Original Article

The effects of maxillomandibular fixation on ventilatory functions in adult Nigerians

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ABSTRACT

Background: Maxillomandibular fixation (MMF) is a routine procedure in maxillofacial surgery in developing countries. **Aim:** The aim of this study was to determine the pulmonary functions (forced expiratory volume in 1 min [FEV_1], forced vital capacity [FVC], and peak expiratory flow rate [PEF_R]) of adult Nigerian patients who had MMF and to find the associated changes in pulmonary functions in the postoperative period vis-à-vis pulmonary function tests among healthy adult Nigerians. **Settings and Design:** The study setting was the Oral and Maxillofacial Surgery Department of a Teaching Hospital in Northern Nigeria, and the study design was prospective hospital based. **Materials and Methods:** One hundred and six patients and 106 controls were recruited between January 2011 and December 2012. Information was obtained using a questionnaire. All study participants had their baseline lung functions measured; the treatment group in addition had their postoperative daily lung function parameters measured for the 1st week and then weekly for the next 5 weeks. **Statistical Analysis:** Statistical analyses were performed using the Statistical Package for Social Sciences (version 16, SPSS Inc., Chicago, IL, USA). The mean and standard deviation values of physical characteristics and ventilatory functions were determined in both men and women. The mean values were compared using Student's *t*-test. Statistical significance was inferred at $P \leq 0.05$. **Results:** One hundred and seventy males and 42 females participated in the study. The control group had a mean age of 30.25 ± 9.05, weight 64.08 ± 9.90, height 1.67 ± 0.10, body mass index (BMI) 23.32 ± 3.07, basal FVC 3.70 ± 0.71, basal FEV_1 3.16 ± 0.54, and basal PEF_R 8.35 ± 1.62. For the treatment group, the mean age was 30.68 ± 8.23, weight 64.91 ± 9.96, height 1.66 ± 0.10, BMI 23.21 ± 3.14, basal FVC 3.72 ± 0.69, basal FEV_1 3.14 ± 0.51, and the basal PEF_R 8.18 ± 1.61. **Conclusion:** The postoperative mean FVC, FEV_1, and PEF_R values drop significantly by more than 50% when compared to the preoperative values in the first postoperative week with the nadir on the second postoperative day in the patients with MMF.

Keywords: Adult Nigerians, maxillofacial surgery, prospective studies, respiratory function tests

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INTRODUCTION

Maxillomandibular fixation (MMF) following reduction of jaw fractures, surgical correction of jaw deformities, and bone grafting is a routine procedure in oral and maxillofacial surgery[1], and it

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is still being carried out in many maxillofacial centers in the third world countries in spite of its obsolete nature. This is because conventional wire-based fixation using eyelets or multiple ligatures in association with arch bars creates good quality MMF despite its many disadvantages such as difficulty in breathing in the immediate postoperative period in most patients.[2] Some other authors[3-5] have also shown that respiratory function was more severely affected by MMF in postoperative patients than in normal participants for which a reduction in the size of the airway by lingual or parapharyngeal edema or hematoma has also been found to be a contributory factor. Fisher[2] stated that the postoperative airway obstruction following the application of MMF may be caused by blood clots, vomitus, or laryngeal spasm resulting from irritation by blood or secretions following endotracheal intubation.

Most people breathe through the nose at rest but switch to mouth breathing with increasing need for ventilation because oral resistance is one-fourth of nasal resistance.[6] MMF itself would cause obstruction of the airway and Niinimaa *et al*.[7] had demonstrated an increase in airway resistance of the mouth when compared with the nose with MMF in place. Barton and Harris[8] showed that although the rate of reduction was minimal in a participant with missing teeth and malocclusion, the peak flow rate measured with the teeth clenched was reduced by more than 90% from the free-breathing value in a participant with complete dentition. Winstock[9] concluded that the mouth should be excluded as an effective route for adequate respiration after application of MMF in patients with complete dentitions. The nose may also not serve as an adequate airway immediately postoperatively because of edema, accumulation of mucus or blood clot, and/or the presence of a nasogastric tube.

