PREDICTION OF FUNCTIONAL OUTCOME OF OBSTETRIC BRACHIAL PLEXUS PALSY

NIHAL IBRAHIEM AL-SHISHTAWY

Rheumatology & Rehabilitation Department, Ain Shams University
Faculty of Medicine

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ABSTRACT

Objective: The aim of this work was to identify parameters that might improve the prediction of recovery of obstetrical brachial plexus palsy (OBPP).

Methodology: Twenty-four OBPP children were included in this study. They were classified into 4 groups: C5-6, C5-7 and C5-T1 without and with Horner’s syndrome. Clinical evaluation was done every 3 months and follow-up until the age of one year using the following methods:

1- Hospital for sick children (HSC) grading system: where elbow flexion elbow, wrist, finger and thumb extensors were evaluated. Score 3.5 or more at 3 months is with good prediction of outcome at final assessment.

2- Shoulder function assessment according to Mallet where global abduction, global external rotation, hand to neck, hand to spine & hand to mouth were evaluated.

3- Hand function grading after Raimondis (6 grades).

4- Functional recovery good or poor after Mallet.

Results: Group I comprised 8 patients, group II 6 patients and groups III & IV 5 patients each. Four (16.6%) patients recovered completely. Two (8.2%) patients had persistent deficit with no treatment and reasonable functions. Seven patients (29.16%) needed a second operation. Eleven patients (45.83%) were operated upon for primary plexus repair; 5 of them were in group IV (all patients). The HSC system was more than 3.5 in 7 patients at the age of 3 months. All showed good prediction according to HSC at final assessment. In two patients in whom HSC showed a score less than 3.5 improvement occurred at 6 months of age. Shoulder function assessment more than 2 and hand grade more than 3
was with good prediction. The functional recovery system is not suitable for prediction of recovery.

**Conclusion:** From this study we can recommend using for group I & II (3.5 or more) HSC scoring system at 6 months of age together with shoulder function system 2 grade or more. And for group III & IV, abduction of grade 2 & grade 3, hand function or more. Also it is recommended to use functional recovery system graded good, moderate & poor where. **Good:** Complete recovery or elbow range of motion >90° with M3 or higher biceps. And shoulder abduction > 120° with external rotation > 25°. **Moderate:** Shoulder abduction <120° and weak external rotation. And elbow range of motion >90° or biceps power >M2. **Poor:** Biceps less than M2 or elbow range of motion < 90° or absence of recovery.

**INTRODUCTION**

Obstetrical brachial plexus palsy (OBPP) usually complicates a very small proportion of births. OBPP occurs in 0.4-2.5 per 1000 live births (Warner, 1998). Although many infants recover completely or have only minor residual functional deficits a number of children have persistent functional impairment and/or deformities and some cases will not recover (Greenwald et al., 1984; Kaye, 1988; Eng et al., 1996 and Kay, 1997).

As neurosurgical intervention has become more effective, OBPP have attracted more interest. The current concept is to refer the patient to microsurgical repair if no contraction of the biceps muscles by the age of 3 months occurs. That fact was concluded after the work of Tassin (1983) who followed 44 patients with OBPP. He found that complete recovery was only seen in patients with contraction of biceps and deltoid in the first month and normal contraction of these muscles by the third month. And a good shoulder was not obtained unless biceps and deltoid contraction began by three months and was normal by five months. Gilbert et al. (1988) modified these criteria and referred patients to surgery in: complete palsy with flail arm and Horner’s syndrome, complete C5-6 palsy without muscle contraction by 3 months and with negative EMG and C5-6 palsy with no recovery in the biceps at 3 months (as deltoid is difficult to be examined without the pectoralis in this age).

Many other investigators Kline et al. (1986), Eng et al. (1996) and myself have noticed a number of children whose biceps did not recover until after 6 months, and then have good and satisfactory recovery without surgical intervention. The decision of surgical intervention is in need of, justifying criteria reliable enough so that the clinician can arrive at a firm
diagnosis and a clear prognosis in order to avoid unnecessary surgery for those who would recover spontaneously and not to miss a case who needs surgical intervention to aid improvement & progress.

