J. Perinat. Med.
20 (1992) 297–305

Oro-naso-pharyngeal suction at birth: effects on respiratory adaptation of normal term vaginally born infants

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1 Introduction

The procedure of suctioning the fluid contained in the newborn's upper airway before or during initial respiration is routine in many institutions and is frequently recommended in the literature [1, 5, 6, 13, 14, 15].

This airway fluid would impair airflow at birth, mainly due to its greater viscosity, which determines greater resistive forces generated between the different phases in movement (airway wall, air and liquid) [3]. These forces impair ventilation and are a cause of increased ventilatory work. The respiratory resistive forces are currently estimated by the Total Respiratory Resistance (R). During initial adaptation after birth, airway fluid is rapidly absorbed into the interstitial space of the lung [2], determining a fall in R [3, 12]. The greatly increased liquid in the lung's interstitial space originates from elastic recoil forces which result in additional ventilatory work [10]. These recoil forces of the lung can be estimated by assessment of the Dynamic Lung Compliance (C. Dyn).

Fluid contained in the respiratory system at birth is thought to be responsible for the increased ventilatory work observed during initial adaptation to extrauterine life [2, 3, 9]. Airway suction at birth aims at rapidly eliminating this fluid, and so improve lung mechanics and diminish respiratory work from the first respiratory movements. The potential advantages obtained with airway suction at birth are based on conjecture and theoretic speculations, without sound scientific evidence to justify its routine use in normal newborns. On the other hand, airway suctioning at birth has been described as a cause of bradycardia and other cardiac rhythm disturbances in the newborn [4]. The possibility also exists, that the volume of fluid withdrawn by this procedure is proportionally so small, that it will not affect mechanical adaptation of the lung. If this were the case, this frequently practiced procedure of suctioning all newborns would not be justified.

Recently we have developed a pneumotachographic system for respiratory function assessment in newborns and described the mechanical and control characteristics of neonatal ventilation [7]. This system, now computerized (MECVENT), allows rapid and minimally invasive determinations of the functional and mechanical changes occurring during respiratory adaptation at birth. With MECVENT it would be possible to measure the potential changes in C. Dyn. and R induced by the procedure of airway suction at birth.

In this paper we describe the effect of oro-naso-pharyngeal suction at birth on the mechanical properties of the respiratory system of normal, term, vaginally born babies.

2 Material and methods

The study was carried out at the Neonatology Unit of the Hospital de Clínicas, Department of Neonatology of the School of Medicine, University of Uruguay, in the period between October 1988 and April 1989.

2.1 Population

Pregnant women in labor were evaluated at admittance to the Labor Section of the Maternity Unit. Only those women fulfilling the following requirements were admitted to the study: a) single, term fetus (37 to 42 weeks), b) without detected fetal or maternal morbidity, c) no medication in the seven days prior to birth, d) intact or less than 24 hours ruptured membranes, e) clear and non fetid amniotic fluid, and f) absence of intrapartum fetal distress.

The mothers were informed of the procedures to be performed on their infants, regarding the aims of the study, before verbal consent was requested.

Obstetrical management was carried out by the clinical staff on call and the clinical decisions were taken independently of the development of this study.

At birth, the infants with good vitality (according to the clinical estimate of the attending neonatologist), were allotted to the Suctioned Group (S) or to the Non Suctioned Group (NS), according to the hour at which the delivery occurred. Thus, those babies born at even hours (for example, from 10:00 to 10:59) were allotted to the first group, whereas those born at uneven hours (for example 11:00 to 11:59) were allotted to the second. The allotment to each Group was made by one of the authors, who was present in all the studies.

Newborns presenting any one of the following characteristics were later excluded from the study: a) umbilical artery pH at birth lower than 7.20; b) Apgar Score at first or fifth minutes lower than 7; c) birth weight less than 2500 or greater than 4200 g; and d) neonatal morbidity in the first 48 to 72 hours of life.

2.2 Procedures carried out with the newborns (figure 1)

At birth, before the first breath and independently of whether the airway was suctioned or not, the umbilical cord was doubly clamped and a sample of umbilical artery blood was obtained for assessing fetal blood gases.