In Nigeria, MMF still remains the main modality of management of patients with fractures involving the maxillofacial complex due to the relative affordability of the treatment procedures by patients and the fact that bone plates are scarce, expensive, and difficult to afford by the patients.

The dental and maxillofacial surgery department of the teaching hospital serves as a major referral center for patients in the Northwest geopolitical zone of Nigeria. The majority of the patients present with facial fractures which often require reduction and immobilization, complemented with MMF. An objective assessment of the effects of MMF on ventilatory functions is, therefore, necessary to establish a database, which is hitherto lacking on adult Nigerian patients as most of the work on the effects of MMF on ventilatory functions was carried out among Caucasians. This information is expected to herald the establishment of parameters of care and appropriate screening criteria for all patients requiring MMF.

MATERIALS AND METHODS

The study was a prospective hospital-based study spanning a period of 2 years (January 2011–December 2012). The study was approved by the Ethics Committee of the Teaching Hospital, and all patients gave written informed consent. Information collected included sociodemographic and anthropometric variables such as sex, age, height, weight, and basal metabolic index (BMI). Two sets of pro forma were designed for the test and control groups.

All consecutive patients seen or referred to the maxillofacial surgery unit of the teaching hospital, who were aged 18–65 years with jaw fracture that had radiologic or clinical evidence requiring MMF during the period under study, were recruited for the study. All such patients had to be free of other respiratory symptoms to be included in the study.

Pulmonary functions of randomly selected healthy controls within the hospital community were used as normal values. The controls were age and sex matched with the test sample.

Individuals who were obese[10] (body mass index [BMI] ³30 kg/m^2), calculated as weight (kg)/(height in m),[2] smokers, or had evidence of previous pulmonary diseases such as asthma, allergic bronchitis, and chronic obstructive pulmonary disease among others were excluded from the study. At the end of the study period, a total of 212 participants were recruited in the study comprising 106 patients and 106 healthy controls.

For the participants under MMF, the pulmonary function readings measured included forced vital capacity (FVC), forced expiratory volume in 1 min (FEV_1), and the peak expiratory flow rate (PEF_R). The equipment used was the spirometer (Spiro Lab III™ diagnostic spirometer series MIR009 with a color liquid crystal display) and Winspiro Pro PC Software-enhanced. This is in compliance with the American Thoracic Society and European Thoracic Society 2005 statement on spirometry. All readings were taken in the sitting position; readings were taken from patients a day preoperatively and then daily postoperatively for the 1st week. These were followed by weekly serial readings for the next 6 weeks (6th week being the day the MMF was removed). While the controls comprised 106 healthy Nigerian participants, who were age and sex matched with the test cases. They acted as reference values for the patients with MMF. The procedure used by Ali[11] in determining the ventilatory functions in nonsmoking healthy Nigerians was adopted to obtain a population of disease and disability-free nonsmokers.

All the participants standing heights were measured in meters without shoes and their body weights in kilograms (with clothes on) using the measuring scale (height and weight) manufactured by the Health O Meter, Inc. Bridgeview, Illinois, USA. All the tests were performed in the sitting position by a single researcher using the Spirolab 111 Diagnostic Spirometer with Winspiro Pro PC software. The sitting position was adopted because spirometries are usually performed in upright–seated position. Spirometry in standing position is also acceptable but usually avoided to reduce the risk of fall due to cough syncope during the procedure.[12,13]

The lung functions were measured by placing the mouthpiece of the Spirolab 111 in the patient's mouth, and the patient was required to blow maximally through the mouthpiece after deep and maximal inspiration with manual occlusion of the nares. The test procedure was demonstrated to the participants before the procedure. Each test was performed at least three times, and the best effort was selected.

Statistical analysis was performed using the Statistical Package for Social Science (version 16, SPSS Inc., Chicago, IL, USA). The mean and standard deviation values of physical characteristics and

ventilatory functions were determined in both men and women. Mean values were compared using Student's *t*-test. Statistical significance was inferred at $P \leq 0.05$.