The aim of this work was to identify parameters that might improve the prediction of recovery.

**MATERIALS AND METHODS**

Twenty-four consecutive patients with OBPP were included in this study. They were classified at the age of 2 weeks and over according to Narakas (1987) into 4 groups:

**Group I:** C5-6, paralysis of deltoid and biceps.

**Group II:** C5-6-7, paralysis of deltoid, biceps, elbow, wrist & digit extensors.

**Group III:** C5-T1, complete paralysis of limb although there is some flexion of the fingers shortly after birth.

**Group IV:** C5-T1, the paralysis is complete and there is Burnard Horner syndrome.

Clinical evaluation every 3 months and follow up until the age of 12 months was performed using the following methods:

1- **Hospital for Sick Children Grading System (HSC):**

By using five motions as evaluation criteria (elbow flexion as well as extension of each of elbow, wrist, fingers and thumb.

<table>
<thead>
<tr>
<th>Gravity elimination</th>
<th>Score</th>
<th>Against gravity</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motion</td>
<td>Score</td>
<td>Motion</td>
<td>Score</td>
</tr>
<tr>
<td>No contraction</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contraction, no motion</td>
<td>0.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motion ≤ ½ range</td>
<td>0.3</td>
<td>Motion ≤ ½ range</td>
<td>0.6</td>
</tr>
<tr>
<td>Motion ≥ ½ range</td>
<td>0.6</td>
<td>Motion ≥ ½ range</td>
<td>1.3</td>
</tr>
<tr>
<td>Full motion</td>
<td>0.6</td>
<td>Full motion</td>
<td>2</td>
</tr>
</tbody>
</table>

If the total weighted score in the first 3 months of age was higher than 3.5, a favorable diagnosis by 12 months of age was expected with 94.8% confidence level (Michelow et al., 1994 and Clarke et al., 1995).
2- Shoulder function was assessed according to Mallet (1972).

<table>
<thead>
<tr>
<th>Grade I</th>
<th>Grade II</th>
<th>Grade III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global abduction</td>
<td>&lt; 30°</td>
<td>30° - 90°</td>
</tr>
<tr>
<td>Global external rotation</td>
<td>&lt; 0°</td>
<td>0° - 20°</td>
</tr>
<tr>
<td>Hand to neck</td>
<td>Not possible</td>
<td>Difficult</td>
</tr>
<tr>
<td>Hand to spine</td>
<td>Not possible</td>
<td>To S1</td>
</tr>
<tr>
<td>Hand to mouth</td>
<td>Marked trumpet sign</td>
<td>Partial trumpet sign</td>
</tr>
</tbody>
</table>

3- Grading of the hand function after Raimondi (1998):

**Grade 0:** Complete paralysis or slight finger flexion of no use, useless thumb- no pinch or no sensation.

**Grade I:** Limited active flexion of fingers; no extension of wrist or fingers; possibility of thumb lateral pinch.

**Grade II:** Active extension of wrist with passive flexion of fingers (tenodesis) passive lateral pinch of thumb.

**Grade III:** Active complete flexion of wrist and fingers- mobile thumb with partial abduction- opposition intrinsic balance- no active supination- good possibilities for palliative surgery.

**Grade IV:** Active complete flexion of wrist and fingers; active wrist extension- weak or absent finger extension- Good thumb opposition with active ulnaris intrinsics- Partial pronation and supination.

**Grade V:** Hand IV with finger extension and pronation- supination.

Functional recovery was assessed with good & poor according to (Mallet 1972).

