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Nasal changes following immersion in chlorinated water

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SUMMARY

Ten swimmers had rhinomanometry, mucociliary clearance time and lung function tests performed pre and post swimming in a chlorinated swimming pool. No evidence of nasal irritation or adverse effects on nasal function were obtained.

INTRODUCTION

Irritation of the conjunctiva is a well known hazard of swimming in chlorinated pools. Coughs, sore throats and wheezing due to lower respiratory tract obstruction have also been recognised (Nastachin and Puckering, 1979). Complaints of nasal obstruction, sneezing or itching are also common and presumably due to nasal mucosal irritation. This trial was set up to investigate changes in nasal function before and after immersion in chlorinated water.

SUBJECTS AND METHODS

A cohort of ten swimmers, eight males and two females whose ages ranged from 13-26, were randomly selected from a squad of 40, and studied. Each was a leading member of Warrender Swimming Club in Edinburgh and on average swims for two hours per day. Each individual did not swim for two weeks prior to the trial so that a fresh exposure to the water with hopefully larger changes in nasal function could be demonstrated. A simple questionnaire asking about nasal symptons or atopy was filled in at the beginning of the study. Anterior rhinoscopy excluded any obvious abnormality, e.g. nasal polyps or grossly deviated nasal septum. In an atmosphere of constant temperature and humidity at the poolside; rhinomanometry, lung function tests and mucociliary clearance were performed. Posterior rhinomanometry using a Mercury NRM2 rhinometer was performed with five consecutive respirations at a fixed pressure of 150 pascals. Mucociliary clearance was measured by the saccharin clearance test (Anderson et al., 1974). A small piece of saccharin was placed 1 cm behind the anterior end of the inferior turbinate and the time before the sweet taste was noted by the subject in the oropharynx, was recorded. The timing was terminated after 20 minutes and the subject was instructed not to sniff or hawk during this period. A simple lung function respirometer was then used to record the FEV1 and FVC. Each swimmer then undertook vigorous surface swimming - with "tumbleturns" at each

each end of the pool – for two hours. The rhinomanometry, mucociliary clearance and lung function tests were repeated on cessation of exercise. The study was conducted and the subjects questionned on nasal symptons, at the Royal Commonwealth Swimming Pool in Edinburgh in which the chlorinating agent is sodium hypochlorite in a cencentration of three parts million. The pH of the water is a constant 8 and the temperature is 80°F. The air temperature is 90°F at roof level (30 feet above water level) and 82°F at water level. All these recordings were checked before and after the trial. Air conditioning in the pool is maintained by external air vents; no recycling of air occurs. The subjects were controlled against themselves as only individual comparisons and no comparisons between swimmers were made. The effect of the nasal cycle and other variables such as menstrual cycles, etc., were minimised by allowing only two hours between the tests.

RESULTS

The two hour swim did not produce symptons of nasal obstruction or rhinorrhoea in any of the swimmers. They all wore goggles to avoid chlorine induced conjunctivitis. Seven swimmers admitted to some form of allergic disorder. Five had a history of hay fever, one of eczema and one of both asthma and hay fever. The results of posterior rhinomanometry and mucociliary clearance are shown in Tables 1 and 2. The nasal resistance increased in three subjects, but decreased in the other seven. The changes in resistance were not statistically significant ($p > 0.5$, Student's t-test). The mucociliary clearance was increased in six subjects, decreased in two and in the other two was prolonged beyond 20 minutes both before and after swimming. There was no statistical significance in these results. The lung function tests showed no change as a result of swimming. This test was performed to exclude respiratory changes influencing nasal resistance or vice versa.

