

# Prompt Referral in the Nonoperative Treatment of Obstetrical Brachial Plexus Injuries

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**Background:** Prompt physical and occupational therapy is crucial in managing nonsurgical candidates with obstetrical brachial plexus injuries (OBPI). The objective of our study was to identify newborns suffering from nonoperative OBPI in need of a “fast-track” evaluation by a multidisciplinary team.

**Methods:** This is a retrospective review of patients with OBPI from June 1995 to June 2015. All nonsurgical candidates (Narakas class 1) were included in the study. The Gilbert score and the Medical Research Council grading system were used to measure shoulder and elbow function, respectively. The relationship between shoulder and elbow functional outcomes and time delay to consultation was studied using analysis of variance and Welch’s tests. Various subgroups were studied based on OBPI risk factors: maternal diabetes, birth weight >4 kg, use of forceps, asphyxia, multiple comorbidities, and Apgar score at 1 and 5 minutes.

**Results:** A total of 168 patients were included in this study. Mean follow-up time was 313.8 weeks (minimum: 52; maximum: 1072; SD: 228.1). A total of 19 patients had an Apgar scores <7 at 5 minutes. Time delay between birth and the first consult to our clinic had an impact on shoulder outcome in the subgroup of newborns with Apgar scores <7 at 5 minutes.

**Conclusions:** The subgroup of newborns with an Apgar score <7 at 5 minutes shows improved long-term shoulder function when promptly examined by an OBPI clinic. We recommend a “fast-track” referral for this time-sensitive population. (*Plast Reconstr Surg Glob Open* 2017;5:e1587; doi: 10.1097/GOX.0000000000001587; Published online 22 December 2017.)

## INTRODUCTION

Obstetrical brachial plexus injury (OBPI) is a well-known entity that often occurs in conjunction with birth trauma. In the literature, multiple risk factors have been associated with the occurrence of brachial plexus injury, including macrosomia, prolonged duration of labor, and the use of forceps, to only name a few.<sup>1,2</sup> Newborns have a wide variety of clinical presentation resulting in weakness of

shoulder abduction/external rotation and elbow flexion. As per Narakas’ classification,<sup>3,4</sup> most obstetrical brachial plexus injuries are classified as type 1: upper Erb’s palsy involving the roots of C5 and C6. Surgical treatment is seldom necessary. Studies have reported recovery rates as high as 80–95%.<sup>5–7</sup> However, prompt physical and occupational therapy is crucial in managing nonsurgical candidates and optimizing functional recovery.<sup>8</sup> Delays in treatment could have an important impact on these patients. With a heavy load of referrals for evaluation in our publicly funded and universal health-care systems, it is important to identify and prioritize the patients who would benefit from earlier interventions by a specialized brachial plexus team.

The objective of our study was to identify newborns suffering from nonoperative OBPI in need of a “fast-track” evaluation by a multidisciplinary team.

## METHODS

After approval from the institutional research ethics board, we performed a retrospective review of all pa-

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**Table 1. Gilbert Score for Shoulder Results**

Score	Gilbert Score
0	Flaccid shoulder
1	Abduction to 45 degree, no active ER
2	Abduction to <90 degree, no active ER
3	Abduction to 90 degree, weak active ER
4	Abduction to <120 degree, weak active ER
5	Abduction to >120 degree, complete active ER

ER, external rotation.

**Table 2. Medical Research Council System of Grading Elbow Function**

Score	MRC Scale
0	No contraction
1	Flicker or trace of contraction
2	Active movement, with gravity eliminated
3	Active movement against gravity
4	Active movement against gravity and resistance
5	Normal power

MRC, Medical Research Council.

tients diagnosed with OBPI in our institution from January 1995 to January 2015. All patients were evaluated and followed by the senior author of this article. Data were collected from both electronic and paper medical records by 2 independent reviewers. Patients were anonymized, and their data were subsequently classified using Narakas' classification. Patients were included if they were classified as Narakas class 1, based on physical examination, nerve conduction studies, electromyography, ultrasound, and magnetic resonance imaging. Patients who were lost to follow-up (<12 mo), surgical candidates, or transferred to another institution were excluded from the study (*n* = 15). A total of 168 patients were included in the study.