RESULTS

The study population was made up of 106 patients and 106 controls. The majority of which were males of the Hausa–Fulani ethnic group and 45.3% of which had a tertiary level education [Table 1].

The mean anthropometric and the measured basal lung function parameters between the treatment groups and the controls were not statistically different Table 2.

There was a statistically significant drop of more than 50% of the preoperative mean FVC, FEV_1, and PEF_R values and the postoperative values in the first 2 days with the nadir on the 2nd day postoperative as shown in Figure 1 and Table 3.

DISCUSSION

MMF is a routine procedure in oral and maxillofacial surgery, and it is still a very common practice in Nigeria.[14,15] The majority of the studies carried out in the developed countries were done several decades ago due to the fact that the use of MMF has become obsolete.[14] However, this is not the case in our environment with over 65% of patients still being treated with MMF.[15,16]

The primary outcome of this study showed pulmonary function readings that were in favor of obstruction with a fall in the FVC, FEV_1, and PEF_R in the patients that had undergone MMF in the first postoperative week [Figure 1]. The lowest pulmonary function readings were observed on the second postoperative day with a statistically significant fall in FVC, FEV_1, and PEF_R of 57%, 58%, and 74%, respectively, which is in keeping with moderately severe obstruction.[17]

The fact that no statistically significant difference was found between the pulmonary function readings of the controls and the patients preoperatively [Table 2] may be attributed to the factors that result in the demand for increased ventilation which is normally associated with a shift in the breathing route from nasal to oronasal.[6] Niinimaa *et al*.[7] corroborated the above by postulating that oral breathing route may represent a vital alternative pathway in conditions involving retropalatal obstructions as seen in multiple mandibular fractures.

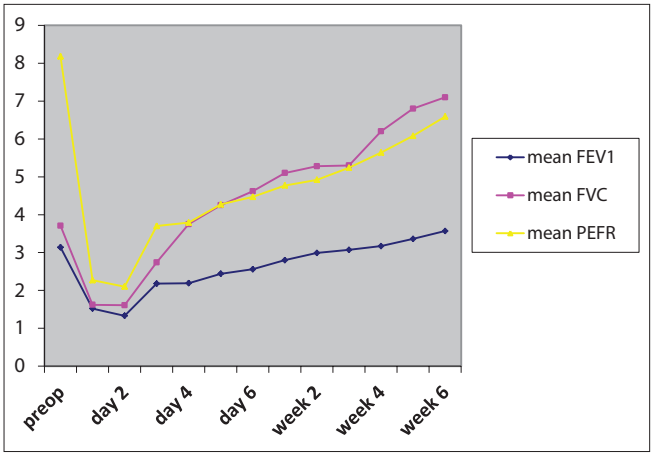

Figure 1: Measured lung function parameters in treatment group versus test days

Table 1: Sociodemographic characteristics of the study population and the indication for treatment

Characteristics	*n* (%)
Gender	
Male	170 (80.2)
Female	42 (19.8)
Ethnicity	
Hausa/Fulani	133 (62.7)
Yoruba	14 (6.6)
Ibo	29 (13.7)
Others	36 (17.0)
Level of education	
Uneducated	18 (8.5)
Primary	17 (8.3)
Secondary	43 (20.3)
Tertiary	96 (45.3)
Islamic	38 (17.9)
Occupation	
Artisan	8 (3.8)
Civil servant	69 (32.5)
Businessman	64 (30.2)
Student	50 (23.6)
Others	21 (9.9)
Indication for MMF	
Facial fractures	88 (83.0)
Orthognathic surgery	3 (2.8)
Tumor surgery	15 (14.2)

MMF: Maxillomandibular fixation

Table 2: Mean anthropometric and basal lung function parameters between the treatment group and the controls

