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ORIGINAL ARTICLE

Obstetric brachial plexus palsy: a population-based retrospective case-control study and medicolegal considerations

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ABSTRACT

Aims: The aim of this study was to examine 24 cases of obstetric brachial plexus palsy (OBPP) in 41,002 deliveries occurred at San Camillo–Forlanini Hospital in Rome, during the period 2000–2012.

Materials and methods: A population-based retrospective case-control study was designed and the database of the hospital was searched; for each case, maternal and fetal records were examined and some risk factors were evaluated.

Results: A statistically significant association between the 24 cases OBPP and the following risk factors: primiparity ($p < .014$), birth weight ($p < .002$), maternal age ($p < .02$), diabetes ($p < .03$) and shoulder dystocia ($p < .003$) was found, moreover all the OBPP cases were recorded only in vaginal deliveries.

Conclusions: The absence of OBPP cases in cesarean deliveries highlighted in this study supports the option of proposing an elective cesarean in the presence of known risk factors after a full disclosure with the mother of risks and benefits in order to obtain a valid consent. Furthermore, when cases of OBPP occur, communication between the physician and the parents of newborns is crucial and it may represent a valid risk-management tool to reduce malpractice lawsuits.

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Obstetric brachial plexus palsy; risk factors; communication; malpractice lawsuits

Introduction

Obstetric brachial plexus palsy (OBPP), also known as perinatal brachial plexus palsy, can be identified in a flaccid paresis of the arm at birth with a passive rather than an active range of motion [1]. According to different studies [2–4] OBPP has an incidence ranging from 0.05 to 0.26% in all deliveries, with full recovery of function in 70–95% of cases [5,6].

The brachial plexus is composed of a group of nerves which includes the lower four cervical roots (C5–8) and the first thoracic root (T1). Taking into consideration that these nerves emerge through the anterior vertebral foramen, past the clavicle, and towards the upper extremity, they can easily be injured through traction of the extremity or distraction of the head away from the clavicle, causing an OBPP [6].

The onset of OBPP is proportional to the degree of acceleration, magnitude, and cosine of the angle formed by the trajectory of the stretching force and the axis of the main susceptible brachial plexus bundle, and inversely proportional to the resistance of the highly vulnerable brachial plexus bundle and of the shoulder girdle muscles, joints, and bones.

However, non-traumatic etiologies, such as familial congenital brachial plexus palsy, maternal uterine malformation, congenital varicella syndrome, intrauterine maladaptation etc., should also be taken into consideration [7].

OBPP can be classified into four different types by evaluating the cranial nerves involved: the upper type (Erb–Duchenne palsy) affects C5-C6 and the functional limitation is a weakness of the external rotation of the shoulder or an abduction of arm and elbow flexion/supination; the middle type affects C5-C6-C7 and in this case the functional limitation, besides those already reported for the upper type, includes the loss

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of wrist extension; the lower type (Klumpke's palsy) affects C8-T1 and is characterized by a floppy hand with claw-like deformity and finally, the complete type involving C5 root to T1 root, causes a flail arm [1,8].

In the pathophysiology of OBPP, the association of several risk factors has been evaluated, such as: an increased birth weight, shoulder dystocia, assisted vaginal deliveries, gestational diabetes etc. but the results obtained are not always concordant. As already highlighted, although numerous studies have reported the incidence of OBPP risk factors, currently reliable predictors are still elusive [2,9].

The aim of this paper is to examine the cases of brachial plexus injury, which occurred at one of the major hospital in Rome, San Camillo–Forlanini hospital, during the period 2000–2012, taking into consideration the OBPP incidence, the role of possible risk factors, their association and the presence of maternal-fetal complications. Moreover, recovery time will also be evaluated together with the medico-legal consequences and possible strategies in reducing malpractice suits related to OBPP.

Materials and methods

The database of San Camillo-Forlanini hospital in Rome, was searched and all deliveries from 2000 to 2012 were examined in order to identify OBPP cases. For each case, maternal and fetal records were examined and the following (risk) factors were evaluated: parity, birth weight, type of delivery (oxytocin for labor augmentation, instrumental vaginal delivery and spontaneous vaginal delivery), maternal age, maternal weight, pregnancy weight gain, maternal height, diabetes and shoulder dystocia.

An adequate control group of 1000 females was selected after matching the clinical relevant points of the study by the Institutional Review Board and included according to the features reported in Table 1.