The Gilbert score (Table 1) and the Medical Research Council grading system (Table 2) were used to measure shoulder and elbow outcomes, respectively.<sup>9,10</sup> Shoulder abduction range of motion (ROM) was measured in degrees against gravity. The hand on the abdomen was considered as -90 degrees when measuring shoulder external rotation ROM, gravity eliminated. Shoulder abduction and external rotation were measured by both the occupational therapist and the physical therapist in the OBPI clinic. In the event of a discrepancy between the occupational therapist and the physical therapist, the larger value was documented. Patients were divided into 4 groups based on their functional outcome (Table 3): excellent, moderate, poor, and flaccid. The relationship between shoulder or elbow outcomes and time delay to consultation was studied using analysis of variance (ANOVA) and Welch's tests. Various subgroups were studied based on the following OBPI risk factors: maternal diabetes, birth weight, use of forceps, asphyxia, presence of multiple complications, and APGAR scores at 1 and 5 minutes. Patients were considered to have multiple complications if they had 2 or more of the following: asphyxia, shoulder dystocia, humeral fracture, or clavicular fracture. Statistical significance was set at a

**Table 3. Functional Outcome based on Gilbert or Medical Research Council Scores**

Outcome	Shoulder	Elbow
Excellent	Gilbert score 5	MRC score 5
Moderate	Gilbert scores 4 and 3	MRC scores 4 and 3
Poor	Gilbert scores 1 and 2	MRC scores 1 and 2
Flaccid	Gilbert score 0	MRC score 0

MRC, Medical Research Council.

*P* value of 0.05. Means and frequencies were calculated for continuous variables and categorical data, respectively. All analysis was carried out using the statistical program SPSS.

We have received ethical approval by our institution's ethics committee. We have followed the World Medical Association's Declaration of Helsinki.

## RESULTS

A total of 168 patients were included in this study. Mean follow-up time was 313.8 weeks (minimum: 52; maximum: 1072; SD: 228.1). Males comprised 53.6% of the study population. Mean birth weight was 3998.5 g (minimum: 2495; maximum: 5670; SD: 558.8), and mean gestational age was 39.5 weeks (minimum: 35; maximum: 42; SD: 1.4). Maternal diabetes was present in 8.9% of cases. Median Apgar score at 1 minute was 6 [mode: 8; interquartile range (IQR): 4]. Median Apgar score at 5 minutes was 9 (mode: 9; IQR: 2). Shoulder dystocia was present in 65.5% of cases. Other complications included shoulder dystocia (66.1%), clavicular fractures (14.3%), humeral fractures (2.4%), and asphyxia (10.1%). A quarter of newborns (25%) had 2 or more complications (eg, shoulder dystocia and asphyxia). Mean delay between birth and initial consultation to our brachial plexus clinic was 13.3 weeks (minimum: 0.5; maximum: 416; SD: 40.3).

Time delay between birth and first consult did not impact shoulder outcomes in the total study population (*P* = 0.34). Multiple subgroup analyses were subsequently performed. In the subgroup of newborns with Apgar scores <7 at five minutes, there was a statistically significant difference in time delay between shoulder outcome groups (Table 4). Prompt consults in this subgroup were associated with an improved long-term shoulder outcome. Table 5 compares the total study population and the subgroup of newborns with an Apgar score <7 at 5 minutes. The following subgroups did not have a clinically significant relationship between shoulder outcome and time delay to consult: maternal diabetes, birth weight >4 kg, use of forceps, asphyxia, multiple comorbidities, and Apgar score at 1 minute. Elbow outcomes remained unaffected by time delay in the total population and in all subgroups.