In the S Group newborns, suction of the upper airway was performed immediately after birth, by the attending neonatologist under the supervision of one of the authors. The procedure was performed with an electric aspirator provided with a sterile polyethylene No 5 catheter with blunt end and 2 lateral holes. Both nares and the oropharynx were successively suctioned, avoiding trauma and withdrawing the largest possible amount of fluid. The maximal pressure delivered by this system was -30 cm H_2O.

Immediately after this first stage and according to the initial evaluation (Apgar score at the first minute), the newborn was wrapped in a dry, sterile napkin and put to the mother's breast, allowing early mother-infant bonding for 1 to 3 minutes. It was then taken to the Reception-Reanimation Area of the Unit (always in sight of the mother), where under a radiant heater, and after a rapid clinical evaluation, its weight and height were determined; at 10 minutes after birth the first spyrometric assessment was performed. Then, routine care procedures followed (eye Crede, vitamin K administration, etc.) and the physical evaluation was completed. Once dressed, a second spyrometric assessment was performed 30 minutes after birth. Then the infant was placed with the mother, who was advised to breastfeed it immediately. As a rule the newborns stayed in bed with their mothers during this initial period so as to avoid cooling. Mother and child were thus transferred to the Rooming In Section. Before 120 minutes after birth and in its own cradle, the infant was again taken to the Reception-Reanimation Area, where a third spyrometric assessment was performed. On all these occasions, the father or other relation was invited to look on at the procedure, so that in most cases a relative of the child was present.

Follow up of the newborns was made until they left the Maternity Unit (usually on the third day), searching for any abnormality which would determine their withdrawal from the study.

2.3 MECVENT System (figure 2)

Our research group has developed a spyrometric system for the automatic determination of neonatal ventilatory parameters. This system is com-

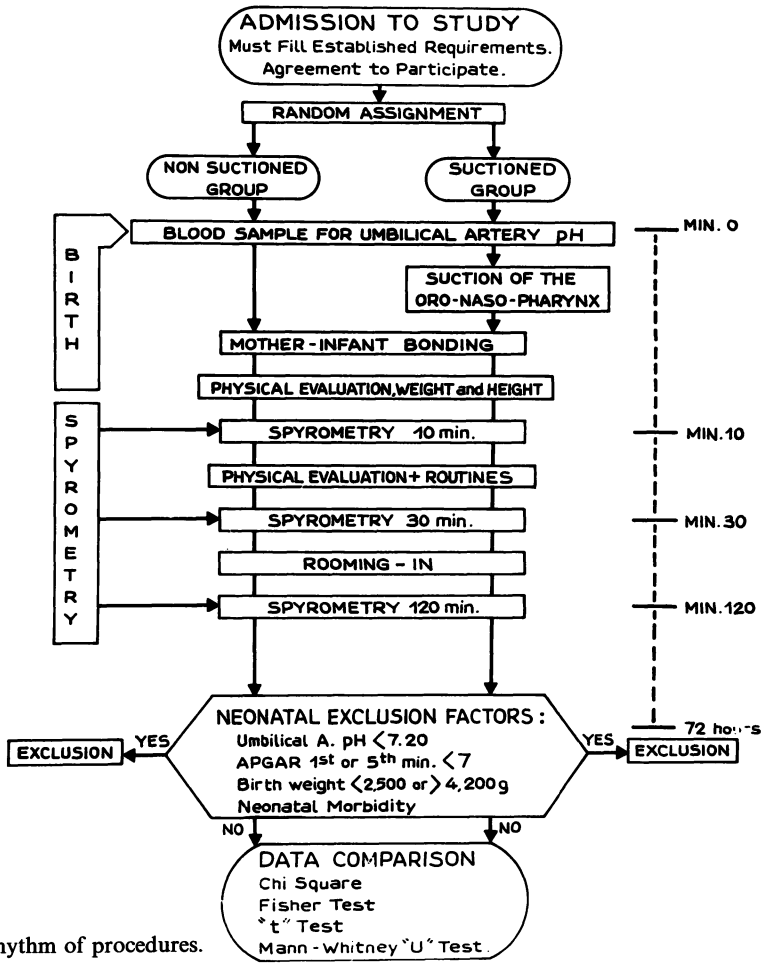

Figure 1. Algorhythm of procedures.