<table>
<thead>
<tr>
<th>Recovery</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>Complete recovery Or: Elbow range of motion &gt; 90° with M3 or higher biceps muscle power And: Shoulder abduction &gt; 120° with external rotation &gt; 25°.</td>
</tr>
<tr>
<td>Poor</td>
<td>Elbow range of motion &lt; 90° or biceps muscle power &lt; M3 Or: shoulder abduction &lt; 120° or weak external rotation or an internal rotation contracture Or: Absence of recovery.</td>
</tr>
</tbody>
</table>

Muscle power was assessed using the British Muscle Movement Scale ref.19, in which M0 indicated no contraction, M1 a perceptible
contraction without movement, M2 active motion when gravity is neutralized, M3 when the muscle can act against gravity, M4 when the muscle can act against gravity and against resistance and M5 normal muscle power.

All patients were under regular program of physical therapy in the form of electric stimulation and exercise.

RESULTS

The twenty-four patients with obstetrical brachial plexus palsy (OBPP) included in this study were 12 boys & 12 girls, 21 children with right and 3 with left palsy.

**Group I:** Comprised 8 patients: 6 of them (75%) showed HSC score more than 3.5 at 3 months of age, the prediction of outcome was good. All of this group, 6 patients showed recovery of the biceps at the age of 3 months. Hand function grading was between 4 & 5 while their shoulder function was variable. At 3 months, 3 of them showed shoulder function of grade 2; only 2 of them improved to grade 3 and showed good functional outcome at 9 months. The other one continued with grade 2 to be with poor functional outcome at 9 months they had reasonable function with resistant deficits, the other 3 showed shoulder function grade 1 they needed shoulder surgery. The rest of the patients 25%, (2 patients) showed HSC of less than 3.5 with prediction of function at age of 3 months. They went for primary surgery at age of 3-6 months (for all the patients, their was no influence on the decision of primary surgery (table 1).

**Group II:** Comprised 6 patients, one of them (16.6%) only showed HSC score more than 3.5 at 3 months with good prediction of function and recovery of biceps function outcome was poor at 3 months. Shoulder function was grade 2, hand function was grade 5, the functional outcome at 9 months was good. The other 5 patients (83.3%) showed HSC less than 3.5 with poor prediction of function and poor function outcome. Three of them went to primary surgery at 3 months of age, one of them continued with poor outcome up to 12 months. The last one showed recovery of biceps at age of 6 months, the prediction of outcome was more than 3.5, hand function was grade 3 and shoulder functions were grade 2 (table 2).

**Group III:** Comprised 5 patients all of whom showed HSC less than 3.5, poor prediction of function and no recovery of biceps at the age of 3 months, with poor functional outcome. One of them went to primary surgery at the age of 6 months. Only one of them showed improvement of HSC at the age of 6 months with good prediction of function, where hand function improved to grade 4 and shoulder function improved to grade 3.
These patients did not show any recovery of the biceps up to 6 months, where the HSC score was 0.3 and at 8 months it was 1.3. At 9 months, the functional outcome was good (table 3), the other 3 children needed 2ry surgery.

**Group IV:** Comprised 5 patients all showed HSC of 0. All of them were operated for primary plexus repair at the age between 3-4 ms, no one in group 4 showed signs of Bernard Horner syndrome (table 3).

Only 4 patients showed complete recovery 2 in group I, one in group II and one in group III. Shoulder functional grade, hand to spine was not possible for all patients as difficult up to 1 year. At 12 months assessment was as 9 months for all patients.

Table (4): The final result of the whole patients groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Complete recovery</th>
<th>Persisting defect- No treatment reasonable function</th>
<th>2nd operation</th>
<th>Primary operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>II</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>III</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>IV</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>4 (16.66%)</td>
<td>2 (8.33%)</td>
<td>7 (29.16%)</td>
<td>11 (45.83%)</td>
</tr>
</tbody>
</table>

**Discussion**

Twenty four children with OBPP were included in this study. They were 12 boys and 12 girls, 3 only were left sided and 21 were right sided. *Nehme et al. (2002)* studied 30 OBPP patients 14 boys and 16 girls, 20 of them were right sided and 10 left sided. The result of our study showed that all the patients could be easily classified according to *Narakas (1987)* into the 4 groups. Although this classification is not new but is simple and justifies all the patients. Categorization of patients according to this classification will verify the patients into the category that may help in predicting functional outcome. *Brich (2002)* described it as a very important contribution to clinical analysis and it deserves to be better known and more widely used.

