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Comparison of Children's Airway Permeability in Three Different Positions Measured through Nuclear Magnetic Resonance Imaging

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SUMMARY

Objective: To compare the airway patency of three different head-and-neck positions in children whom underwent to magnetic resonance imaging (MRI). **Material and methods:** Twenty-one children scheduled to MRI were randomly assigned to either group: 1) sniffing position or 2) simple head extension. In a head neutral position, a basal image was taken. Antero-posterior and transverse diameters were measured on sniffing and simple head extension positions. Airway area was calculated arithmetically. Descriptive statistical analysis was used. Parametric tests were used for dependent variables. A $p < 0.05$ was considered statistically significative. **Results:** In the simple head extension group, the airway average area was 53.47 ± 25.36 mm^2, compared to the neutral position basal measure: 59.51 ± 23.81 mm^2 ($p = 0.29$). In the sniff position group, the airway average area was 74.27 ± 43.84 mm^2, compared to the neutral position basal measure: 70.21 ± 30.20 mm^2 ($p = 0.401$). There were not significative differences in the calculated area among the groups. **Conclusion:** In pediatric patients who have undergone MRI with sedation and spontaneous ventilation, there were not significative statistical differences when comparing three airway patency maneouvers. Clinically, airway obstruction was absent.

Key words: Airway patency, magnetic resonance image, children.

RESUMEN

Objetivo: *Comparar la permeabilidad de la vía aérea en 3 posiciones diferentes en niños sometidos a resonancia magnética nuclear.* ***Material y métodos:*** *Se estudiaron 21 niños programados para resonancia magnética y asignados aleatoriamente a uno de dos grupos: 1) posición de olfateo y 2) extensión simple de la cabeza. En ambos grupos se tomó una imagen de resonancia inicial en posición de decúbito dorsal y con la cabeza en posición neutra. Dependiendo del grupo asignado, se colocaron en posición de olfateo o extensión simple de cabeza. Se midieron los diámetros anteroposterior mínimo y transverso en las dos posiciones. El área de la vía aérea se calculó aritméticamente. El análisis estadístico se realizó mediante estadística descriptiva. Las variables dependientes con escalas de intervalo se analizaron con pruebas paramétricas tipo t de Student considerando una $p < 0.05$ como estadística-*

mente significativa. ***Resultados:*** *El área en posición de extensión tuvo una media de 53.47 ± 25.36 mm² y su control en posición neutra fue de 59.51 ± 23.81 mm² (p = 0.29). El área en posición de olfateo obtuvo una media de 74.27 ± 43.84 mm², con su control en posición neutra de 70.21 ± 30.20 mm² (p = 0.401). No hubo diferencias significativas en las áreas determinadas entre los dos grupos.* ***Conclusión:*** *No hay diferencia estadísticamente significativa en el área entre las diferentes posiciones que se emplearon para medir la permeabilidad de la vía aérea, lo cual se corroboró clínicamente por la ausencia de obstrucción durante la ventilación espontánea en la realización del estudio de imagen en los pacientes.*

Palabras clave: *Vía aérea, resonancia magnética nuclear, paciente pediátrico.*

BACKGROUND

The use of images of nuclear magnetic resonance (NMR) in pediatric patients has increased with the aim of improving diagnoses, defining therapeutic planning, and providing new information about the physiological changes of diseases. In order to obtain these images, it is required around 30 minutes of the patient's cooperation and immobility[1]

In children, proper airway management during NMR is a common problem[2]. The different anesthetics required to carry out those mentioned studies attenuate muscle tone in a dose-dependant way, with the result of a trend to airway obstruction and hypoxemia.

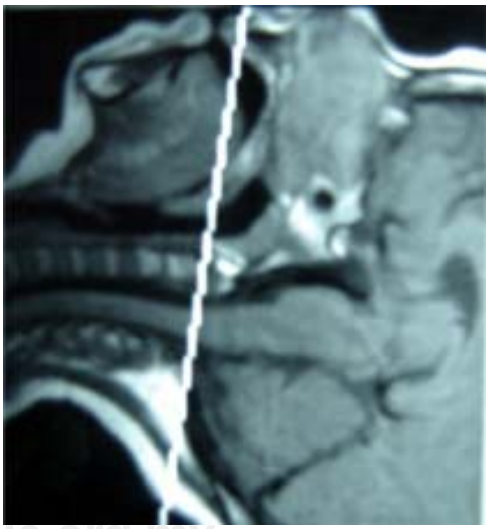
It has been described several techniques for performing NMR diagnostic studies with spontaneous ventilation without any kind of devices in airway. However, some professionals prefer its better control by means of tracheal intubation[2].

