ORIGINAL ARTICLE

Rhinoscintigraphic analysis of nasal mucociliary function in patients with Bell's palsy

S Boynuegri, S Ozer[1], I Peksoy[2], A Açıkalın, EÜ Tuna, E Dursun[3], A Eryılmaz

Department of Otorhinolaryngology, Ankara Numune Education and Research Hospital, [1]Department of Otorhinolaryngology, Faculty of Medicine, Hacettepe University, [2]Department of Nuclear Medicine, Ankara Numune Education and Research Hospital, Ankara, [3]Department of Otorhinolaryngology, Faculty of Medicine, Recep Tayyip Erdoğan University, Rize, Turkey

Abstract

Objective: Mucociliary transport (MCT) is an important defense mechanism of the respiratory tract. One of the major factors determining MCT is the ciliary activity of the respiratory epithelium. Rhinoscintigraphy is the most commonly used method for the analysis of mucociliary activity. The aim of this study was to investigate the effect of facial paralysis on the nasal mucociliary clearance.

Materials and Methods: This study included 38 Bell's palsy patients as the study group and 10 subjects without any history of paranasal sinus disease or facial paralysis as the control group. A drop of technetium 99m-labeled macroaggregated albumin (Tc-99m MAA) was placed posterior to the head of the inferior turbinate and followed with a gamma camera. MCT rate was measured as the velocity of Tc-99m MAA drop.

Results: The mean MCT rate was 4.27 ± 0.76 millimeters per minute (mm/min) on 20 sides of 10 healthy controls, 4.11 ± 2.91 mm/min on the affected sides of the patients with Bell's palsy, and 6.03 ± 3.13 mm/min on the nonparalyzed sides of the patients. MCT rate was statistically significantly faster in the nonparalyzed side when compared to the paralyzed side in Bell's palsy patients ($P = 0.001$). MCT rates were not significantly different in the control group and paralyzed sides of the Bell's palsy patients ($P = 0.810$). The MCT rate was statistically significantly faster in the nonparalyzed sides of Bell's palsy patients when compared to the controls ($P = 0.017$).

Conclusion: This study showed a faster MCT rate on the nonparalyzed side in Bell's palsy patients when compared to the paralyzed side and the control subjects. A compensatory mechanism could be the underlying reason for faster MCT on the nonparalyzed side. Further studies on larger patient groups are needed to investigate the effect of facial paralysis on the MCT and changes of facial nerve function on the opposite, nonparalyzed side of the face.

Key words: Bell's palsy, mucociliary transport, rhinoscintigraphy

Date of Acceptance: 02-Nov-2015

Address for correspondence:
Dr. S Ozer,
42, Cad. 1465, Sok. 2/33, Balgat, Ankara, Turkey.
E-mail: drserdarozer@gmail.com

Access this article online	
Quick Response Code:	**Website**: www.njcponline.com
	DOI: 10.4103/1119-3077.179287

How to cite this article: Boynuegri S, Ozer S, Peksoy I, Açikalin A, Tuna EÜ, Dursun E, *et al*. Rhinoscintigraphic analysis of nasal mucociliary function in patients with Bell's palsy. Niger J Clin Pract 2016;19:359-63.

Introduction

Mucociliary transport (MCT) is an important defense mechanism of both upper and lower airways. Ciliary activity and the properties of the mucus layer are the factors that determine the MCT. MCT depends to a large extent on the activity of cilia.

Ciliary beat and MCT can be measured with different methods. One of the most accurate methods for establishing MCT rate is Gamma scintigraphy, which measures radioactive matter's transport rate in the nasal cavity.[1,2]

Nasal mucous secretion and its content are controlled by the autonomic nervous system. Parasympathetic activity increases both the amount of secretion and nasal obstruction. Any decrement in the parasympathetic activity leads to a more viscous secretion, which may alter MCT rate of the nasal mucosa. Parasympathetic innervation of the nasal mucosa originates from superior salivatory nucleus situated in pons. The parasympathetic fibers are transmitted through the intermediate nerve, which travels in internal acoustic and Fallopian canals with the facial nerve.[3,4]