Study group	*n*	Mean±SD	LTFEV	df	*P*	95% CI
Age (years)						
Normal	106	30.25±9.05	0.75	210	0.72	−2.78-1.91
Under MMF	106	30.68±8.23				
Weight (kg)						
Normal	106	64.80±9.90	0.93	210	0.52	−1.80-3.58
Under MMF	106	63.91±9.96				
Height (m)						
Normal	106	1.67±0.10	0.54	210	0.60	−0.12-0.03
Under MMF	106	1.66±0.10				
BMI						
Normal	106	23.32±3.07	0.98	210	0.80	−0.73-0.95
Under MMF	106	23.21±3.14				
Basal FVC						
Normal	106	3.70±0.71	0.59	210	0.80	0.21-0.17
Under MMF	106	3.72±0.69				
Basal FEV_1						
Normal	106	3.16±0.54	0.50	210	0.81	−0.13-0.16
Under MMF	106	3.14±0.51				
PEF_R						
Normal	106	8.35±1.62	0.79	210	0.43	−0.26-0.61
Under MMF	106	8.18±1.61				

LTFEV: Levene's test for equality of variance (significant at <0.05). *P* (significant at <0.05). SD: Standard deviation, MMF: Maxillomandibular fixation, FVC: Forced vital capacity, FEV_1: Forced expiratory volume in 1 min, PEF_R: Peak expiratory flow rate, CI: Confidence interval, BMI: Body mass index

Table 3: Lung function parameters versus day 2

Test day and lung function parameter	Mean	*n*	*t*	df	*P*	95% CI
Preoperative FVC	3.71	106	30.51	105	<0.001	1.96-2.24
Day 2 FVC	1.61	106				
Preoperative FEV_1	3.14	106	28.47	105	<0.001	1.68-1.94
Day 2 FEV_1	1.33	106				
Preoperative PEF_R	8.18	106	35.27	105	<0.001	5.73-6.41
Day 2 PEF_R	2.10	106				

CI: Confidence interval, FVC: Forced vital capacity, FEV_1: Forced expiratory volume in 1 min, PEF_R: Peak expiratory flow rate

In the immediate postoperative period, most of the patients with MMF have been known to complain of difficulty in breathing, difficulty in feeding, and oral toileting among others.[3,4] These symptoms have been attributed to blood clots, vomitus, or laryngeal spasm resulting from irritation by blood or secretions.[2] Respiratory insufficiency after jaw surgeries has also been attributed to airway obstruction from edema of the respiratory tract and difficulty expectorating sputum.[2-4] In most of the orthognathic surgeries, the risk of negative pressure pulmonary edema causes narrowing of the patient's upper airway space by moving the lower jaw backward and oozing from the wound which sometimes irritates the patient's larynx thereby initiating laryngospasm.[18] Summatively, these factors could be responsible for the fall in pulmonary function readings recorded in these patients with MMF. The findings of a decrease in the PEF_R values in this study were similar to what was reported by Kohno *et al*.[4] where the authors recorded a decrease in PEF_R of up to 52.1%. However, the reduction in the FEV_1 and FVC were higher than that reported by Amuwha and Saheeb[19] who documented a fall of 5.0%–8.9% this difference could be attributed to the fact that a Vitalograph was used in that study;[19] though the author did not state the specific model of the Vitalograph, the date of the study suggests it was a much older model as compared to the Spirometer (Spirolab III) used in the present study. That study[19] also did not consider the effect of MMF on PEF_R.

CONCLUSION

This study has documented that the postoperative mean FVC, FEV_1, and PEF_R values drop significantly by more than 50% when compared to the preoperative values in the first postoperative week with the nadir on the 2nd postoperative day in the patients with MMF.

We, therefore, recommend the need to monitor patients who have undergone MMF in the Intensive Care Unit for at least the first 48 h postoperatively to avoid the risk of respiratory failure in these patients. For facilities where an Intensive Care Unit is not available, there is a need for the provision of suction machines, pulse oximeters, intubation, and wire cutting sets as well as a qualified surgeon or anesthesiologist at the bedside of these patients at these critical periods.

The limitation of this study is the sample size. More studies with larger sample sizes are needed to validate the results of this study.

Future research directions should aim at assessing the use of steroids in the immediate postoperative period. This is to test its effectiveness in reducing the postoperative inflammation and airway edema and possibly to improve the observed significant drop in the pulmonary functions postoperatively.

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Conflicts of interest

There are no conflicts of interest.

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