Children are susceptible to airway obstruction, especially when being new-born babies, because of their anatomic (e.g.: tongue size is relatively larger when compared to the rest of the oral cavity and it is placed nearer the upper palate %mouth ceiling) and physiological (e.g.: forced nasal breathing) characteristics[4]. Imaging studies agree with the idea that tongue posterior displacement is the main cause of airway obstruction[3]. Other studies suggest that obstruction also occurs in other areas, such as epiglottis and soft palate[2,3].

The patient's proper position seems to be a determining factor in order to avoid airway obstruction. Several articles describe different methods to obtain the most correct position[5-10].

METHOD

Before the approval from the Committees of Ethics and Research and the signature of the informed consent, it was studied 21 patients, with ages ranging from one to 12 years old, with ASA I-IV physical condition, programmed for head and/or neck NMR, who required anesthesia for study. The patients were assigned to one of two groups randomly. Patients from Group 1 were positioned in "sniffing" position (SP), which was obtained placing the patient on a flat surface (NMR device table), with neck extension and inserting a support (pillow) underneath the head, with a height of 7 to 9 cm[5] and axis flexion in the neck over the axis on the chest between 30º and 35º (Figure 1). Patients from Group 2 were positioned with their in simple head extension (EP %extension position) on a flat surface (NMR device table), with a gentle extension and without any support, with an angle of about 110º between the imaginary line connecting the lateral commissure of the eye and the tragus of the ear pavilion (Figure 2).



Line on wich we measure the minimun diameter anteroposterior.

Figure 1. *Sniffing position.* The patient was placed on a flat surface (table of the NMR apparatus), With an extention of the neck and inserting a bracket (it donates or pillow) below the head of 7 to 9 cm[5] and with a bending axis in the neck on the shaft into the chest of between 30° and 35°.

The patients were prepared in the pre-anesthesia room, where the peripheral venous access was performed. Without any pre-anesthetic medication, the patients were taken to the area of nuclear magnetic resonance, where they were positioned on the table of the resonator, and the devices for standard monitoring (cardiac frequency, respiratory frequency, artery blood pressure, and SpO_2 %pulsioximetry) were placed.

The patients were induced with progressive concentrations of sevoflurane with 100% O2 and a minimal flow of 3 L/min up to the reach of a proper anesthetic deepness for the practice of the study and keeping the spontaneous ventilation.

In dorsal decubitus and neutral positions, defined as the placing of the patient on a flat surface (the NMR device table), without any support on the head (pillow), and without cervical flexion or extension (Figure 3), it was taken a NMG image that served as a control for every patient. From this image, the minimal antero-posterior and transversal measurements were taken (Figure 4), as well as the calculation of the airway area, taken the two previous measurements (π x minimal antero-posterior diameter^2 x transversal diameter^2) as a reference. After that, the patient was positioned according to the distribution in the two groups and the same measurements were performed in the selected position, EP or SP (Figures 5 and 6).

The statistical analysis was carried out through descriptive statistics for age and weight variables, determining the average and the standard deviation (SD), and percentages were obtained for the variables of sex and ASA classification.

The analysis of the dependant variables with interval scales were analyzed by parametrical tests, such as Student's "t" test from a tail with different variances, considering $p < 0.05$ as statistically significant.

RESULTS

Twenty-one patients from 1 to 12 years old were studied, with a mean of 2.58 ± 1.21 years old for the SP Group (11 patients) and 4.1 ± 1.33 years old for the EP Group (10 patients).

In the OP Group, the 63.63% corresponded to the male sex and the 36.37% to the female sex; while for the EP Group, the 40% of the patients were from the female sex and the 60% from the male sex.

In the EP Group, the 10% had ASA II and the 90% ASA III classification. In the OP Group, the 18% corresponded to ASA II; the 64%, ASA III; and the 18%, ASA IV classification.