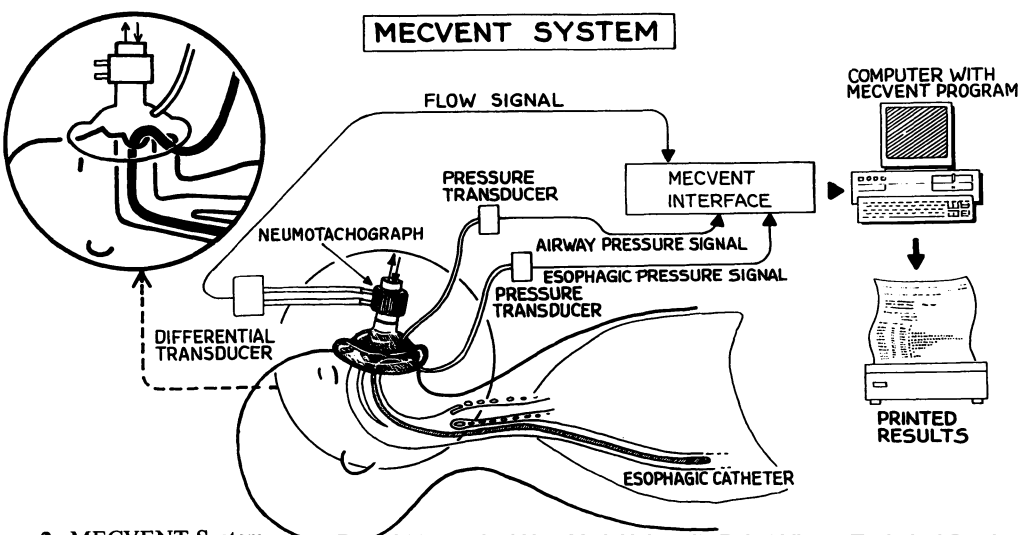

Figure 2. MECVENT System.

posed of pressure transducers, a pneumotachograph, an interface for signal isolation and adaptation, as well as a personal computer and the required software for its operation. Airway and esophageal pressure are assessed by means of piezoresistive pressure transducers (Microswitch 163PC 1D48). Airflow was determined with a Hans Rudolph pneumotachograph R3600 (10.2 ml dead space) with temperature control, provided with a Vacumed 4500-2 pressure transducer. Signal processing was achieved with a standard computer (PC AT compatible, Epson Equity III) provided with a digital analog conversion card (A/D) (Data translation DT 2808). The design and electronic achievement of MECVENT is of our own group. The system is in clinical use since 1988.

2.4 Spyrometric studies

These were performed in all newborns at 10, 30, and 120 minutes after birth (range $\pm$ 1 minute). Determinations were obtained with the infant under radiant heating, awake and without crying, lying on its back and breathing air (figure 2).

A polyethylene catheter with blunt end and lateral holes, filled with sterile distilled water, was placed in the lower third of the esophagus. This catheter was connected to a MECVENT pressure transducer (range $\pm$ 40 cm H_2O) to record intraesophagic pressure. Permeability was maintained through an Intraflow (R) system, with a continuous flow of sterile, distilled water. The appropriate insertion of the catheter was confirmed through a withdrawal record, looking for the fall in pressure that occurred when the end of the catheter passed from the gastric chamber into the lower third of the esophagus. Once correctly placed and fixed, a Leardal (R) plastic, transparent inflated mask was gently applied to the infant's face (figure 2). This mask was connected to the pneumotacograph (range $\pm$ 170 ml/s).

The pressure changes in the airway were determined with a second transducer (range $\pm$ 3 cm H_2O) connected to the mask (figure 2).