Bell's palsy is an idiopathic, acute, unilateral paresis, or paralysis of the face, in a pattern consistent with the peripheral facial dysfunction.[5] It accounts for 60–75% of all cases with unilateral facial paralysis.[6] Any condition that affects the facial nerve function may also affect the intermediate nerve. Parasympathetic innervation of the lacrimal glands is provided by greater petrosal nerve, which is a branch of the intermediate nerve, and Schirmer's test has been used as a topographic test in Bell's palsy. Greater petrosal nerve also carries parasympathetic fibers to the nasal cavity and plays a role on MCT. Although Schirmer's test has been studied and used as a prognostic test in Bell's palsy, to our knowledge, no studies in English literature have studied the effect of Bell's palsy on nasal MCT up to date. The aim of this controlled study was to investigate the changes in the MCT rate in the nasal cavity in patients with unilateral Bell's palsy.

Materials and Methods

Subjects

The study population consisted of 38 patients with unilateral Bell's palsy (19 men and 19 women between the ages of 20 and 68 years) and 10 healthy adults (6 men and 4 women between the ages of 25 and 55 years). The healthy subjects did not have either anatomical variations on physical examination or clinical symptoms or signs of nasal or paranasal sinus diseases. The inclusion criteria for Bell's palsy patients were presence of unilateral facial paralysis for <2 weeks (mean: 1.4 ± 7.6 days, range: 1–11 days), absence of any treatment for facial paralysis before admission to our clinic, absence of any previous nasal/paranasal sinus symptoms or any nasal/paranasal sinus surgery, and normal nasal examination on admission. The exclusion criteria for Bell's palsy patients included duration of facial paralysis more than 2 weeks, previous treatment for Bell's palsy after its onset, history of previous Bell's palsy, presence of nasal/paranasal disease symptoms including allergic rhinitis and rhinosinusitis, history of diabetes mellitus, chronic renal failure, liver disorders or hypo/hyperthyroidism, use of any topical or systemic drugs that could affect nasal physiology (topical or oral decongestants, antihypertensives, antidepressants, antipsychotics, etc.), presence of nasal septal deviation, nasal polyps, nasal mucosal abnormalities, or any other structural conditions of the nose on anterior rhinoscopy. We started the treatment with steroids after rhinoscintigraphic evaluation of MCT rate. Facial paralysis grade of the patients were determined according to the House and Brackmann (HB) facial function scoring system.[7]

Rhinoscintigraphy

Rhinoscintigraphy was performed with Mediso Medical Imaging System Nucline Spirit (DHV/S) 2008, Hungary Class I, Type B equipment. A drop (15 μl) of radioactive solution (technetium 99m-labeled macroaggregated albumin [Tc-99m MAA]) was placed 1 cm posterior to the head of the inferior turbinate with a micropipette. All subjects were in the supine position with gamma camera set laterally, and they were advised to breathe normally through the nose or mouth to avoid sniffing. Thirty-second dynamic images were obtained for a period of 20 min. The distance between the point Tc-99m MAA was placed on the inferior turbinate and the point where the particles reached the nasopharynx was measured in millimeters, using the system's software. Nasopharynx was regarded as the place where the radionuclide material angulated inferiorly, after following a straight line in the nose. This length was divided by the time elapsed to determine the MCT rate as millimeters per minute (mm/min). We used Tc-99m MAA, which is the most commonly used particle in literature.[8-10] During rhinoscintigraphy, the room had a standard and constant temperature and moisture. The same physician performed all scintigraphic examinations, blinded to the paralyzed side of the patient. Nonparalyzed side was examined first, and we waited for 3 h before examining the paralyzed side for clearance of Tc-99m MAA. Since the nuclear medicine physician was intended to be blinded to the paralyzed side, the otorhinolaryngologist determined the paralyzed side, and he placed the radioactive material into the patient's nose. The nuclear medicine physician did not see the patient, but just examined the gamma camera images.

