Pulmonary function of adult Nigerians placed on intermaxillary fixation

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Abstract

Objective The use of intermaxillary fixation to treat jaw fractures is a procedure still widely carried out in third world countries either because of the unavailability of miniplates to treat jaw fractures or due to their expensive nature. The purpose of this study was to determine the effects of intermaxillary fixation on ventilatory functions of adult Nigerians so as to establish baseline data for future comparisons in Africans.

Methods One hundred and forty-eight subjects comprising 120 (81%) males and 28 (19%) females were studied. Their age ranged from 18 to 60 years with a mean age of 24 years. The patients' pulmonary function tests were done using a vitalograph spirometer to measure FEV₁ and FVC immediately postoperatively, 7 days postoperatively, immediately after removal of IMF, and on the 7th day of IMF removal. The mean values of the FEV₁ and FVC at 7 days postoperatively were significantly higher than the values obtained immediately postoperatively ($p < 0.001$). The FEV₁ and FVC values obtained immediately postoperatively and 7 days postoperatively were significantly lower than the values obtained immediately after removal of the wires ($p < 0.001$).

Results The results also show that there was a further increase of the mean values of FEV₁ and FVC on the 7th day of wires removal.

Conclusion It was observed that there was a reduction of pulmonary function values due to airway obstruction following IMF. The reduction was 5.7% to 8.9% in males, and 5.0% to 6.9% in females compared to the normal values established for adult Nigerians. In addition, the average of the mean FVC values immediately postoperatively and 7 days postoperatively were 87.9% and 90.9% for males and 91.7% to 93.6% for females respectively of their normal values obtained from the FVC values on the 7th day of wire removal.

Keywords Pulmonary function · Adult · Nigerians · Intermaxillary fixation

* FEV - Forced Expiratory Volume, IMF - Inter Maxillary Fixation, TLC - Total Lung Capacity

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Introduction

A large proportion of maxillofacial fractures in the third world countries still require the application of intermaxillary fixation (IMF*) to aid stability of the reduced fragments [1–5]. It is the traditional method of treating fractures of the jaws despite reports of hazards to the airway resulting from the procedure [6,7]. Until the advent of miniplate osteosynthesis, IMF* was also the versatile method widely used in the management of maxillofacial fractures in advanced countries. The general principles of

treatment of fractures of the mandible do not differ essentially from the treatment of fractures elsewhere in the body. The fragments are reduced into a good anatomical position and immobilized until such a time when bony union occurs [8]. Intermaxillary fixation is also useful as a pre-surgical solution for weight reduction in preparation for bariatric surgery [9].

It is well recognised that such fixation increases the risk of airway obstruction, which is greatest during the hours immediately following anaesthesia [1,3]. IMF* in a patient with a complete or near-complete dentition can virtually exclude the

mouth as one effective route for adequate respiration [10]. The resistance of the mouth to airflow following IMF* is greater than that of the nose [4].

Studies have been carried out to establish normal pulmonary function values for adult Nigerians [11,12]. The range of normal values show that the pulmonary function values of males are higher than that of females. The mean values of total lung capacity (TLC*) and all its subdivisions are also greater in males than in females; but when the ratios are expressed as percentages of the TLC*, they are similar in both sexes showing that the ventilatory patterns are similar [11,12].

The purpose of this study was to determine the effects of IMF* on the ventilatory functions in adult Nigerians so as to establish baseline data for future comparisons in Africans.

Materials and methods

This prospective study was carried out from September 2002 to October 2005 on consecutive oral and maxillofacial surgery patients that required IMF* for the treatment of jaw fractures and as part of weight reduction programme at the University of Benin Teaching Hospital Benin City, Nigeria. The Ethics Committee of the Hospital gave an approval to carry out the study. A verbal and signed consent were also obtained from each of the patients.

The subjects were selected after careful oral interviews and clinical examinations. The patients who met the following criteria were studied: negative history of heart and or respiratory diseases either past or present, negative history of smoking, either past or present, negative history of working in a sawmill, a cement factory and in a bakery. Any of these patients placed on IMF* for the treatment of jaw fractures or as part of weight reduction programme were also included in the study. However, patients were excluded from the study if they had a positive history of any of the above or any case of jaw fractures complicated by multiple injuries

All the ages of the patients were approximated to the nearest birthday. The patients were weighed in kilograms in light clothes and without shoes using the Seca weighing machine (Medical Scales and Measuring System, Seca Ltd., Birmingham). Their heights were measured in centimetres without shoes. The forced expiratory volume in one second and the forced vital capacity and were recorded in litres using a vitalograph spirometer machine.