The electric signals generated by these transducers were entered into the interface. There, after they were modulated and the flow signal integrated in time, generating a volume signal, they were acquired by the computer, where the MECVENT software runs. The signals for airway and esophagic pressures, airflow and volume are displayed on the monitoring screen, as they are acquired and stored in diskette file for later analysis.

In all cases, a minimum of 20 seconds of quiet breathing was recorded. After each record, the esophagic catheter was withdrawn and the infant submitted to the routine care procedures for normal newborns at the Maternity.

2.5 Respiratory parameter calculations

After biological signals are stored on diskette, MECVENT calculates, in the periods selected by the operator (in this case never less than 10 s), the parameters of respiratory mechanics: Dynamic Compliance (C. Dyn) in Inspiration and Expiration, and Total Respiratory Resistance (R) in Inspiration and Expiration, both by linear adjustment of minimal squares method. Other parameters are calculated, such as: Respiratory Frequency, Tydal Volume, Minute Ventilation, and Time Constants. All calculated values are expressed as arithmetical means of the observed values in the selected periods.

The criteria for selecting the study periods were: regular breathing without artifacts, no crying or grunting, these last evidenced in the graphically displayed pressure volume loops.

2.6 Sample size

Our null hypothesis is that the parameters of respiratory mechanics do not differ between NS and S groups. The evidence of these measurements will allow us to discard this hypothesis (Hypothesis zero, Ho), or not. To perform a power study of the statistical test to be applied, we set as clinically significant differences between the study parameters, those which separate values of normality from abnormality. These limits (table I) have been determined by our group in previous studies [7, 8].

Accepting an alpha type error of 5% and a beta type error of 5% (95% power), a difference in C. Dyn of 0.50 (ml/cm H_2O/kg), with a within the group standard deviation of 0.40, gives a calculated sample size of 14 newborns for each group. The same calculations made for R, considering a difference of 35 cm H_2O/l/s, and a

Table I. Limits of normality for Dynamic Lung Compliance (C. Dyn) and Total Respiratory Resistance (R) in normal newborns, older than 24 hours, obtained from previous studies [7, 8].

C. Dyn (ml/cm H_2O/kg)	1.40	0.90	0.50
R (cm H_2O/l/s)	22.0	57.0	35.0

within the group standard deviation of 23.0, also gives a calculated sample size of 14 babies in each group. It was therefore decided to work with 20 cases in each group.

2.7 Data analysis

All clinical information from the mother, pregnancy, delivery, and newborn, as well as cord blood gas values were collected on a computer file, to which we added the data of the three spyrometric studies.

The data obtained in both groups, S and NS, were compared by the Student "T" test in the case of continuous variables of normal distribution, or by the Mann Whitney U-test for those with non normal distribution. Discrete variables were studied by analysis of contingency tables with Chi square tests with Yate's correction and the Fisher test. Level of significance was set at Alpha = 0.05.

2.8 Ethical aspects

The project was approved by the Ethical Committee of the Pan American Health Organization (PAHO/WHO, Washington DC, USA).

3 Results

3.1 Population (table II)

After antenatal exclusions and only one postnatal exclusion, a total of 40 cases remained in the study, 20 in the NS group and 20 in the S group. The excluded case was that of a newborn weighing 3200 g, assigned to group S, which became secondarily depressed (Apgar score 5 at the fifth minute) and had an umbilical artery pH at birth of 7.12.

Twelve cases (30%) were born from primigravidae. Ten mothers (25%) had four of fewer prenatal controls. In four cases (10%), there was rupture of membranes for more than 12 hours,

Table II. Characteristics of the study population

	Suctioned group (n = 20)	Non suctioned group (n = 20)	Statistical significance
Primigravidae	4	8	ns
<5 controls	5	5	ns
Ruptured membranes >12 and <24 hours	1	3	ns
Pharmacologic induction	3	3	ns
Low forceps	2	3	ns
Sex ratio (M/F)	11/9	10/10	ns
Birth weight (g) ($\bar{x} \pm -1$ DS)	3314 ± 409	3212 ± 340	ns
Height (cm) ($\bar{x} \pm -1$ DS)	50.3 ± 1.6	49.8 ± 1.6	ns
Umbilical A pH ($\bar{x} \pm 1$ DS)	7.36 ± 0.06	7.34 ± 0.09	ns