Statistical analysis

The data were analyzed with SPSS (SPSS for Windows, Version 11.5, SPSS, Chicago, IL, USA). Shapiro-Wilk test was used to determine whether the distributions of the continuous and intermittent variables were close to the normal. Levene test was used to determine the homogeneity of the variables. Descriptive statistics was expressed as mean ± standard deviation for the continuous and intermittent variables, and number and percentage (%) were used for the categorical variables. Significance of the difference between the groups was evaluated with Student's *t*-test when the number of independent groups was two. This evaluation was performed with one-way ANOVA when the number of independent groups was more than 2. Significance of the difference for the mean values of the clinical statistics within the groups was analyzed with dependent-*t*-test. Significant correlations among the continuous variables were analyzed with the Spearman's correlation test. $P < 0.05$ was considered as statistically significant.

Results

The mean age of 38 patients with Bell's palsy was 47.00 ± 13.85 years and 19 of them were females. Facial paralysis was unilateral in all patients in the study group and 21 of the patients had it on the left side. According to the HB grading system, 6 (15.8%) patients had Grade 2, 15 (39.5%) had Grade 3, 7 (18.4%) had Grade 4, and 10 (26.3%) had Grade 5 facial paralysis [Table 1]. A high-grade (Grades 4–5) paralysis was seen in 44.7% (17/38) of the patients.

The mean MCT rate was 4.27 ± 0.76 mm/min on 20 sides of 10 healthy controls, 4.11 ± 2.91 mm/min on the affected sides of the patients with Bell's palsy, and 6.03 ± 3.13 mm/min on the nonparalyzed sides. The MCT rates of the patients and the controls are presented in Table 2.

MCT rate was statistically significantly faster in the nonparalyzed side when compared to the paralyzed side in Bell's palsy patients ($P = 0.001$) [Table 3]. The grade of facial paralysis did not affect the MCT rate [Table 4].

Table 1: General characteristics of the study group

Sex	
Male/female (number)	19/19
Age (years)	
Mean age±SD	47.00±13.85
Side of facial paralysis (%)	
Left	21 (55.3)
Right	17 (44.7)
Grade (House-Brackmann) (%)	
Grade 2	6 (15.8)
Grade 3	15 (39.5)
Grade 4	7 (18.4)
Grade 5	10 (26.3)

SD=Standard deviation

Table 2: The mucociliary transport rates of the Bell's palsy and the control groups

Patient no	Mucociliary transport rate (mm/min)	
	Paralyzed side	Non-paralyzed side
1	2.92	5.04
2	2.98	3.53
3	5.54	5.80
4	4.62	4.71
5	1.31	4.31
6	3.56	4.45
7	1.75	4.25
8	3.92	4.82
9	1.85	2.65
10	3.41	5.18
11	3.23	4.55
12	2.41	3.15
13	5.18	6.84
14	3.01	5.40
15	7.79	8.56
16	4.71	4.99
17	5.37	8.50
18	14.88	5.50
19	5.45	11.77
20	4.94	7.84
21	1.75	3.70
22	2.92	3.33
23	3.70	4.21
24	2.92	14.36
25	1.75	6.71
26	3.81	8.39
27	3.33	4.15
28	2.77	3.70
29	2.33	5.03
30	3.41	4.62
31	2.11	2.41
32	5.37	6.83
33	3.56	6.66
34	2.41	3.33
35	2.41	4.07
36	4.45	11.12
37	14.88	16.58
38	3.35	8.09
Control no	**Mucociliary transport rate (mm/min)/ control group**	
	Right	**Left**
1	4.47	4.71
2	3.41	3.15
3	4.81	4.84
4	4.71	4.99
5	4.47	4.39
6	2.51	2.92
7	5.23	5.11
8	4.56	4.80
9	3.67	4.21
10	3.92	4.47

Table 3: The mucociliary transport rates in the study group

Side	Mean±SD (mm/min)	*P*
Paralyzed side	4.11±2.91	0.001
Non-paralyzed side	6.03±3.13	

SD=Standard deviation

Table 4: The mucociliary transport rates in the study group in accordance with House - Brackmann grade