All the gas volumes were measured at ambient temperature and pressure. It was decided not to correct the gas volumes to body temperature and pressure, saturated with water vapour at body temperature because it was unlikely that the large volume of air ventilated during vital capacity estimation will reach 37°C fully saturated with water vapour [11].

All the tests were carried out with the patients seated after the purpose of the

Table 1 Age and gender distribution of the subjects

Age groups (Years)	Males		Females		Total	
	n	%	n	%	n	%
20–24	64	43	8	5	72	48
25–29	36	24	13	9	49	33
30–34	20	14	7	5	27	19
Total	120	81	28	19	148	100

Table 2 Measurement of FEV₁/FVC after operation (after 1 hour under LA and between 24–36 hours under GA)

Age groups	FEV ₁		FVC	
	Male	Female	Male	Female
	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD
20–24	2.16 ± 0.42	1.73 ± 0.70	2.98 ± 0.48	2.38 ± 0.22
25–29	2.32 ± 0.44	1.86 ± 0.27	3.24 ± 0.21	2.59 ± 0.08
30–34	2.86 ± 0.18	1.89 ± 0.42	3.35 ± 0.06	2.30 ± 0.04

Table 3 Measurement of FEV₁/FVC 7days postoperatively

Age groups	FEV ₁		FVC	
	Male	Female	Male	Female
	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD
20–24	2.29 ± 0.43	1.81 ± 0.48	3.06 ± 0.41	2.42 ± 0.22
25–29	2.64 ± 0.37	2.02 ± 0.25	3.35 ± 0.32	2.67 ± 0.21
30–34	3.15 ± 0.38	1.91 ± 0.42	3.48 ± 0.84	2.32 ± 0.52

test was explained and the method of testing demonstrated to them. Each of the patients was instructed to wrap his/her lips tightly round the disposable mouthpiece to prevent leaks around it. A nose-clip was applied to prevent air from escaping through the nostrils during the manoeuvres and they were instructed to take in a deep breath, and then exhale into the mouthpiece as deeply and as fast as possible while being encouraged. For each spirometric study, the test was repeated after an interval of 5 to 10 minutes to allow the patient to regain his or her equilibrium [11]. The exercise was repeated 3 times and the maximum tracing was taken.

Four different spirometric studies were carried out as follows:

- Postoperatively, (this was between 24–36 hours if treatment was carried out under general anaesthesia to allow for recovery and reduction of secretions, or after one hour if treatment was carried out under local anaesthesia).

- Seven days postoperatively with the wires still in place.
- Immediately after removal of IMF*.
- Seven days after the removal of IMF*.

At the end of all measurements, the patients were grouped according to age. The mean FEV₁* and FVC obtained postoperatively, 7 days postoperatively, immediately after removal and 7 days after removal of wires, were calculated. The results were expressed as mean FEV₁* ± SD, FVC ± SD. The student's t-test was used to determine the significance of difference between the means of the various FVC values. In addition, the mean FVC values of females on IMF* for weight-reduction were compared with the values of those on IMF* for fractures. The mean FVC values of this study were also compared with the mean FVC values obtained for normal adult Nigerians [12] using student's t-test. Statistical analysis was done using Microsoft Office Excel® 2003 and SPSS® version 10 computer packages, and P-values of less than 0.05 was considered as significant at 95% confidence level.

Results

One hundred and fortyeight (148) subjects were studied. Of these, 28 (19%) were females while 120 (81%) were males with a male to female ratio of 4.5:1. All the males had IMF* as a result of jaw fractures following Road Traffic Accidents (RTA), whilst amongst the 28 females studied, 8 (5%) were on IMF* as a result of jaw fractures following RTA and 20 (14%) were on IMF* as part of weight reduction programme. Table 1 shows the age and gender distribution of the patients. Tables 2, 3, 4 and 5 show the mean FEV_1 and FVC values postoperatively, 7 days postoperatively, the day of removal of IMF* and 7 days of removal respectively.

Discussion

This study shows that the presence of obstructive impairment of respiration following intermaxillary fixation was manifested by a significant decrease in FVC values immediately postoperatively and 7 days postoperatively when compared with the values for adult Nigerians obtained from the studies of Femi-Pearse and Elebute [12]. It was also observed that the FVC values returned to or close to the normal values for adult Nigerians on the day of IMF* removal. There was a further increase in FVC values on the 7th day of IMF* removal from the values recorded on the day of removal. This further increase could be accounted for by the respiratory muscles regaining strength with the resumption of normal breathing and feeding habits after the removal of the IMF*.

The mean FVC values for the males in this study on the 7th day of removal of IMF* in the 25–29 years and 30–34 years age groups was higher than the figures obtained for normal adult Nigerians [12]. This could be due to the fact that most of the patients in this study were involved in farming activities whereas, in the study of Femi-Pearse and Elebute [12], the subjects were mainly employees of the Nigerian Railway Corporation working as accounting and printing executives (there were no engine drivers, firemen or foundry workers amongst the group), medical students, nurses and civil servants.