The statistical analysis of data was performed by using a multivariable logistic regression model in order to assess the effect of each risk factor independently from the others. The STATA software 11.0 version was used.

Results

From 2000 to 2012, 24 cases of OBPP were identified in 41,002 deliveries and the main features are reported in Table 2. The mean incidence of OBPP was 0.06 ± 0.025; the temporal trend from 2000 to 2012 is reported in Figure 1. The 24 cases of OBPP were recorded only in vaginal deliveries.

The association between OBPP and each risk factor is shown in Table 3. A statistically significant association ($p < .05$) between OBPP and the following risk factors was found: *primiparity* ($p < .014$), in 22 cases (91.7%) women were primiparous and the odds ratio for primiparous is 24, which means that the likelihood of having palsy in their newborns, increases by a factor of 24 in comparison to multiparous; *birth weight* ($p < .002$), the odds ratio for birth weight is 1.003, which means that, for each increase of 100 g in weight at birth, the likelihood of having palsy increases by a factor of 1.003; *maternal age* ($p < .02$), the odds ratio for maternal age is 1.249. This means that, for every increase of one year in age, the likelihood of having palsy increases by a factor of 1.249; *diabetes* ($p < .03$), the odds ratio for diabetes is 8.6. This means that, women with diabetes (diabetes mellitus and gestational diabetes) show a likelihood of having palsy in their newborns increased by a factor of 8.6 and *shoulder dystocia* ($p < .003$), the odds ratio for dystocia is 11.7, which means that, newborns with dystocia show a likelihood of developing palsy increased by a factor of 11.7.

Shoulder dystocia was associated with OBPP in six cases (25%), whereas there were injured roots in 22 cases (91.7%) C5-C6 (upper brachial plexus) and in 2 cases (8.3%) C5-C7 (middle brachial plexus) (Table 4).

The association between OBPP and the following risk factors was not statistically significant ($p > .05$): type of delivery (assisted vaginal delivery (drugs), instrumental vaginal delivery and spontaneous vaginal delivery), maternal age, maternal weight, pregnancy weight gain, and maternal height (Table 3).

The percentage of full recovery at 3 months was 96% (23 cases). Only one of the two cases of middle brachial plexus had a late full recovery at 1 year (data in Table 4).

Table 1. Baseline characteristics of the control group ($n = 1000$).

Mean birth weight (g) ± SD	Delivery	Parity	Maternal age (years) ± SD	Maternal weight (Kg) ± SD	Pregnancy weight gain (Kg) ± SD	Maternal height (cm)	Diabetes
3434.01 ± 404.14	SVD = 940 AVD = 40 IVD = 20	Para 0 = 660 Para 1 = 250 Para 2 = 80 Para 3 = 10	27.15 ± 4.14	66.71 ± 6.92	12.33 ± 1.67	162.29 ± 4.94	No diabetes = 940 Maternal diabetes = 30 Gestational diabetes = 30

For all control group cases ($n = 1000$) the weeks of gestation at delivery were within the range 39–41.
SVD: spontaneous vaginal delivery; AVD: assisted vaginal delivery (drugs); IVD: instrumental vaginal delivery (forceps).

Table 2. Baseline characteristics of the study sample, which includes 24 cases of OBPP.

Cases (I.D./year)	Birthweight (g)	Maternal weight (Kg)	Pregnancy weight gain (Kg)	Maternal height (cm)	SVD	OLA	IVD forceps	Parity	Maternal diabetes	Gestational diabetes	Maternal age (years)
1/2000	3950	63	11.5	161	+			Para 0	No	No	27
2/2000	4015	71.5	10	166	+			Para 0	No	No	32
3/2001	3990	71.7	19.5	169			+	Para 0	No	No	26
4/2001	3650	59.7	9	163	+			Para 0	No	No	27
5/2002	4110	77.5	13.5	158		+		Para 0	No	No	29
6/2003	4225	72.3	18.8	165	+		+	Para 0	Yes	No	34
7/2004	3685	61	12	166	+			Para 0	No	Yes	25
8/2004	4100	83.5	14.5	170	+			Para 0	No	No	28
9/2004	3795	71	11	162	+			Para 0	No	Yes	33
10/2005	3880	64.5	10.6	165			+	Para 0	No	No	29
11/2005	4225	62.5	9.1	158	+			Para 0	No	No	25
12/2006	3605	63	12.7	155	+			Para 0	No	Yes	36
13/2007	3710	62.3	10.8	166		+		Para 0	No	No	34
14/2007	4055	59	9.2	160	+			Para 1	Yes	No	32
15/2007	3765	72.3	17.4	170	+			Para 0	No	No	34
16/2008	4050	68	11.7	159	+			Para 0	No	Yes	26
17/2008	3870	70.5	13.2	168			+	Para 0	No	No	28
18/2009	3650	64.3	14	157	+			Para 0	No	No	34
19/2010	3350	66.6	9.2	158		+		Para 0	No	No	31
20/2010	4090	82.5	10.5	168	+			Para 0	No	No	28
21/2011	3735	67.4	16.5	163	+			Para 1	No	Yes	26
22/2011	3455	74	13.4	171	+			Para 0	No	No	28
23/2011	4135	63.6	12.9	167	+			Para 0	No	No	35
24/2012	3490	58.5	11.2	159	+			Para 0	No	No	26
Mean ± SD	3857.7 ± 249.8	67.9 ± 6.9	12.6 ± 3	163.5 ± 4.7							29.7 ± 3.6