HSC score system was used in this study, all the patients (*7 patients*) who showed HSC more than 3.5 at 3 months of age showed good prediction of HSC at 3 months and at final assessment. All of them showed recovery of the biceps by 3 months of age. Two patients who showed good prediction of HSC at final assessment showed HSC score less than 3.5 at the age of 3
months, but above 3.5 at 6 months of age, one of them in group II and one in group III. In those 2 patients the biceps did not recover up to 6 months of age, one in group III improved at 8 months. This means that HSC prediction is of 77.7% confidence at 3 months and 100% at 6 months. In studies conducted by Michelow et al. (1994) and Clark & Curtis (1995) they found that HSC above 3.5 at 3 months was accompanied by favorable prognosis by 12 months of age with 99.8% confidence. Yilmaz et al. (1999) recommended further studies to reach a definitive conclusion about its reliability.

The HSC can only be applied for groups I & II OBPP. But for groups III & IV other parameters like hand flexion (wrist & fingers) and thumb opposition should be included to help in predicting the outcome. Again, if it is used at 6 months, or between 6 & 9 months, this will increase its accuracy to 100%. Also the use of the biceps alone to be a predictor of function is not fair as, it seems that the biceps, specially, may be delayed until the age of 8 months with good result at the end. The argument regarding making 3 months of age as the time of referral to primary plexus repair if no improvement of the biceps occurred is since 1983. Zancolli & Zancolli (1988) stated that 75% of biceps recovery began at five months. Yilmaz et al. (1999) found one patient (out of 13) in whom the biceps improvement was delayed between 3-6 months.

Nehme et al. (2002) studied thirty patients with groups I & II and found 20 patients improved, 3 of them improved at 3 months, 12 patients at 9 months and five after the first 9 months. They added that though elbow flexion at 3 months is the best early predictor of outcome, this also had an unacceptable high error rate (36%). They also recommended that at 3 months, if elbow flexion is used as a single parameter for predicting a good recovery, M2 muscle power is sufficient to predict good recovery, while at 6 and 9 months, M2 is not sufficient and M3 strength is needed.

In this study we used assessment of shoulder function by Mallet (1972). This system is highly indicative of function and simple and easy to perform except for movement of hand to spine; it was not possible at that age. From the results we can observe that patients with grade 2 or more shoulder function at 3 months, did not need surgery and recovered completely except in one case in who needed to be operated upon. But at the age of 6 months. By combining the results of HSC and the results of shoulder assessment at 6 months not at 3 months (more than 3.5 HSC score and 2 or more shoulder function grade). This will increase the accuracy of predicting good recovery function to 100% and patients will only need operation for the shoulder if it is grade 2 and no operation if all shoulder function is grade 3.
Hand function was also used in this study as a predictor of function. All patients with grade 5 hand function showed full recovery with no surgery whether primary or secondary. Grade 4 hand function and in only one patient grade 3 was accompanied by improvement that needed shoulder surgery not plexus surgery. Combining the result of HSC score above 3.5 and the grading of hand function 3 or above will indicate full recovery or secondary operation only.

The good outcome related to the higher grade of hand function might be because of the absence of C7 affection or the good recovery of it if present. Nehame et al. (2002) found that most of the bad impairment of hand function was in children who suffered damage of C7 root. They explained it as involvement of C7 indicates an increased force of injury, resulting in greater stretching of the roots involved and thus poor outcome.

Brich (2002) stated that any function in the hand in the newborn is a cause of celebration as the outlook is very different for the partial lesion affecting C5/6 and C7, than for the complete lesion that affects the whole limb. A child with grasp function by the age of 6-8 weeks, will in all likelihood, go on to recover good hand function in adult life (Narakas, 1997).

In two patients of group III the grading for the hand was not fitting any of the grades. The 2 patients had flexion of the fingers & wrist (M3) which is not full but not limited & extension of the fingers (M2) but no wrist extension so not fitting grade 1 or grade 3. It can be noted that this classification includes useless hand and types of hand in which surgical solution is designed but other types of hands in which surgical solution is not yet designed are not included.