House-Brackmann	Paralyzed side Mean±SD (mm/min)	*P*	Non-paralyzed side Mean±SD (mm/min)	*P*
Grade 2-3	3.98±2.75	>0.05	5.81±3.34	>0.05
Grade 4-5	4.26±3.17		6.30±2.93	

SD=Standard deviation

Table 5: Comparison of the study and the control groups for mucociliary transport rates

	Mean±SD (mm/min)	*P* (paralyzed side vs control)	*P* (non-paralyzed side vs control)
Paralyzed side	4.11±2.91	0.810	0.017
Non-paralyzed side	6.03±3.13		
Control	4.27±0.76		

SD=Standard deviation

On the other hand, MCT rates were not significantly different between the right and left sides of the control group ($P > 0.05$). MCT rates were not significantly different when the control group and paralyzed sides of the Bell's palsy patients were compared ($P = 0.810$) [Table 5]. However, MCT rate was statistically significantly faster in the nonparalyzed sides of Bell's palsy patients when compared to the controls ($P = 0.017$) [Table 5].

Discussion

In this study, rhinoscintigraphic evaluation of the Bell's palsy group demonstrated that the values obtained in the paralyzed side of the patients were similar to the values obtained in the control group. MCT rate was statistically significantly faster on the nonparalyzed sides of the Bell's palsy patients when compared to both paralyzed sides of the patients, and the control group.

Nasal mucosa is rich in vasculature and glandular tissue, which play important roles in the mucus layer and MCT. Any factor affecting mucus layer may lead to alteration of nasal mucociliary clearance function. Nasal glandular secretion is important for the nasal mucociliary clearance.

Functional problems seen in the lacrimal gland in patients with Bell's palsy may be also seen in the nasal glands. Change in the mucous secretion and content may alter MCT. Similar to the most of the studies in literature, we placed Tc-99m MMA on the head of the inferior turbinate for the rhinoscintigraphic study. By this method, the transport rate and the behavior of the nasal mucosa may be observed as a whole. Moreover, this method eliminates the influence of individual differences such as the palatal length and the positioning of the test substance. Radiation exposure may be considered as the disadvantage of this method, but the patients are exposed only to 1.2 mrad radiation, which is 200 mrad in the chest X-ray.[11] The effect of age on the MCR is controversial. Kao *et al.* found MCT rate as 4.4 mm/min in patients younger than 60 years of age and 4.8 mm/min in the ones older than 60 years of age.[12] The difference was not statistically significant. MCT rates were found similar in males and females in the study of Kao *et al.*, similar to our study.[12]

Rhinoscintigraphy has been used to analyze MCT rate since it is a cheap, easy, noninvasive, sensitive, and objective test. In this study, MCT rate was found as 4.2 mm/min in the normal control subjects. There is no consensus in literature for normal MCT values.[12,13] Quinlan *et al.* reported MCT rate as 7 mm/min and Kao *et al.* reported it as 4.4 mm/min in the normal individuals.[12,14] Englender *et al.* found mean nasal MCT rate as 6.8 mm/min.[9] Nuutinen reported that MCT rate could be asymmetrical in normal subjects, possibly in relation with the nasal cycle;[15] however, this was not the case in our control group [Table 2].

When this study was planned, it was hypothesized to find a slower MCT rate on the paralyzed side due to parasympathetic denervation. As expected, we found statistically significantly slower MCT rate in the paralyzed sides of the patients with Bell's palsy. On the other hand, MCT rate on the paralyzed side was slower when compared to the control group, but this difference was not statistically significant. The most striking result of our study was a significantly faster MCT rate at the nonparalyzed side of the face in patients with Bell's palsy when compared to the control group. Such a finding has not been reported earlier in literature. It has been supposed that decreased mucus production and dryness in the paralyzed site may be detected by the trigeminal nerve fibers and transmitted to the central nervous system. Central nervous system may increase parasympathetic tone to overcome this. Possibly, parasympathetic tone and hence MCT rate increases in the nonparalyzed side due to stimulation by the central nervous system, but MCT rate cannot be increased in the paralyzed side since parasympathetic innervation is decreased or lost there. Another explanation may be asymmetry of the MCT in left and right nostrils in patients with nasal pathologies and in healthy individuals,[15] although this was not the case in our control group. Deterioration of sympathetic – parasympathetic tone in the nasal cavity may be another possible explanation.