Table III. Suction of the Oro-Naso-Pharynx at birth: effect on respiratory mechanics

Parameter	Group	n	10 minutes $\bar{x}$	10 minutes 1 DS	10 minutes tind (NS−S)	30 minutes $\bar{x}$	30 minutes 1 DS	30 minutes tind (NS−S)	120 minutes $\bar{x}$	120 minutes 1 DS	120 minutes tind (NS−S)
C. Dyn (Inspiratory) ml/cm H_2O/kg	NS	20	0,72	0,22	ns	0,86	0,33	ns	1,24	0,41	ns
	S	20	0,74	0,43		0,76	0,25		1,51	0,83	
C. Dyn (Expiratory) ml/cm H_2O/kg	NS	20	0,69	0,52	ns	0,72	0,21	ns	1,18	0,45	ns
	S	20	0,54	0,22		0,69	0,24		1,25	0,65	
R (Inspiratory) cm H_2O/l/s	NS	20	23,8	19,1	ns	19,3	16,9	ns	15,7	14,2	ns
	S	20	30,3	26,3		18,8	15,7		17,9	16,1	
R (Expiratory) cm H_2O/l/s	NS	20	23,1	28,6	ns	16,3	8,3	ns	11,2	9,6	ns
	S	20	26,0	20,4		18,2	16,6		19,0	19,0	

NS = Non Suctioned Group S = Suctioned Group tind = "t" test ns = non significant differences
$\bar{x}$ = mean 1 DS = one standard deviation

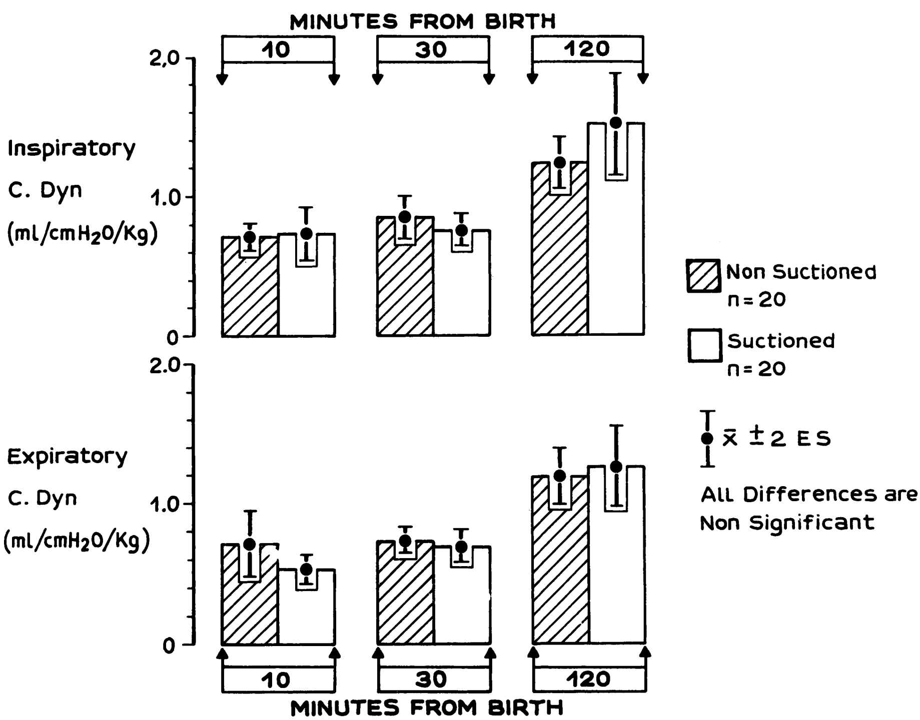

Figure 3. Effect of suction of the oro-naso-pharynx at birth on the Dynamic Compliance (C. Dyn).

but always less than 24 hours. In six cases (15%) labor was induced with oxytocin infusion, and in five cases (12.5%) delivery ended with low forceps. In 21 cases the newborn was a boy (52.5%) and in 19, a girl (47.5%). Birth weight was 3303 ± 383 g ($\bar{x}$ ± 1 SD) and height was 50.0 ± 1.6 cm. Umbilical artery pH at birth was 7.325 ± 0.075. There were no statistically significant differences in the distribution of any of these variables between the two groups (table II).