All cases were recorded only in vaginal deliveries, in none of them vacuum extractor was used and for all cases the gestational age was in the range of 39–41 weeks. Epidural analgesia was not performed in any of the 24 women in labor.
SVD: spontaneous vaginal delivery; OLA: oxytocin for labor augmentation; IVD: instrumental vaginal delivery.

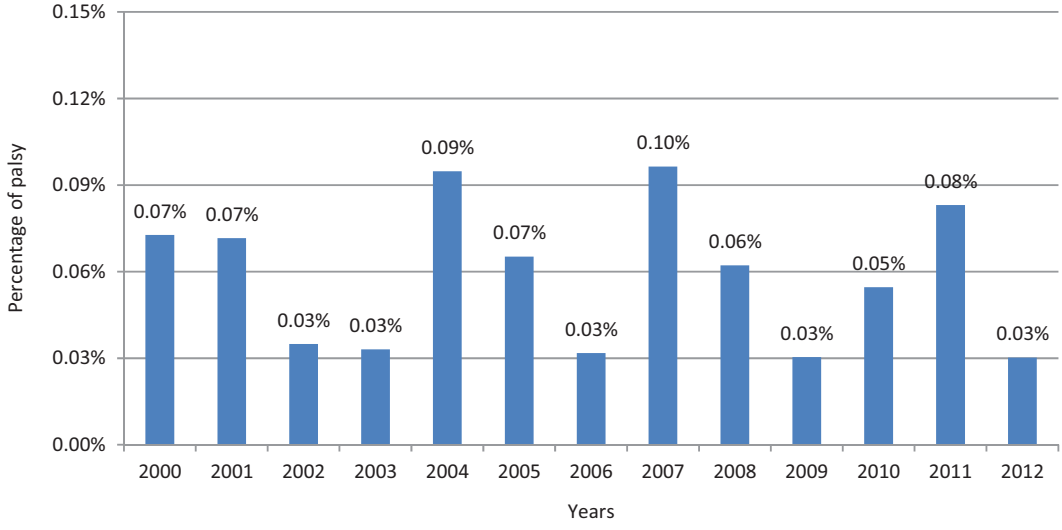

Figure 1. Percentages of OBPP at San Camillo-Forlanini Hospital from 2000 to 2012.

All infants underwent physical therapy consisting of daily passive range-of-motion exercises and prevention of muscular contractures. Shoulder abduction and adduction, flexion and extension, elbow flexion and extension, forearm supination and pronation, wrist and hand flexion and extension were performed.

Discussion

This population-based retrospective case-control study about the incidence and the predictive role of the known risk factors for OBPP provides us with various medico-legal evaluations and considerations.

It is interesting to compare the mean incidence of OBPP (0.06% ± 0.025) based on more than 41,000 deliveries between 2000 and 2012, with the results obtained by Chauhan et al. [10] in a recent paper where 63 publications were examined and 53 provided useful data in calculating the OBPP rate per 1000 total births. The overall rate of OBPP was 0.14% (range: 0.01–0.63), which is more than double the one reported here (0.06%), however taking into

consideration the temporal trend of OBPP and examining the publications after 2000, the OBPP rate significantly decreases to 0.05%, which is consistent with our rate.

Chauhan et al. [10] also examined the OBPP rate in over 1,873,000 vaginal deliveries and it was 0.16%; in our retrospective study the OBPP incidence in 24,512 vaginal deliveries was 0.1%, whereas there were no cases of OBPP in 16,490 cesarean deliveries; Chauhan et al. [10] have provided an overall rate of OBPP in cesarean deliveries of 0.03%.