This study has some limitations. First, the number of the patients and the controls included is small. Second, the Bell's palsy patients were not followed up to determine whether the asymmetry between the right and left sides recovered after recovery of the disease. The prognostic significance of decreased MCT rate on the paralyzed side was not also studied since the patients were not followed up.

Conclusion

The findings of our study indicated for the first time that parasympathetic functions of the nose might be affected in patients with Bell's palsy. Further studies are needed to investigate the mechanism of increased MCT rate in the nonparalyzed sides of the patients with Bell's palsy, and whether MCT rate returns to normal values after recovery of facial paralysis on the affected side.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Escudier E, Bernaudin JF, Bernaudin P, Reinert P, Canet J, Boucherat M, *et al.* Stroboscopic study of the respiratory mucosal ciliary beat frequency. Ann Otolaryngol Chir Cervicofac 1984;101:150-2.
2. Yergin BM, Saketkhoo K, Michaelson ED, Serafini SM, Kovitz K, Sackner MA. A roentgenographic method for measuring nasal mucous velocity. J Appl Physiol Respir Environ Exerc Physiol 1978;44:964-8.
3. Lund VJ. Anatomy of the Nose and Paranasal Sinuses. In: G.K. Alan, ed. Scott Brown's Otolaryngology Vol. 1. Oxford: Butterworth-Hienemann; 1997. p. 1-30.
4. Randall KJ. The nose and paranasal sinuses. In: Lee KJ, editor. Essential Otolaryngology Head and Neck Surgery. 8th ed. New York: McGraw-Hill; 2003. p. 682-723.
5. Holland J. BellMcGraw-Hill; 2003. p. 682-723.008;01:1-8.
6. Morris AM, Deeks SL, Hill MD, Midroni G, Goldstein WC, Mazzulli T, *et al.* Annualized incidence and spectrum of illness from an outbreak investigation of Bell's palsy. Neuroepidemiology 2002;21:255-61.
7. House JW, Brackmann DE. Facial nerve grading system. Otolaryngol Head Neck Surg 1985;93:146-7.
8. Di Giuda D, Galli J, Calcagni ML, Corina L, Paludetti G, Ottaviani F, *et al.* Rhinoscintigraphy: A simple radioisotope technique to study the mucociliary system. Clin Nucl Med 2000;25:127-30.
9. Englender M, Chamovitz D, Harell M. Nasal transit time in normal subjects and pathologic conditions. Otolaryngol Head Neck Surg 1990;103:909-12.
10. Sun SS, Hsieh JF, Tsai SC, Ho YJ, Kao CH. Evaluation of nasal mucociliary clearance function in allergic rhinitis patients with technetium 99m-labeled macroaggregated albumin rhinoscintigraphy. Ann Otol Rhinol Laryngol 2002;111:77-9.
11. Ahmed A. When is facial paralysis Bell palsy? Current diagnosis and treatment. Cleve Clin J Med 2005;72:398-401, 405.
12. Kao CH, Jiang RS, Wang SJ, Yeh SH. Influence of age, gender, and ethnicity on nasal mucociliary clearance function. Clin Nucl Med 1994;19:813-6.
13. Slater A, Smallman LA, Logan AC, Drake-Lee AB. Mucociliary function in patients with nasal polyps. Clin Otolaryngol Allied Sci 1996;21:343-7.
14. Quinlan MF, Salman SD, Swift DL, Wagner HN Jr, Proctor DF. Measurement of mucociliary function in man. Am Rev Respir Dis 1969;99:13-23.
15. Nuutinen J. Asymmetry in the nasal mucociliary transport rate. Laryngoscope 1996;106:1424-8.