Brich (2002) stated that Raimondi’s system for the hand has the merit of being simple but, as the originator freely admits, full evaluation of hand function requires very much more than this. Sensory evaluation can add more information but sensory evaluation is not possible at all at that age.

In this study, we did not include elbow grading for function as it is included in the HSC score prediction and also in the functional outcome prediction. The functional recovery system of the patient only showed good recovery in 4 patients, 2 patients in group I and one in each of groups II & III. The good recovery only appeared in the 4 patients at 9 months of age. Jahnke et al. (1991) found 2 patients out of 64 children.

In this study 2 patients only (8.33%) had persisting deficit with reasonable function, which needed no treatment. They were one in group I & one in group II. Their functional recovery system was poor at final
assessment. *Nehme et al. (2002)* stated that in upper brachial plexus palsies, only about 57% of children recover sufficiently to avoid the need for primary plexus surgery. However, in these patients mild sequelae, such as scapular winging, limited shoulder flexion and abduction and internal rotation are expected. Contracture as well as limited forearm supination were found. Although this restricted some functional activities but the general function and cosmetic appearance of these patients was very acceptable. Therefore they recommended that the techniques for predicting a poor or good recovery should be as precise as possible. They only justified surgery when C7 root is initially involved, birth weight was above the 90th percentile and there was only poor elbow flexion at 6 and 9 months of age.

In this study 7 patients (29.16%) needed 2nd surgery. Those patients were considered to have poor estimate according to the functional recovery system. This functional recovery system cannot be used to predict functional recovery at 3 months or even 6 months of age. It also lacks assessment of hand and wrist function, so can be applied only for patients of group I.

So, we recommended that this functional recovery system is to be applied only for patients in group I and at final assessment and to add hand functional grading to use it for all groups of OBPP. We also recommend adding a moderate grade between good & poor to fit patients who need 2nd operation. This grade includes shoulder abduction < 120° and weak external rotation or elbow range of motion < 90° or biceps muscle power < M3 and poor to absent recovery or biceps less than M2 or elbow range of motion less than < 90°.

*Nehme et al. (2002)* Stated that the result of functional recovery system at 3 or 6 months did not predict the final outcome, though this could be predicted to some degree by the outcome at 9 months. However, this did not reliably predict the final outcome. They found an error rate of 41% in predicting a good outcome and 15% error rate for predicting a poor outcome at final assessment. They added that this means that two of the thirty patients *(they studied)* would not have had surgery when it was required and seven out of thirty would have had surgery unnecessarily.

In our study eleven patients (45.83%) were operated for primary plexus injury. One was in group III, 2 were in group I and 3 were in group II and all the patients (5) in group IV. This means that, nearly half of the patients could not complete the follow-up. *Brich (2002)* stated that group IV lesion is not necessarily hopeless and high level of function have been seen in older children who still had a Bernard Horner sign and who had shown no evidence of recovery during the first 6 months of life or even longer. *Bisinella & Brich (2003)* referred all patients in group IV to surgery.
Several trials and many efforts had been made to improve the way of predicting the functional outcome of patients with OBPP at a suitable time in order not to miss patients who might need primary surgery and to avoid unnecessary surgery for those who are not in need. Zancalli & Zancalli (1988) suggested that for each level of plexus injury, there was a different key muscle so that for group I: biceps & deltoid were the key (but deltoid examination is difficult at that age so is not a justifiable criteria), and for middle plexus C5-7, the key muscle is the triceps and in complete paralysis the key muscle is finger flexors & thumb extensors. In general they operated between 6-8 months if there were no clinical or electrophysiological signs of recovery, or if recovery had stopped for some time at a value of M2 or less on the British Muscle Movement Scale.