Table 1. Nasal Resistance at 150 Pascals.

subject	pre swimming (Pascal sec/ccs)	post swimming (Pascal sec/ccs)
1	0.36	0.30
2	0.607	0.943
3	0.382	0.198
4	0.387	0.124
5	0.280	0.211
6	0.333	0.302
7	0.494	0.434
8	0.34	0.465
9	0.36	0.245
10	0.669	0.914

Table 2. Mucociliary Clearance.

subject	pre swimming (minutes)	post swimming (minutes)
1	6	7
2	8	11
3	7	10
4	8	18
5	18	17
6	14	9
7	4	5
8	>20	>20
9	>20	>20
10	4	10

DISCUSSION

Despite chlorine's irritative effects on the conjunctiva, this paper does not support the hypothesis that chlorinated water produces a similar acute reaction in the nose. The swimmers were subjected to exposure to the chlorinated water by tumble-turns after swimming each length of the pool. Swimmers who are constantly under the water, e.g. synchronised swimmers, tend to wear a nose clip to prevent ingress of water into the nose. These results refer only to acute changes of the nasal mucosa, but any chronic changes of initiative rhinitis were excluded by the normal nasal symptom questionnaire and clinical examination.

The decrease in nasal resistance in seven subjects was the opposite to our expected result that the chlorinated water had an irritant effect on the nose. The decreased resistance presumably reflects the physiological effect of exercise producing a clear nasal airway.

The relatively high incidence of apparent allergy related problems in this small group (50%) may reflect the current trend for these patients to overcome their disability with vigorous exercise, particularly swimming. An alternative explanation is that the symptoms of chronic rhinorrhoea may be confused with "hay fever". Allergic rhinitis has been shown to increase the mucociliary clearance time (Hady et al., 1983) but in the present study there was no statistical difference between those subjects claiming a history of atopy and those without such a history.

Sakakura et al. (1985) measured the average nasal saccharin time in 85 healhty controls (aged 15–59) as 13.7 ± 8.9 minutes. We chose 20 minutes as our upper limit and the finding of two patients with saccharin clearance time above this agrees with Proctor's (1983) findings that 20% of all groups in the population exhibit prolonged mucociliary clearance times. The increase in the mucociliary clearance time measured in six subjects did not reach statistical significance but may indicate a degree of ciliary stasis secondary to exposure to the chlorinated water.

The chlorinous smells in swimming pools are caused not by chlorine gas but by nitrogen trichloride and to a lesser extent monochloramine and chloroform, all of which are irritants. These are produced when free chlorine (in solution as hypochlorous acid) reacts with organic contaminants such as urine and sweat, introduced into the pool by bathers (Penny, 1983). The fact that our tests were carried out in the early morning before any such contaminants would have accumulated, lessened the likelihood of adverse reactions in our subjects. The venting of air from the pool to the outside, prevents the accumulation of irritants reported in some pools (Penny, 1983).

The apparent effect of nasal obstruction after swimming may, in part, be attributed to changes in the temperature and humidity on leaving the poolside atmosphere and going on outside.

From our trial in this selected group there is no evidence that swimming in a chlorinated pool has any acute effects on the nose. None of the swimmers noted a change in nasal function immediately after the study but felt that swimming in a different pool always produced nasal blockage. The Royal Commonwealth Pool has closely regulated levels of chlorine, pH and temperature which undoubtly mitigate against bodily upset.

CONCLUSION

A controlled trial of ten swimmers was set up to study the acute effects of swimming in a chlorinated pool on the nasal mucosa. There does not appear to be any objective evidence from this trial to suggest that sodium hypochlorinated water in a concentration of three parts per million, has any short term effect whatsoever on nasal mucosa, despite fairly prolonged immersion.

RÉSUMÉ

Dix sujets ont nagé dans une piscine chlorurée pendant deux heures et ont été soumis avant et après à la rhinomanométrie et aux épreuves pour évaluer l'activité mucociliaire et la fonction des poumons. On n'a observé aucune évidence d'irritation nasale, ni aucun effet défavorable sur la fonction nasale. On conclue donc que la présence de 3 parties par million du chlore dans l'eau de la piscine laisse la fonction nasale aussi bonne qu'auparavant.

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