Table 3. Risk factors for OBPP.

Features	Adjusted odds ratio[a]	*p* Value
Parity		
Primiparous	24.0	<.014
Multiparous	Referent group	
Birth weight		
For unit increase (100 g)	1.003	<.002
Type of delivery		
Oxytocin for labor augmentation	3.9	n.s.
Instrumental vaginal delivery	3.3	n.s.
Spontaneous vaginal delivery	Referent group	
Maternal age		
For unit increase (year)	1.249	<.02
Maternal weight		
For unit increase (kg)	1.001	n.s.
Pregnancy weight gain		
For unit increase (kg)	0.955	n.s.
Maternal height		
For unit increase (cm)	1.017	n.s.
Diabetes		
Yes	8.6	<.03
No	Referent group	
Dystocia		
Yes	11.7	<.003
No	Referent group	

[a]Based on logistic regression model including all the variables reported in the table.

Shoulder dystocia, intended as a specific case of obstructed labor whereby after the delivery of the head, the infant's anterior shoulder cannot pass below, or needs significant manipulation in order to pass below the pubic symphysis, has an incidence ranging from 0.2% to 3% of all vaginal deliveries according to different studies [11,12]. It is considered as one of the major risk factors for OBPP, whose incidence in deliveries complicated by shoulder dystocia has a wide variation from 4% to 40% [13]. OBPP, according to the Royal College of Obstetricians and Gynecologists and the American Congress of Obstetricians and Gynecologists represents the most harmful complication of shoulder dystocia [14,15]. In our study, 25% of OBPP cases were associated with diagnoses of shoulder dystocia. The comparison of this rate with other previously published studies shows a high variability of this association ranging from 11% reported by Sony et al. [16] and Levine et al. [17] to 94% reported by Ouzounian et al. [18]. As stated by Molleberg et al. [19], who reported an association rate between OBPP and shoulder dystocia of 26%, this wide range is probably due to unclear definitions and therefore results in underreporting.

As reported by different authors [2,19], high birthweight represents another significant risk factor for OBPP. According to Molleberg et al. [19] the risk of OBPP for infants who weigh between 4000 and 4500 g is higher than that of the general population and it increases sharply over 4500 g. In the 24 cases of OBPP, the mean birth-weight was 3857.7 g ± 244.5 (range: 3350–4225 g) and only in nine cases (37.5%) the

Table 4. Association between obstetric palsy and shoulder dystocia, injured roots and recovery time.

Year	Cases of obstetric palsy	Shoulder dystocia	Injured roots	Recovery at 3 months	Recovery at 1 year
2000	1.	No	C5–C6	Yes	–
2000	2.	No	C5–C6	Yes	–
2001	3.	No	C5–C6	Yes	–
2001	4.	No	C5–C6	Yes	–
2002	5.	No	C5–C6	Yes	–
2003	6.	Yes	C5–C6	Yes	–
2004	7.	No	C5–C6	Yes	–
2004	8.	No	C5–C6	Yes	–
2004	9.	No	C5–C6	Yes	–
2005	10.	Yes	C5–C6–C7	Yes	–
2005	11.	No	C5–C6	Yes	–
2006	12.	No	C5–C6	Yes	–
2007	13.	Yes	C5–C6	Yes	–
2007	14.	Yes	C5–C6	Yes	–
2007	15.	No	C5–C6	Yes	–
2008	16.	Yes	C5–C6	Yes	–
2008	17.	No	C5–C6	Yes	–
2009	18.	No	C5–C6–C7	No	Yes
2010	19.	No	C5–C6	Yes	–
2010	20.	No	C5–C6	Yes	–
2011	21.	Yes	C5–C6	Yes	–
2011	22.	No	C5–C6	Yes	–
2011	23.	No	C5–C6	Yes	–
2012	24.	No	C5–C6	Yes	–

birth-weight exceeded 4000 g. Moreover, the comparison between the birth-weight of OBPP without shoulder dystocia (18 cases) and OBPP with shoulder dystocia was statistically not significant ($p > .05$): 3829 g versus 3942 g, respectively, whereas the comparison between the mean birth-weight in OBPP cases and the control group (3857.7 g ± 244.5 versus 3434 g ± 404.2) was statistically significant ($p < .001$).

