J Surg Med. 2022;6(1):5-8.
DOI: 10.28982/josam.1011145

Journal of Surgery and Medicine
e-ISSN=2602-2079

Long term outcome in obstetric brachial plexus injury at a tertiary care center

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Ethics Committee Approval
The study approval was obtained from the ethics committee of Izmir Bakircay University, faculty of medicine, with the number 343/323.
All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

Conflict of Interest
No conflict of interest was declared by the authors.

Financial Disclosure
The authors declared that this study has received no financial support.

Published
2022 January 7

Abstract

Background/Aim: Obstetric brachial plexus injury (OBPI) is caused by traction to the brachial plexus during labor. Traction injury may vary from neurapraxia or axonotmesis to neurotmesis and can cause edema, avulsion, or rupture of the nerve. Improvement in the first two weeks after birth is a good indicator of outcome. The disability varies according to the location and severity of the effect in the plexus. However, most injuries are transient, with a total return of function in many cases. This study aimed to obtain clues for the prevention and follow-up of obstetric brachial plexus injuries by revealing the outcome and clinical features.

Methods: In this retrospective cohort study, hospital records of patients with brachial plexus injury due to delivery were reviewed between January 2017 and September 2021. Injury levels, birth weights, other injuries at birth, maternal age, gravidity, gestation time, and treatment response were recorded. Brachial plexus injuries of the patients were classified per the NARAKAS classification. The Spearman correlation and Pearson correlation tests were used for correlation analyses. The variables were evaluated with the Chi-Square and Student's t-tests. The normality of the distribution was assessed with the Kolmogorov-Smirnov test. A value of $P<0.05$ was considered statistically significant.

Results: Thirty-nine cases were included in the study (21 males, 18 females). The mean and median birth weights were 3857 (392) grams, and 3880 (3100-4600) grams, respectively. The median gestational week of birth was 39 weeks. Most mothers were primigravida. All patients were born by vaginal delivery. Per the NARAKAS classification, 29 patients (74.4%) were in group 1, 5 patients (12.8%) were in group 2, 4 patients (10.3%), in group 3, and 1 patient (2.5%) was in group 4. The mean follow-up period was 23.2 (14.1) months. Twenty-four patients recovered spontaneously; six had sequelae without functional impairment, five had sequelae with functional impairment, and two had contractures. The relationship between the NARAKAS groups and birth weight was insignificant ($P=0.09$). There was a significant correlation between the NARAKAS group and recovery ($P<0.001$). A correlation was found between sequelae and functional loss ($P=0.01$) and the NARAKAS group. Functional loss was not related to maternal age, week of birth, birth weight, baby gender ($P=0.15$, $P=0.30$, $P=0.20$, $P=0.15$ respectively).

Conclusion: Permanent functional loss in brachial plexus injury is associated with the NARAKAS classification, and patients in groups 3 and 4 should undergo imaging as soon as possible. Electromyography (EMG), a complex invasive procedure for the newborn, should be preferred if there is no satisfactory recovery. We recommend performing brachial plexus magnetic resonance imaging before EMG to give the patient a chance for early surgery.

Keywords: Brachial plexus injury, NARAKAS, Outcome, Children, Birth weight

How to cite: Tekin HG, Olukman Ö. Long term outcome in obstetric brachial plexus injury at a tertiary care center. J Surg Med. 2022;6(1):5-8.

Introduction

Obstetric brachial plexus injury (OBPI) was at similar rates in numerous studies and is estimated to be between 1.5 and 4 per 1000 births [1–3].

Brachial plexus injury mostly involves the C5 and C6 spinal nerves. The patients' rate of spontaneous recovery is the highest at this level. Less involvement is observed in C5-C7 and C7-T1 localizations, with high rates of loss of function [4]. Generally, these infants are diagnosed with brachial plexus injury at the first examination. The difficulty is to determine the level of damage. Early identification of the affected spinal nerves and their severity is essential to determine the prognosis, for which clinical examination, electromyography (EMG), and plexus magnetic resonance (MR) are used [5, 6]. We aimed to determine the risk factors for obstetric brachial plexus injury, measure the prognostic differences between patients with and without functional sequelae, and find out which diagnostic test should be used in these patients.

Materials and methods

This retrospective cohort study was conducted in a tertiary care hospital between January 2017 and September 2021. Thirty-nine patients with obstetric brachial plexus injury were followed for about two years. Patients' birth weight, number of births, maternal age, gestational week, delivery type, health personnel accompanying the birth, predisposing factors, location and severity of the injury, treatment methods, the long-term outcomes, and NARAKAS groups were recorded [7] (Table 1).