## DISCUSSION

The Apgar score, along with the rest of the risk factors included in our study, can be objectively measured shortly after birth. Apgar is a quick and simple test to as-

**Table 4. Association between Shoulder Outcome and Birth-to-Consult Delay in Subgroups Determined by Risk Factors on Initial Presentation**

Subgroups (N)	P
Maternal diabetes (15)	0.20
Birth weight >4kg (77)	0.42
Use of forceps (24)	0.61
Presence of asphyxia (17)	0.53
Multiple complications (42)	0.51
Apgar 1 min <7 (62)	0.78
Apgar 5 min <7 (19)	<b>0.002</b>

Bold values are values with a statistically significant result (*p*-value<0.05).

sess a newborn’s overall status after delivery and response to resuscitation. Breathing effort, heart rate, muscle tone, reflexes, and skin color are assessed; each element is then assigned a score from 0 to 2.<sup>11,12</sup> The Apgar score at 1 minute may be affected by variation in normal transition; therefore, it does not accurately predict any outcomes.<sup>13,14</sup> On the other hand, the score at 5 minutes is more reliable at predicting long-term outcomes. For example, an Apgar score of 0–3 at 5 minutes correlates with neonatal mortality. The American College of Obstetricians and Gynecologists, in collaboration with the American Academy of Pediatrics, defines a 7–10 Apgar score as reassuring.<sup>12,15</sup> An Apgar score below 7 is often used as a cut-off in the literature.

Our analysis showed that the Apgar score <7 at 5 minutes in nonsurgical OBPI newborns is an independent predictor of poor shoulder outcomes in the event of a delay in evaluation and treatment by a specialized brachial plexus team. This could be due to multiple factors, including an increase in comorbidities. When comparing the total population of newborns with the subgroup of Apgar scores <7, the latter group has a significantly higher rate of multiple complications (68.4% vs 25%). They are also

more likely to have comorbidities involving systems other than the musculoskeletal and nervous systems, potentially contributing to nutritional problems and failure to thrive. High energy requirements from certain neonatal comorbidities, such as respiratory issues, may lead insufficient nutrients for normal axonal growth and regeneration. Dabydeen et al.<sup>16</sup> has showed that axonal growth can be hindered by an insufficient caloric intake in newborns.

Moreover, the presence of multiple complications could also result in referral to a greater number of services and more frequent follow-ups when compared with the group of Apgar ≥7. This can be a burden on the family. Parents can suffer from anxiety and depression as a result of their newborn’s health issues. One study showed that among parents of sick neonates, 20% of fathers and 24% of mothers had symptoms of anxiety, whereas 30.8% of fathers and 35% of mothers had depressive symptoms, significantly higher rates than the general population (*P* < 0.01).<sup>17</sup> Depression, anxiety, stress, and a lack of a good social support could result in insufficient psychosocial stimulation of the newborn, which could impact care and potentially affect outcomes of brachial plexus injuries.<sup>17</sup> Insufficient physical care (eg, decreased feeding) is also associated with maternal depression and can contribute to low-energy intakes and failure to thrive in the newborn.<sup>18,19</sup>

Serious complications associated with lower Apgar scores result in a higher rate of prolonged hospitalization and intubation. Serious or multiple health conditions could shift the focus away from OBPI and result in a delayed presentation to the brachial plexus specialized team. Moreover, newborn manipulation can be impeded in this population because of physical barriers (intravenous lines, endotracheal tube, etc.), failing to maintain full ROM of the involved limb and potentially leading to an increase in fixed contractures.