3.2 Effect of oro-naso-pharyngeal suction at birth on respiratory mechanics (table III)

Inspiratory C. Dyn: There was a progressive increase during the whole study period in both groups. No significant differences were found between the values obtained from NS and S groups at 10, 30 or 120 minutes (figure 3).

Expiratory C. Dyn: A progressive increment was also found during the whole study period in both groups. No significant differences were found between the values of NS and S groups at 10, 30 or 120 minutes (figure 3).

Inspiratory R: Both groups showed a moderate fall in the first 30 minutes after birth. No significant differences were found between the values of NS and S groups at 10, 30 or 120 minutes after birth (figure 4).

Expiratory R: Also in this case both groups showed a moderate fall in the first 30 minutes after birth. No significant differences were found between the values of NS and S groups at 10, 30 or 120 minutes (figure 4).

4 Discussion

During the first two hours of life, an important increase in both inspiratory and expiratory C. Dyn, was observed. They rise until they reach values greater than the 10th percentile for newborns older than 24 hours [8]. A slight decrease in R between 10 and 30 minutes of life was observed in both groups. The changes in C. Dyn. during the study period agree with the absorption of lung luid from the interstitial space to the vascular space [2]. The changes in R may be

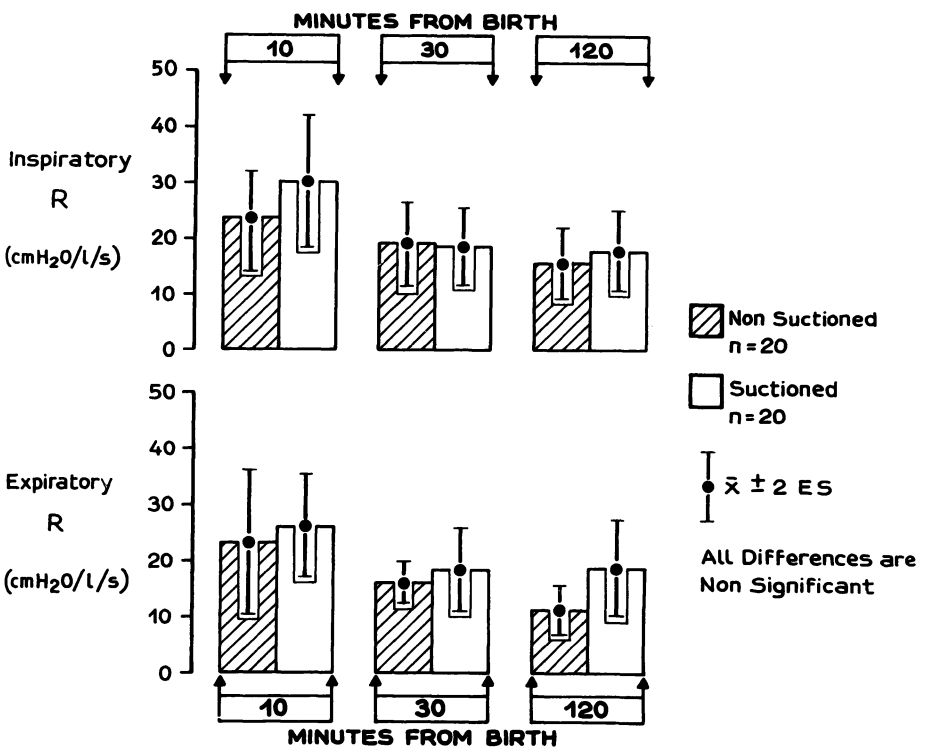

Figure 4. Effect of suction of the oro-naso-pharynx at birth on the Total Pulmonary Resistance (R).

due to the persistence of some fluid in the airway during the first determination at 10 minutes after birth [3], which is rapidly absorbed into the interstice by the time of the second spyrometric study at 30 minutes of life.