I the PE Group the minimal antero-posterior distance in neutral position was of 6.01 ± 1.21 mm, while in extension

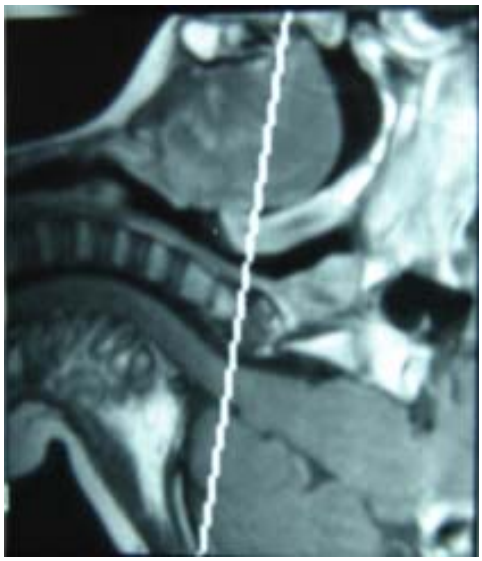


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Figure 2. *Simple extension of head.* Patient was placed on a flat surface (table of the NMR apparatus) sligth extension of head and without support (it donates or pillow) and at angle approximately 110° between the horizontal plane of the NMR table and the line connecting the lateral commissure of eye and the tragus of the ear pavilion[(2)].

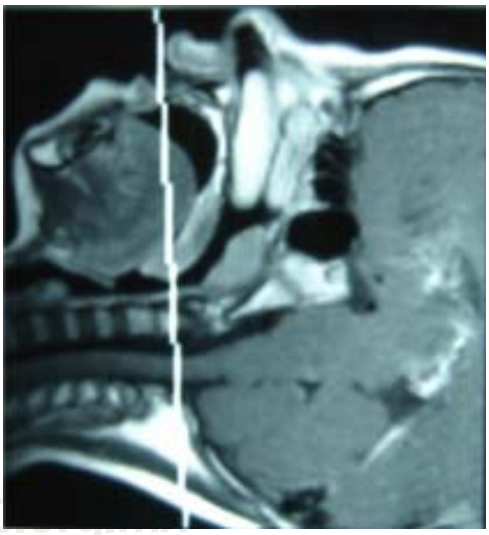

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Figure 3. *Neutral position.* Patient was placed on a flat surface (table of the NMR apparatus) without support on head (it donates or pillow) and without flexion or cervical extension.

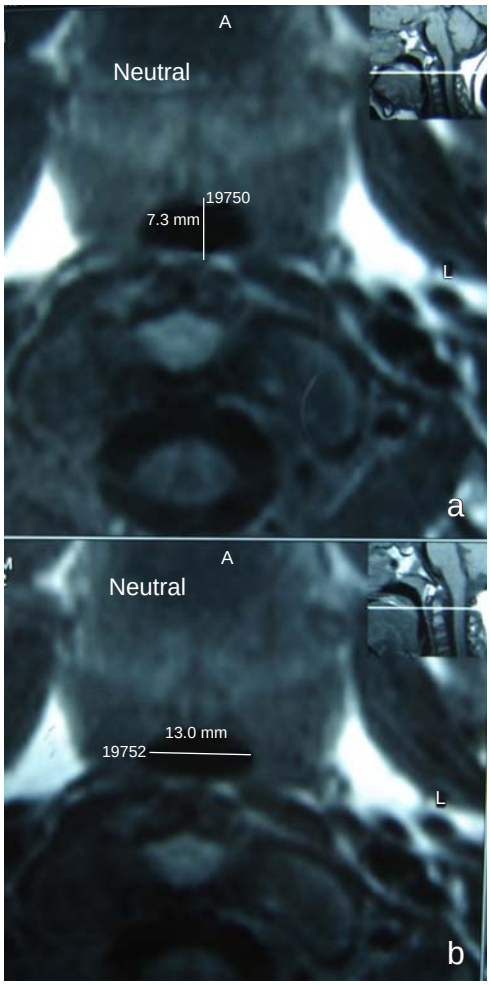

Figure 4. The line in *figure 4a* shows minimum anteroposterior diameter and *4b* measurement of transverse diameter in neutral position transverse (b) neutral position.