Table 1: NARAKAS Classification

Group	Level	Clinic Presentation
Group 1	C5-C6	Shoulder abduction, shoulder external rotation, elbow flexion, and wrist extension
Group 2	C5-C6-C7	Wrist flexors, finger flexors, intrinsic muscles of the hand
Group 3	C5-T1 without Horner syndrome	Upper extremity flaccid paralysis
Group 4	C5-T1 with Horner syndrome	Upper extremity flaccid paralysis and miosis, ptosis, and enophthalmos

The patients were examined for the first time in the neonatal unit, then at two weeks of age. After the 2nd week, they were followed monthly for the first six months and every 2-3 months thereafter.

Selection bias was avoided by recruiting every patient diagnosed with brachial plexus injury in the outpatient clinic between the specified dates.

Statistical analysis

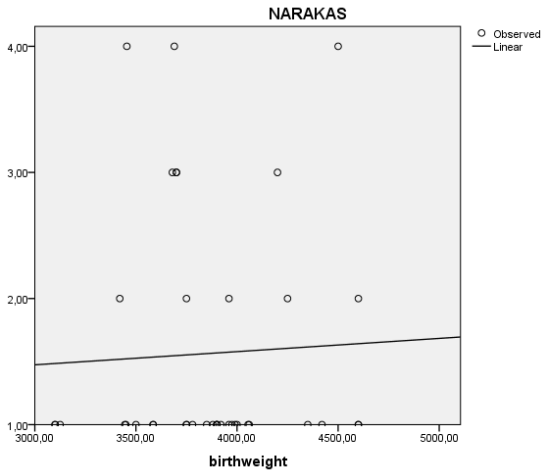
The Spearman and Pearson correlation tests were used to analyze ordinal and continuous variables, respectively. Calculations of the mean, median, frequency, and standard deviation (SD) were made using the Statistical Package for Social Sciences (SPSS) software for Windows, version 23.0, and the results were given as mean (SD). The variables were evaluated with the Chi-Square and Student's t-tests. The student's t-test was used to compare the means between the two groups. The normality of the distribution was evaluated with the Kolmogorov-Smirnov test. A value of $P<0.05$ was considered statistically significant.

The study approval was obtained from the ethics committee of Izmir Bakircay University, Faculty of Medicine, with the number 343/323. Informed consent forms were obtained from all parents.

Results

Twenty-one patients were male, and 18 were female. The mean and median birth weights were 3857 (392), and 3880 (3100-4600) grams, respectively. The median gestational week of birth was 39 weeks. The mean maternal age was 28.05 (4.99) (21-39) years. Most mothers were primigravida. All patients were born by vaginal delivery. The doctors managed 26 deliveries, and nurses managed the rest. There was no relationship between the groups of NARAKAS and the health personnel who assisted the birth. The brachial plexus injury rate was 4.5 per 1000. The accompanying findings were Horner syndrome in 4 patients, clavicle fractures in 11 patients, and hypoxic-ischemic encephalopathy in 2 patients. Per the NARAKAS classification, 29 patients (74.4%) were in group 1, 5 patients (12.8%), in group 2, 4 patients (10.3%), in group 3, and 1 patient (2.5%) was in group 4. The mean follow-up period was 23.2 (14.1) months. Twenty-six patients recovered spontaneously, 6 had sequelae without functional impairment, 5 had sequelae with functional impairment, and 2 had contractures. The relationship between the NARAKAS groups and birth weight was insignificant ($P=0.09$) (Figure 1).

Figure 1: NARAKAS classification and birth weight distribution



Plexus MRI was performed in 14 patients, and EMG was performed in 11 patients. EMG was performed when there was no improvement in the second or third visits of the patients. Although surgery was recommended to four patients, only one underwent surgery in the 5th month.

Patients received physical therapy, surgical treatment, or just observation. The treatments applied and their results are shown in Table 2. NARAKAS groups and recovery were correlated ($P=0.003$). Physical therapy is still administered to patients with sequelae.

Table 2: Treatment and outcome of the patients

	Surveillance	Physiotherapy	Surgery
Complete recovery	19	7	-
The residual deficit without loss of function	-	6	-
The residual deficit with loss of function	-	5	-
Contracture	-	1	1

No correlation was found between NARAKAS groups and birth weight ($P=0.089$). NARAKAS groups and sequelae with functional loss were significantly correlated ($P=0.01$). Twenty mothers were primiparous.

Rhere was no relationship between functional loss and maternal age, week of birth, birth weight, and baby gender (P=0.15, P=0.30, P=0.20, P=0.15 respectively).