This population-based retrospective case-control study has allowed us to highlight the role of primiparity as a strong risk factor for OBPP in comparison to multiparity ($p < .014$), in fact in 22 cases of OBPP (91.7%), the women were primiparous and the odds ratio for primiparous was 24, which means that the likelihood of their newborns having palsy, increases by a factor of 24 in comparison to the multiparous. Tandon and Tandon [20] in assessing the risk factors associated with OBPP, have reported that in the presence of similar neonatal variables, brachial plexus injury is more likely to occur if labor is accelerated in neonates of primiparous women in the presence of shoulder dystocia.

Diabetes is included among the recognized obstetric risk factors for OBPP [1,2] and this study confirms its role (OR.: 8.6, $p < .03$). As reported by Al-Qattan et al. [21], who retrospectively compared OBPP in newborn babies of diabetic (253 cases) and nondiabetic mothers (402 cases), children of diabetic mothers were more prone to develop total palsy whereas children of non-diabetic mothers were more likely to develop extended Erb's palsy. It is interesting to note that babies of diabetic mothers showed significantly higher birth weight in comparison to those of non-diabetic mothers regardless of the type of palsy, whereas in our study the comparison between the birth-weight of OBPP without diabetes (18 cases) and the six cases of OBPP with diabetes (mellitus and gestational diabetes) was statistically not significant ($p > .05$): 3849 g ± 322.2 versus 3878.6 g ± 101.5, respectively.

One of the most important medical and legal issues related to OBPP is represented by prognosis and recovery. Prognosis for babies affected by OBPP is usually associated to the degree of motor deficit [22].However, it is important to underline as stated by Shenaq et al. [23] that although no reliable data have been established in the literature in determining the recovery of this kind of plexopathy, it has been shown that the majority of OBPP spontaneously recover. Several studies [23–26] have supported the findings of the Collaborative Perinatal Study where 95% of infants with OBPP have had a spontaneous recovery, 93% of which had some function as early as 4 months [26], whereas in our study the percentage of full recovery at 3 months was 96% (23 cases) and only physiotherapy was adopted in all cases. In the same study, Shenaq et al. reported that 5% of babies with OBPP needed surgical treatment. When surgery is promptly performed, about 90% of the infants improve function significantly, instead when there is a delay improvement was only 50–70%.

This makes it important to distinguish between the patients who only need physical therapy and the ones who might need surgical treatment, making the diagnosis of the level of injury a significant prognostic factor in predicting functional recovery and helping to decide between physical therapy or surgery [27,28].

Together with the therapeutic approach to adopt in cases of OBPP another very important factor worthy of attention is represented by the communication between physicians and the infant's parents, which as stated by McAbee and Ciervo [22] may represent an "effective risk-management tool in reducing malpractice lawsuits". The latter cannot be considered a negligible aspect, taking into consideration that when cases of permanent and severe weakness in infants with OBPP occur, high costs of compensation can represent a frequent scenario.

Data extrapolated from the database of the Physician Insurers Association of America (Data Sharing Project) [22] show that almost 60% of lawsuits related to OBPP between 1985 and 2001 have resulted in monetary compensation and the total costs were higher for doctors working in teaching hospitals in comparison to those in non-teaching hospitals.

Conclusions and future perspectives

This population-based retrospective case-control study has allowed us to highlight a statistically significant association among the 24 cases of OBPP (in 41,002 deliveries) and the following risk factors: primiparity ($p < .014$), birth weight ($p < .002$), maternal age ($p < .02$), diabetes ($p < .03$) and shoulder dystocia ($p < .003$), moreover all the OBPP cases were recorded only in vaginal deliveries.

The absence of OBPP cases in cesarean deliveries highlighted in this study, together with the evaluation of the overall incidence of OBPP in cesarean deliveries, which is significantly lower in comparison to vaginal deliveries (0.03% versus 0.16%; $p < .01$), support the option of proposing an elective cesarean in the presence of known risk factors after a full disclosure with the mother of risks and benefits in order to obtain a valid consent.

Moreover, when cases of OBPP occur the parents of the newborn need to be involved and made aware

not only of the options available (physical therapy versus surgery) but also the possibility they might not recover before several months and that there is a risk of permanent weakness. Although the risk of long-term sequelae cannot be avoided, awareness plays a crucial role as demonstrated by different studies where parents suing for malpractice involving newborns at a later date often complain of a lack of communication between their doctors and themselves [22,29].

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Disclosure statement

No potential conflict of interest was reported by the authors.

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