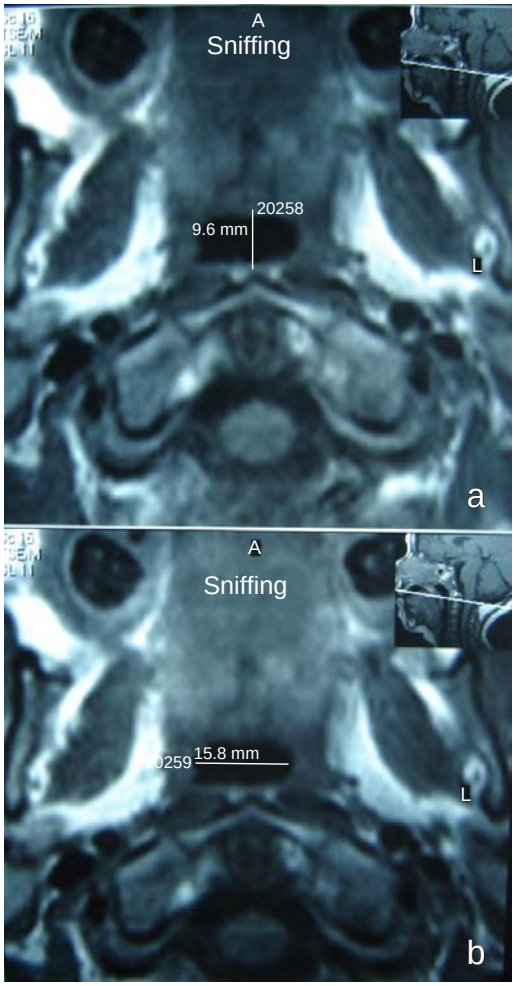

Figure 5. The line in *figure 5a* shows minimum anteroposterior diameter and *5b* measurement of transverse diameter in neutral position transverse (b) sniffing position.

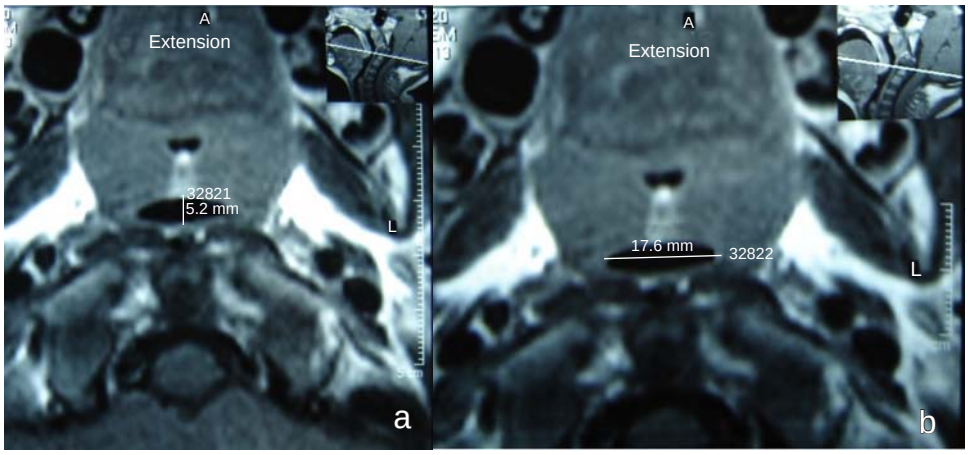

Figure 6. The line in *figure 6a* shows minimum anteroposterior diameter and *6b* measurement of transverse diameter in neutral position transverse (b) position of extension.

position that measurement was of 5.6 ± 1.82 mm (p = 0.281). The transversal diameter in neutral position was of 12.44 ± 4.17 mm, while in the extension, position it was 12.07 ± 5.35 mm (p = 0.432). The area was of 59.51 ± 23.81 mm^2 in neutral position, and in extension position, it was of 53.47 ± 25.36 mm^2 (p = 0.29) (Table I).

In the PO Group, the minimal antero-posterior distance in neutral position was of 7.48 ± 2.46 mm, while in the "sniffing" position, it was of 7.58 ± 2.77 mm (p = 0.46). The transversal diameter in neutral position was of 11.63 ± 2.96 mm, and in the "sniffing" position, it was of11.59 ± 4.18 mm (p = 0.488). The area was of 70.21 ± 30.20 mm^2 in neutral position, and it was of 74.27 ± 43.84 mm2 (p = 0.40) in "sniffing" position (Table II).

DISCUSSION

Our findings suggest that there is no significant difference among the "sniffing" position, the simple head extension, and the neutral position for keeping airway permeability in children subjected to NMR (Nuclear Magnetic Resonance) studies.

