IN VITRO STUDY OF SONIC AEROSOL TO MAXILLARY SINUSES TREATMENT

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INTRODUCTION

Aerosols are widely used in rhinology in France. However, in contrast with pneumology, the international literature contains very few reports of scientific and clinical studies in this field. Furthermore, no studies have hitherto demonstrated the efficiency of aerosol therapy in ENT pathologies. No studies have been performed to assay the amount of active substance penetrating the maxillary sinuses. Nevertheless, simultaneous use of sound waves with pneumatic aerosol generators has been recommended since the end of the 1950 to ensure maximum penetration into sinuses (1). The aim of this study was to determine the effects of sound waves on aerosol (sonic aerosol) deposition in a model of maxillary sinuses. A first step was carried out to determine the optimal sound frequency and a second step was carried out to test the optimized sound on an aerosol of gentamicin in a plastinated head model.

MATERIAL AND METHODS

Step 1: An ENT anatomical model was built (Figure 1). An Atomisor NL11 nebulizer (DTF, France) loaded with NaF solution at 2.5% was used with a sound generator. A sinus pump was used to simulate the patient's breath. After 15 min of nebulization, NaF deposited in maxillary sinus model was assayed by electrochemical method. Different sound frequencies (0, 50, 100, 500, and 1000 Hz) were used to evaluate the influence of the frequency on particle deposition into maxillary sinus.

Step 2: Plastination, a technique used in anatomical preservation, was selected as the model providing the greatest possible degree of information in this study. It involves a standard human specimen in which the maxillary sinus ostium may be exposed. Endoscopic controls and CT scans were performed for each plastinated head. An aminoglycoside antibiotic, gentamicin (80 mg/4 mL), was used as the marker. Gentamicin aerosol was generated first with the optimized sound and secondly without sound addition. The nebulizer was operated for 10 min. Gentamicin was collected from the maxillary sinuses by flushing with physiological serum using a syringe containing 1 mL for the right sinus and 1 mL for the left sinus. The sinuses were flushed 4 times using

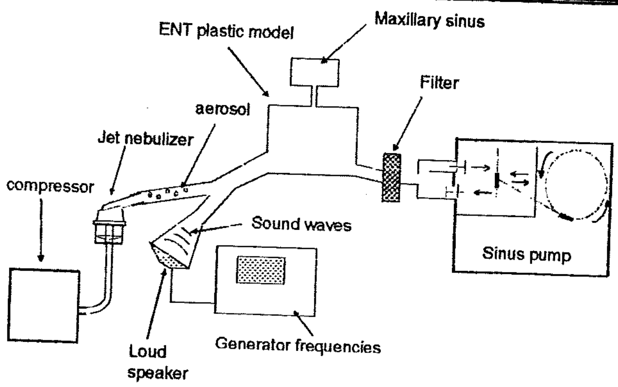

Figure 1. Experimental set-up to optimize the sound frequency on aerosol deposition into maxillary sinus.

the same physiological serum. The liquid recovered from the right and left sinuses was assayed by the bacteriology laboratory.

After recovery, the head was washed with tap water so as to remove all traces of residual gentamicin. Gentamicin was assayed by fluorescence polarization immunoassay method (FPIA). 44 gentamicin nebulizations were performed for each side, 22 without sound and 22 with sound, giving a total of 88 gentamicin assays.

Figure 2. Experimental set-up to measure aerosol gentamicin deposited into maxillary sinuses using a plastinated head model.

RESULTS

Figure 3 shows the influence of the sound frequency on NaF aerosol deposition into maxillary sinuses. The optimal frequency was obtained at 100 Hz.

The mean values for gentamicin collected from the maxillary sinuses after nebulization were: <0.27 mg/L for aerosol without sound (44 tests on left and right) and 0.75 mg/L for aerosol with sound (44 tests on left and right).

In comparison with the aerosol produced without sound, the addition of the optimized sound increased by a factor of at least 3 the quantity of gentamicin deposited into maxillary sinuses (Figure 4 and Figure 5). This difference was statistically significant ($p<0.001$).

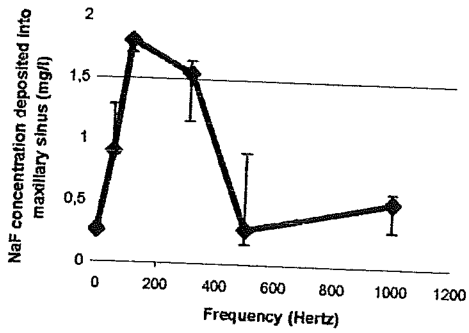

Figure 3. Sound frequency influence on the deposition of NaF aerosol generated by Atomisor NL11 nebulizer into a maxillary sinus model (n=6 for each point).

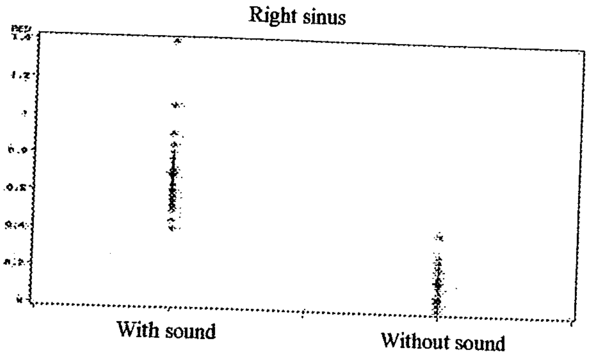

Figure 4. Gentamicin concentration values in the right maxillary sinus using a jet nebulizer Atomisor NL11 with optimized sound and without sound.

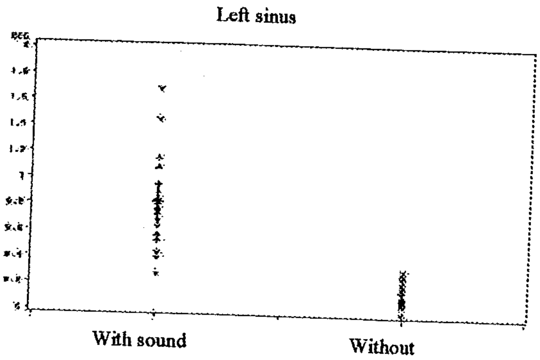

Figure 5. Gentamicin concentration values in the left maxillary sinus using a jet nebulizer with optimized sound and without sound.

CONCLUSION

The optimal effect of sound on aerosol deposition into maxillary sinuses was obtained with sound frequency at 100 Hz. This optimized sound tested with gentamicin aerosol delivered by an Atomisor NL11 nebulizer in a plastinated model showed an increase by a factor 3 of aerosol deposition into maxillary sinuses in comparison with aerosol generated without sound.

REFERENCES

1. Guillerm, R., Badre, R., Flottes, L., Riu R., and Rey, A. (1959), "A new method of aerosol penetration into the sinuses," *Press Med.*, 27, 1097-1098.