**Table 5. Comparison between the Total Population (N = 168) and the Subgroup of Newborns with an Apgar Score <7 at 5 minutes (N = 19)**

	Total Population	Apgar <7 at 5 min	P
Total N	168	19	—
Mean follow-up time in (wk)	313.8 (minimum: 52; maximum: 1072; SD: 228.1)	303.7 (minimum: 63; maximum: 1063; SD: 287.4)	0.86
Male (%)	53.6	57.9	0.72
Mean gestational age (wk)	39.5 (minimum: 35; maximum: 42; SD: 1.4)	39.5 (minimum: 36; maximum: 42; SD: 1.3)	1.0
Mean birth weight (g)	3998.5 (minimum: 2495; maximum: 5670; SD: 558.8)	4146 (minimum: 2955; maximum: 5090; SD: 571.2)	0.28
Maternal diabetes (%)	8.9	15.8	0.34
Forceps delivery (%)	13.7	10.5	0.70
Shoulder dystocia (%)	66.1	94.7	<b>0.01</b>
Clavicular fracture (%)	14.3	15.8	0.86
Humeral fracture (%)	2.4	10.5	0.056
Asphyxia (%)	10.1	57.9	<b>&lt;0.001</b>
Multiple complications (%)	25	68.4	<b>&lt;0.001</b>
Mean delay between birth and initial visit (wk)	13.3 (minimum: 0.5; maximum: 416; SD: 40.3)	9.2 (minimum: 0.5; maximum: 25; SD: 5.2)	0.66
Excellent shoulder outcome, N (%)	143 (96.4)	17 (89.5)	0.61
Moderate shoulder outcome, N (%)	6 (3.6)	2 (10.5)	0.16
Poor shoulder outcome, N	0	0	—
Flaccid shoulder, N	0	0	—

Bold values are values with a statistically significant result (*p*-value<0.05).

Multidisciplinary management of OBPI is of utmost importance to optimize functional outcomes. Our brachial plexus team consists of the following health professionals: plastic and reconstructive surgeon, physical therapist, and occupational therapist. Physical and occupational therapy is the mainstay of nonoperative treatment in newborns. ROM and strengthening exercises prevent contractures and muscle imbalance. Our results demonstrate that newborns with an Apgar score <7 at 5 minutes are sensitive to a time delay, resulting in poor long-term shoulder outcomes. Patients who had excellent shoulder outcomes were all seen within 11 weeks from birth, except for 1 patient who was seen at 17 weeks (mean: 7.8 wk, SD: 4.6). The 2 newborns with a moderate shoulder outcome had their initial consultation at 17 and 25 weeks. An initial assessment beyond 3 months of age has been described as “poor” in Canadian publicly funded and universal health-care systems.<sup>20</sup> More recently, Canada’s national clinical practice guideline in OBPI recommends a referral to a multidisciplinary center within 1 month of age.<sup>21</sup> Early assessment and intervention by a specialized brachial plexus team are crucial, particularly in newborns with an Apgar score <7 at 5 minutes, as time delay is associated with poor long-term shoulder function in this subgroup.

We acknowledge paucity of patients/data as a limitation to our study. We also recognize that there are multiple methods of classifying shoulder outcome.<sup>22</sup> The Mallet classification (or modified Mallet) is another commonly used grading system. We arbitrarily chose to use the Gilbert scoring system because its contents could be easily extracted from a retrospective review of charts. We recognize that it is difficult to extrapolate results from a single-center experience. There was a statistically significant association between time delay to initial consult and shoulder outcome. Whether this translates into clinical significance is unclear. A concrete cut-off is difficult to conclude based on a simple retrospective association. Proof of generalizability of our findings and a clear time line will require external validation by other investigators. We also acknowledge that the results are subject to the forms of bias associated with retrospective reviews, such as inferring causality. Retrospectively disentangling the interactions of Apgar score and time-delay sensitivity is difficult. Potential confounding factors such as frequency, intensity, and parental compliance to physical/occupational therapy were not accounted for. The definition of asphyxia varied and was not documented clearly. Moreover, risk factors like shoulder dystocia and humeral fracture were not evaluated in the subgroup analysis and could represent potential confounding factors.

## CONCLUSIONS

The objective of our study was to improve patient care by identifying a subgroup of newborns in the nonoperative patient population who would benefit from earlier referral to a specialized brachial plexus team. The subgroup of newborns with an Apgar score <7 at 5 minutes shows

improved long-term shoulder function when promptly examined and treated by a brachial plexus team. We recommend a “fast-track” referral for this time-sensitive population.

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