The FEV_1 and FVC values obtained immediately post IMF* and 7 days post IMF* were statistically significantly

Table 4 Measurement of FEV_1 /FVC on the day of removal of IMF

Age groups	FEV_1		FVC	
	Male	Female	Male	Female
	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD
20–24	2.62 $\pm$ 0.20	2.07 $\pm$ 0.22	3.38 $\pm$ 0.37	2.56 $\pm$ 0.30
25–29	2.86 $\pm$ 0.41	2.17 $\pm$ 0.18	3.57 $\pm$ 0.20	2.77 $\pm$ 0.10
30–34	3.35 $\pm$ 0.26	1.98 $\pm$ 0.26	3.64 $\pm$ 0.07	2.39 $\pm$ 0.21

Table 5 Measurement of FEV_1 /FVC after 7 days of removal of IMF

Age groups	FEV_1		FVC	
	Male	Female	Male	Female
	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD
20–24	2.82 $\pm$ 0.30	2.23 $\pm$ 0.14	3.41 $\pm$ 0.37	2.66 $\pm$ 0.25
25–29	2.96 $\pm$ 0.39	2.27 $\pm$ 0.13	3.68 $\pm$ 0.20	2.82 $\pm$ 0.02
30–34	3.69 $\pm$ 0.12	2.24 $\pm$ 0.18	3.80 $\pm$ 0.07	2.45 $\pm$ 0.20

Table 6 The mean FVC values of female subjects put into IMF for weight-reduction compared with those of female fracture cases

Age groups (years)	Fractured cases				Weight-reduction cases			
	FVC Immediately Postoperatively	FVC 7 Days Postoperatively	FVC Day of Removal	FVC 7th Day of Removal	FVC Immediately Post IMF	FVC 7 Days Post IMF	FVC Day of Removal	FVC 7th Day of Removal
20–24	2.37	2.42	2.56	2.65	2.49	2.54	2.55	2.67
25–29	2.41	2.47	2.78	2.83	2.53	2.58	2.76	2.82
30–34	2.31	2.35	2.42	2.46	2.42	2.47	2.38	2.44

reduced when compared with the values of Femi-Pearse and Elebute [12]. This observation can be accounted for by the studies of Williams and Cawood [13] and Kohno et al. [4] who stated that there is a significant decrease in airway obstruction when the teeth are placed in occlusion. Furthermore, the immediate postoperative pain may reduce effective respiratory manoeuvres, which can have effect on FEV_1 and FVC values obtained during this period. This is supported by the observation made between the FVC values of weight-reduction cases and those of fracture cases in the females as shown in Table 6.

The pulmonary function values of the patients as indicated by FEV_1 and FVC increased appreciably on removal IMF* because with their removal, the increased resistance to flow was eliminated by free passage of air through the mouth and nose. Nonetheless, the pulmonary function of the subjects increased with age when IMF* was in place and after

removal. This agrees with the studies on normal adult Nigerians by Femi-Pearse and Elebute [12] in which pulmonary function values increased with age upto 34 years before it fell again as age increases. It was also observed that the pulmonary function increased with anthropometric measurements such as height and weight as it occurred in the study of Femi-Pearse and Elebute [12]. Our study also showed that the pulmonary function of females is significantly lower than that of males. In the 20–24 years and 25–29 years age groups, the pulmonary function is 22% higher in males than in females, while it is 33% higher in the 30–34 years age group. In the females, their pulmonary function increases with age upto 29 years after which it begins to decline, while it increases upto 34 years in the males before declining. The early decline of pulmonary function in Nigerian females can be attributed to the fact that, at about 29 years, the females begin to settle down

fully into married life, and are no longer actively involved in physical outdoor activities. The 22% difference in pulmonary function values between males and females in this study is in agreement with the findings of Guyton [14].

Conclusion

This study showed that there was a reduction of pulmonary function values due to airway obstruction following IMF*. The reduction was 5.7% to 8.9% in males, and 5.0% to 6.9% in females compared to the normal values established for adult Nigerians. In addition, the average mean FVC values immediately postoperatively and 7 days postoperatively were 87.9% and 90.9% for males and 91.7% to 93.6% for females respectively of their normal values obtained from the FVC values on the 7th day of wire removal. The pulmonary function values of patients placed on IMF* can be measured at intervals of time as part of their postoperative management. This will show any development of respiratory complication or disease during the course of IMF*

particularly in patients who had pulmonary diseases that may not have been detected before surgery.

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