In 1913, Chevalier Jackson published the first study on airway position in patients in order to achieve optimum ventilation and intubation conditions. This author remarked the importance of the anterior flexion in lower cervical spine and the extension of the atlanto-occipital joint, called "sniffing" position[5,9]. We establish our hypothesis assuming that if the "sniffing position" allows better ventilation by aligning the oral, pharyngeal and laryngeal axes, it might be obtained a greater airway permeability (defined by the measurement of its area) when compared to the ventilation produced by the neutral and simple extension positions. Nevertheless, we could not demonstrate this development in our study.

Further modifications in the "sniffing" position have described the need for the axis flexion in neck over the axis over the chest of about 30º to 35º, in order to improve airway permeability. In spite of this last fact, there are reports that do not confirm the superiority of this position over the head simple extension[5], what matches with our results.

There are several studies that have found an extension in the antero-posterior and transversal diameters when some simple action is performed over the patient, such as the lifting of the jaw[2,5]. However, we did not find any significant difference in the antero-posterior diameter (p = 0.28) or in the transversal diameter (p = 0.43) when we compared the neutral position against the extension position. Probably, this may be because the movement of head simple extension does not produce the same effect as the lifting of the jaw over the tongue.

Some authors assert that airway obstruction in patients under anesthesia is produced by a decrease in the antero-posterior diameter[3,4]. In our study, we did not find any statistical difference in these diameters between the neutral position compared against the extension and the "sniffing" (p = 0.28 and p = 0.46, respectively), what could be observed clinically, since there were no cases of airway obstruction.

Table I. Comparison of measurements obtained between neutral and sniffing positions.

Number. patient	Age (months)	Anteroposterior diameter minimum		Transverse diameter		Area	
		Neutral	Sniffing	Neutral	Sniffing	Neutral	Sniffing
1	23	8.60	7.8	11.6	9.8	78.35	60.04
2	24	8.40	4.3	15.1	7.4	99.62	24.99
3	60	7.30	9.6	13.0	15.8	74.53	119.13
4	36	9.90	10.7	13.5	14.5	104.97	121.85
5	41	3.70	6.5	10.0	17.7	29.06	90.36
6	13	9.70	8.2	7.9	8.4	60.19	54.10
7	48	6.20	4.8	9.1	9.5	44.31	35.81
8	24	3.60	4.2	6.7	3.8	18.94	12.53
9	36	7.90	10.0	16.0	13.4	99.27	105.24
10	16	5.80	5.2	13.6	12.1	61.95	49.42
11	20	11.20	12.1	11.5	15.1	101.16	143.50
Mean		7.48	7.58	11.63	11.59	70.21	74.27
(SD)		(2.46)	(2.77)	(2.96)	(4.18)	(30.20)	(43.85)
Value p		0.46		0.48		0.40	

It was considered p < 0.05 as statistically significant

Table II. Comparison of measurements obtained between neutral and extension positions.

Number. patient	Age (months)	Anteroposterior diameter minimum		Transverse diameter		Area	
		Neutral	Extension	Neutral	Extension	Neutral	Extension
1	18	5.8	6.00	10.90	15.70	49.65	73.98
2	36	5.7	4.30	12.40	12.50	55.51	42.22
3	48	4.5	5.10	16.20	17.80	57.26	71.30
4	48	4.4	3.40	5.00	3.20	17.28	8.55
5	48	5.2	5.20	17.80	17.60	72.70	71.88
6	48	8.4	4.00	13.70	6.40	90.38	20.11
7	54	6.2	5.50	11.10	9.20	54.05	39.74
8	60	7.3	6.10	15.70	15.70	90.01	75.22
9	72	6.5	6.40	15.10	16.20	77.09	81.43
10	72	6.1	10.00	6.50	6.40	31.14	50.27
Mean		6.01	5.60	12.44	12.07	59.51	53.47
(SD)		(1.21)	(1.82)	(4.17)	(5.35)	(23.81)	(25.36)
Value p		0.28		0.43		0.29	

It was considered $p < 0.05$ as statistically significant

Upon the base of our results, we are not able to recommend the routine use of any of the studied positions ("sniffing", head simple extension, or neutral) in order to achieve greater airway permeability in pediatric patients subjected to NMR (Nuclear Magnetic resonance) under anesthesia. Nevertheless, since the groups were not completely homogeneous and the sample was reduced, the results cannot be extrapolated to the general pediatric population.

Due to the great existing differences in children's airway anatomy, we considered to perform a further study that includes the comparison by age groups and of the three different positions ("sniffing", head simple extension, or neutral) in each of the patients.

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