Although upper airway suction at birth seems justified in some cases [11], its systematic use in all newborns increases the risk of occurrence of complications attributed to the procedure [4]. To this risk, we should add the considerable cost of providing the required materials (sterile catheterse, etc), for routinary and systematic airway suction at birth.

In this study no significant differences in the mechanical behavior of the respiratory system, related to the oro-naso-pharyngeal suction at birth, have been found between 10 and 120 minutes after birth. Both groups, S and NS, evidenced similar mechanical behavior, so that we may assume that the procedure does not benefit the mechanical adaptation process of the respiratory system in the normal, term, vaginally delivered newborn.

This finding strengthens the idea that the volume of fluid eliminated by the procedure is only a minimal fraction of that contained in the respiratory system at birth. In the normal, term newborn, all this fluid is totally and rapidly disposed of shortly after birth, by entirely physiological mechanisms [2].

Considering that oro-naso-pharyngeal suction at birth does not benefit respiratory mechanics, and that cardiac rhythm abnormalities have been described in association with this procedure [4], its routinary and indiscriminate use should be curtailed. Situations do exist in which airway aspiration could be of benefit. This seems to be the case when amniotic fluid is stained with meconium [11], or foul smelling, or when the newborn requires cardiopulmonary resuscitation. These cases have not been considered in this study.

Abstract

The effect of oro-naso-pharyngeal suction at birth on pulmonary mechanics is described in a random assigned controlled study of 40 normal term vaginally born infants. Twenty cases had their oro-naso-pharynx suctioned immediately after birth (S Group), whereas 20 were not suctioned in the neonatal period (NS Group). A computerized pneumotachographic system (MECVENT) was used for the assessment of respiratory mechanics (Dynamic Compliance (C. Dyn.) and Total Pulmonary Resistance (R) in inspiration and expiration at 10, 30 and 120 minutes after birth. In both groups the C. Dyn increased during the study period whereas the R decreased, mainly in the initial 30 minutes. No significant differences were observed between S and NS groups for any of the parameters of respiratory mechanics. The results obtained in this study provide no physiological basis to recommend routine airway suction at birth in normal, term, vaginally born infants.

Keywords: Birth, newborn, respiratory.

Zusammenfassung

Einfluß der oro-naso-pharyngealen Absaugung bei der Geburt auf die Atemanpassung bei unauffälligen, vaginal entbundenen Neugeborenen am Termin

Um den Einfluß einer oro-naso-pharyngealen Absaugung bei der Geburt auf die Lungendynamik zu prüfen, wurde bei 40 unauffälligen und vaginal entbundenen Reifgeborenen eine kontrollierte randomisierte Studie durchgeführt. In 20 Fällen wurden unmittelbar nach der Geburt Mund, Nase und Rachen abgesaugt (Gruppe S), während in den 20 anderen Fällen nicht abgesaugt wurde (Gruppe NS). Zur Bestimmung der Atemmechanik (dynamische Compliance – C. Dyn – und totale Lungenresistance R) bei In- und Expiration wurden 10, 30 und 120 Minuten nach der Geburt Messungen mit einem computergestützten Pneumotachographen (MECVENT) vorgenommen. In beiden Gruppen nahm während der Untersuchungsperiode die dynamische Compliance zu, während der Gesamtwiderstand abnahm. Dies galt besonders für die ersten 30 Minuten. Zwischen den beiden Gruppen gab es keine signifikanten Unterschiede hinsichtlich der verschiedenen Parameter, die die Atemmechanik charakterisieren. Folgt man den Ergebnissen unserer Studie, gibt es keine physiologische Grundlage, auf der eine routinemäßige Absaugung von unauffälligen, vaginal entbundenen Neugeborenen am Termin nach der Geburt empfohlen werden sollte.

Schlüsselwörter: Atmung, Geburt, Neugeborenes.