Discussion

Between the years of our study, the rate of brachial plexus injury in our hospital was 4.5 per 1000 live births, higher than in the literature. This may be attributed to the very low number of cesarean sections in our hospital, the high number of immigrant patients admitted for emergency delivery without follow-up, and the insufficient number of midwives.

Macrosomia, breech presentation, maternal diabetes mellitus, use of assistive devices during delivery, and having a child with brachial plexus palsy in previous births are risk factors for brachial plexus palsy [4]. However, no consensus or meta-analysis studies recommend cesarean section in patients with these risk factors. In addition, macrosomia is defined as a newborn weight of over 4000 g, whereas in our patients, the average birth weight was 3880 g. Even if there was an indication for a cesarean section in macrosomia, our patients would still be born by vaginal delivery. However, studies drew attention to cases over 3800 g [8]. The fact that the gestational week of the patients was above 39 weeks seems to be a risk factor in our study. Similar results are available in the literature [9]. There are studies in which spontaneous recovery is quite high in obstetric brachial plexus injury compared to our study [10]. The rate of recovery without sequelae is 82% in our patients.

Group 1 and group 4 patients often do not experience management difficulties. Almost all NARAKAS group 1 patients recover within two weeks to 2 months. The cases with C5-T1 involvement and Horner syndrome should undergo surgery as soon as possible.

All NARAKAS group 1 patients recovered without sequelae. Contracture was observed in the patient in group 4. Although early surgery was recommended, he underwent surgery in the fifth month. However, it is often difficult to decide when to perform surgery in patients in groups 2 and 3. In a study of 66 infants, normal upper extremity use was achieved in cases whose biceps function improved before 3 months of age [11]. However, long-term functional outcomes were worse in infants whose biceps function improved at 4, 5, and 6 months. Another study observed that if there was no movement against gravity in the proximal muscle groups when the babies were six months old, severe muscle weakness continued in the future [12].

When the infant was one month old, examination and EMG findings were superior in detecting brachial injury than the examinations performed in the first week. Although the false-positive and false-negative rates are lower in the tests performed at three months of age, it seems appropriate to examine them at one month since it may cause a delay in patients requiring surgery. In addition to the time of examination, early detection of localization is also crucial in determining the prognosis. Elbow extension, elbow flexion, and motor unit potentials in biceps muscle evaluations revealed the detection rate of mild and severe cases as 93.6% [10]. It implies that children should be referred to centers where physiotherapy and surgery can be performed if active elbow extension is insufficient when the infant is one month old. Needle EMG should be performed on the patient who cannot achieve elbow flexion. The absence of MUPs in the biceps muscle in EMG is an indication for referral to surgery centers [13]. If there is any disability in the 1st-month evaluations of the patients under follow-up, we initiate physical therapy. If there is limited forearm flexion in the 1st month of evaluation, we recommend plexus MRI and/or EMG in addition to physical therapy and plexus MRI in a patient with NARAKAS group 4 in the first evaluation.

Although electromyography and nerve conduction studies are considered "overly optimistic" in infants, early examinations can save costs later, but invasive procedures such as sedating the baby during the examination may be required [14]. EMG is performed in the first week after birth for medico-legal reasons to distinguish intrauterine or delivery damage. It is performed in patients with brachial plexus injury who have not recovered after the 1st month, those who will undergo tendon transfer, to identify candidates for surgical exploration, and to determine the appropriate surgical procedure [13].

In severe cases, plexus MRI is superior to an invasive technique such as EMG, which may lead to misdiagnosis in the first month, in not missing the chance of early surgery. Plexus magnetic resonance imaging is important in determining the location of the damage (pre-ganglionic or post-ganglionic) and distinguishing between complete ruptures and avulsions [15].

New protocols are implemented instead of MRI protocols that require sedation and long-term imaging. Rapid non-sedated volumetric Cube Proton Density MRI protocol detected the location and severity of the injury quickly and accurately without sedation [16, 17].

The accompanying findings were Horner syndrome in 4 patients, clavicle fracture in 11 patients, and hypoxic-ischemic encephalopathy in 2 patients in our study. About 26% of patients with a clavicular fracture also sustained a brachial plexus injury. This incidence is consistent with the other data from Turkey [9].

Limitations

The main limitation of this study is its retrospective nature and the lack of a control group.

Conclusion

Among many factors such as maternal age, primiparity, birth weight, and gestational age, only the NARAKAS group was a predisposing factor that could indicate permanent damage in infants with brachial plexus injury. All patients with NARAKAS group 3-4 should be assessed for early imaging and early surgery. Plexus MRI seems a suitable method for these patients. EMG can be preferred in patients with Horner's syndrome or in patients whose wrist flexion has not improved after one month of age.

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