Laurent et al. (1993) used the biceps, triceps and deltoid for group I. If no improvement in two of the three muscles at least one grade by 4-6 months, surgery is indicated and improvement had to be continued up to M3 for another four months to avoid surgery. Michelow et al. (1994) followed 39 patients over 3 years as they considered primary surgery between 9 months & one year; so, they were able to analyze this number. They used shoulder abduction adduction, elbow, wrist and finger flexion and extension (ten movements).

**Recommendations:**

From this study we can recommend for group I & II using (3.5 or more) HSC scoring system at 6 months of age together with shoulder function system grade 2 or more and for group III & IV abduction of grade 3 hand function or more. Also it is recommended to use functional recovery system graded good, moderate & poor where.

- **Good:** Complete recovery. Or elbow range of motion > 90° with M3 or higher biceps and shoulder abduction > 120° with external rotation > 25°.
- **Moderate:** Shoulder abduction < 120° and weak external rotation and elbow range of motion > 90° or biceps power > M2.
- **Poor:** Biceps less than M2 or elbow range of motion < 90° or absence of recovery.
REFERENCES


توافق النتائج النهائية لتشكل الضفيرة العضدية عند الولادة

نهال إبراهيم الشتاوی
قسم الرومانطيزم والتأهيل، كلية الطب جامعة عين شمس

الهدف من البحث: هو التعرف على الممارسات التي يمكن أن تحسن من القدرة على توقع النتائج النهائية لمرض شلل الضفيرة العضدية عند الولادة.

الطريقة: اشتملت البحوث على مرضى شلل الضفيرة العضدية فيhospital وقد تم تقسيمهم إلى 4 مجموعات. تم تقسيم المرضى كل ثلاثة أشهر وحتى 12 شهر حيث استخدمت طريقة تقييم المستشفى للأطفال (HSRS) خاصاً للعصابات والعضد وال)Mathical الأسابيع واليوم الباسطة. كما تم تقييم وظائف الكتف، قياس الحركة المباعدة والدوران الخلفي، وتقدير الديد من كل من الرقية والفرعات، وفقاً لطريقة شنة 1972. كما تم تقييم وظائف الديد من 6 درجات بطيعة ريموندي 1998. وقد تم إجراء الدراسات على مرضى شلل الضفيرة العضدية من 6 أشهر.

النتائج: اشتمل البحوث على 24 مريض مجموعتين 1 و8، مرضى ومريضين في مجموعة 10 3% من المرضى شفاء كامل كما وجد أن عدد 2 (3, 8%) من المرضى شفاء مع وجود إعاقة بسيطة في 11 2% منهم (6-11). مع 45.8% عملياً أول مرة للضفيرة العضدية. وقد أثبتت الدراسة أن في الثالثة شوية كل المرضى الذين أخذوا 3.5 درجات جيدة في نهاية مدة الدراسة. وقد وجد أن عدد أثر من المرضى الذي أخذوا أقل من 3.5، تقييم المستشفى للمرضى الأطفال (HSRS) تحسن في سنتان 6 شهور. كما أثبتت الدراسة أن المرضى الذين كان لهم تقييم وظائف الكتف أو أكثر وظاهرة الديد 3 توقع جيد.

التوصيات: أوصى البحث باستخدام طريقة تقييم المستشفى للأطفال في مدة 6 أشهر مع تقييم وظائف الكتف في نفس الوقت، وذلك في مرضى مجموعة 2، مع إضافة وظائف الديد في مجموعة 3. كما أوصى الدراسة باستخدام طريقة التقييم الوظيفي فقط إلى ثلاثة درجات جيد ومن ثم وضعية.

حيث أن جيد: استشفاء تام أو محور العضد أكثر من 90° والعضلة ذات الرايسين درجة 3، مع وجود مباعدة للكتف أكثر من 120° ودوران للجلف أكثر من 25°. متوسط: مباعدة للكتف أقل من 120° ودوران ضعيف للجلف مع وجود محور حركة العضد أكثر من 90° والعضلة ذات الرايسين أكثر من درجة 2. ضعيف: العضلة ذات الرايسين درجة أقل من 90° ومحور عضد أقل من 90° أو عدم استشفاء.