Résumé

Aspiration oro-naso-pharyngée, à la naissance: effets sur l'adaptation respiratoire des nouveaux-nés normaux, à terme et nés par voie basse

L'effet de l'aspiration oro-naso-pharyngée, à la naissance, sur les mécanismes pulmonaires est décrit, dans une étude randomisée portant sur 40 nouveaux-nés, à terme, normaux et nés par voie basse. Vingt d'entre-eux ont subi une aspiration oro-naso-pharyngée, immédiatemment après la naissance (groupe A), alors que les vingt autres n'ont pas été aspirés (groupe nonA). Un système pneumotachographique informatisé (MECVENT) a été utilisé pour apprécier les mécanismes respiratoires (compliance dynamique, résistances pumonaires totales) lors de l'inspiration et de l'expiration, à 10, 30 et 120 minutes après la naissance. Dans les deux groupes, la compliance dynamique augmente pendant la période étudiée, alors que les résistances diminuent, particulièrement au cours des trente premières minutes. Il n'a pas été observé de différences significatives entre les groupes A et nonA pour l'ensemble des paramètres des mécanismes respiratoires. Les résultats fournis par cette étude ne procurent pas de base physiologique pour recommander, en routine, une aspiration de l'arbre respiratoire, à la naissance des nouveaux-nés normaux, à terme et nés par voie basse.

Mots-clés: Système respiratoire du nouveau-né à la naissance.

References

[1] ALISTAIR GS: neonatology, 2nd Ed, Med Exam Pub Co Inc, Garden City, New York 1980
[2] BLAND R: Lung liquid clearance before and after birth. Sem Perinat 12 (1988) 124
[3] CHERNICK V: Mechanics of the first inspiration. Sem Perinat 1 (1977) 347
[4] CORDERO L, HE HON: Neonatal bradycardia following nasopharyngeal stimulation. J Pediatr 78 (1971) 441
[5] DIAZ ROSELLO JL, P ESTOL, M MARTELL: Guías para la organización y normatización básica de la asistencia neonatal. Centro Latino Americano de Perinatologia. Pub Cientif 1928, Montevideo 1984
[6] EPSTEIN M, I (III) FRANZ, G OSTHEIMER: Resuscitation in the delivery room. In: CLOHERTY J, A STARK: (ed): Manual of Neonatal Care. Little Brown and Co. Boston 1980
[7] ESTOL P, H PIRIZ, L PINTOS, F NIETO, F SIMINI: Assessment of pulmonary dynamics in normal newborns. A pneumotachographic method. J Perinat Med 16 (1988) 183
[8] ESTOL P, H PIRIZ: Función respiratoria en 75 recién nacidos de término y pretérmino, sanos de 24 horas a 21 días de vida. XII Congreso Nacional de Tisiología y Neumología, Montevideo, Uruguay 1991
[9] FAXELIUS G, H HAGNEVIK, H LAGERKRANTZ, B LUNDELL, L. IRESTEDT: Catecholamine surge and lung function after delivery. Arch Dis Child 58 (1983) 262
[10] GERHARDT T, E BANCALARI: Lung compliance with patent ductus arteriosus before and after surgical ligation. Biol Neonate 38 (1980) 96
[11] GREGORY G, C GOODING, R PHIBBS, W TOOLEY: Meconium aspiration in infants. A prospective study. J pediatr 85 (1974) 848
[12] KARLBERG P, G KOCH: Respiratory studies in newborn infants III. Development of mechanics of breathing during the first week of life. A longitudinal study. Acta paed Scand Supp 135 (1962) 121
[13] MATTOS SEGRE CA: Atendimento ao RN ao sala de parto. In: MATTOS SEGRE RN, C ARMELLINI (eds): RN. P Editorial Sarvier, S Paulo, Brasil 1985
[14] OSTHEIMER G: Delivery room care and resuscitation of the newborn. In: WILLIAMS TJ (ed): Handbook of neonatal care. Riverside, Calif Bourns Inc 1975
[15] PERNOLL A, S BENDA, S BABSON: Initial care of the infant in the birth room. In: MOSBY (ed): Diagnosis and management of the fetus and neonate at risk. A guide for team care. 5th Edition 1986

Received August 12, 1991. Accepted August 21, 1991.

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