OBPI includes muscle weakness, abnormal posture, joint dislocations, and arm shortening.[1]

Accurately predicting the potential for and the degree of recovery remains a challenge. Surgeons have historically relied on serial motor examination to determine extent of injury and need for surgical intervention. Due to an infant's inability to cooperate with a sensory and motor examination, these evaluations have an inherent subjective bias, depending on the infant's level of interest and his/her comfort with the examiner.[4]

Multiple scoring systems have been established to allow for more objective measurements. One such tool is the Toronto Active Movement Scale (AMS), developed by Clark and Curtis.[4,6] The AMS is a validated tool, which assesses 15 different upper limb movements in both gravity-eliminated positions and movements against gravity. Movements are graded on an 8-point scale, from zero when no contraction is visible, to seven for full motion against gravity (Table 1).

Table 1 The hospital for sick children active movement scale.

Grade	Observation	
0	No contraction	Gravity eliminated
1	Contraction, no motion	"
2	Motion $\leq$1/2 range	"
3	Motion >1/2 range	"
4	Full motion	"
5	Motion $\leq$1/2 range	Against gravity
6	Motion >1/2 range	"
7	Full motion	"

*ASM scale was first reported in Clarke HM, Curtis CG. An approach to obstetrical brachial plexus injuries.
Hand Clin 1995; 11:11:563–580. Please refer here for more detailed grading information.

Noted advantages include the ability to grade movement in the entire upper extremity in infants without command, the ability to evaluate overall joint movements (rather than individual muscle testing), the ability to discriminate smaller change in movement with an 8-point scale, and the ability to use the same scale over time from infancy to adulthood before and after intervention, which allows for direct comparison of paired data for statistical analysis.[4] When used by trained evaluators on children between 1 and 15 months of age, the AMS has demonstrated moderate to excellent intra- and inter-rater reliability.[4,6] However, studies have shown that evaluators tend to overestimate the range of movement using the AMS.[7] Despite its flaws, the AMS remains the most universally accepted system to measure OBPI.

Another tool is the "cookie test", which is generally performed at 9 months of age. In this test, a child is observed attempting to bring a lightweight cookie from hand to mouth while the humerus is restrained at the child's side.[2,8] This forces the child to use elbow flexion at the primary means to bring the cookie to his/her mouth. A child who is able to bring the cookie to his/her mouth without flexing the neck more than 45° passes the cookie test, while a child who requires neck flexion and/or supplemented arm movements to reach the cookie to his/her mouth fails the text.

Translating physical exam findings and scoring systems into treatment recommendations is controversial and there is no universal OBPI treatment algorithm at present. Elbow flexion is an essential movement for most activities of daily living (ADLs) and is relatively easy to observe during a motor examination. As evidenced by the common use of the "cookie test," it historically is the most commonly used guide for OBPI management: absent elbow flexion by 3 months of age (and a subsequent failed cookie test at 9 months) suggests need for operative intervention; its presence is an indication for conservative therapy.[2,3,9–11] In an effort to more accurately predict OBPI recovery, the more complicated 3-month Test Score of Clark and Curtis was developed. This converts selected AMS scores using a set scale conversion, and adds the converted scores to predict likelihood of recovery without surgery. In addition to elbow flexion, the 3 months Test Score includes elbow, wrist, finger, and thumb extension. Several studies have validated the 3-Month Test Score and it has been shown to reduce incorrect recovery predictions from 12 to 5.2%, compared to evaluation of elbow flexion alone.[2,4,5,12]

Despite advances in OBPI management, there remains a relative lack of attention to other movements such as shoulder external rotation and forearm

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