The Cardiac Effect of Rapid Maxillary Expansion on Patients with Maxillary Deficiency

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Abstract

Objectives: The aim of this study is to evaluate the effect of rapid maxillary expansion (RME) on patients with maxillary deficiency to the cardiologic parameter.

Methods: A total of 12 patients (4 male and 8 females) with maxillary deficiency and bilateral cross-bite were selected to this study group. Before RME 24 h Holter monitoring of electrocardiography was used on patients. The prevalence analysis of arrhythmias, mean heart rate (MHR) and ventricular premature contraction (VPC) analysis was assessed over a 24-h period. Six months after achieving successfully expansion the Holter procedure was repeated again on patients.

Results: VPC count per day and MHR, detected on 24 h ambulatory electrocardiography, showed significant statistical difference was present in pre and post-treatment periods. (VPC; 54.25±69.56/day, 6.50±5.98/day p<0.05; MHR; 108±12/day, 82±8/day p<0.05: respectively).

Conclusions: The patients with maxillary deficiency may have been a potential with cardiologic abnormalities. The expansion may improve the cardiac problems by expansion. To our knowledge, this is the first report about this subject; this may be a basis for future large randomize studies.

Keywords: Maxillary deficiency, rapid maxillary expansion, cardiologic parameter.

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Introduction

Maxillary deficiency is a common cause of upper airway obstruction in children (1). Rapid maxillary expansion (RME) has become an accepted procedure for the treatment of maxillary arch constriction or maxillary width deficiency (2). Many years ago Timms mentioned that medical aspect of RME is very great as, neuromuscular, blood chemistry, lungs, heart, and endocrine systems (3).

The cardiac complications of upper airway obstruction have been investigated by many scientists by using supplemental diagnostic modalities such as chest radiography, electrocardiography, echocardiography and radionuclide ventriculography (4). The cardiovascular death constitute the highest number in the adult population of Western societies, but the pathological processes and risk factors associated with its development have been shown to begin during childhood (5). Previous studies showed that, cardiovascular risk factors are common in children (6, 7). Children with upper airway resistance can manifest with secondary growth impairment, neurocognitive deficits, and less often cardiovascular squeal (8).

In our knowledge, this is the first study in the literature about the evaluation of cardiologic parameters on before and after RME treatment. The aim of this study was to evaluate cardiologic parameters before and six months later after RME.

Materials and Methods

Patients

The present study was conducted in the department of orthodontics and cardiology. Twelve children consisting of 8 female and 4 male patients (mean ages 11.09 ± 2.02) year who were admitted to University Hospital Orthodontics outpatient were included. Each patient had severe maxillary width deficiency, bilateral cross bite, and no history of nasal disease. Children suffering from any cardiorespiratory or renal diseases, or having upper airway obstruction due to other causes like nasal polyps or adenotonsillar hypertrophy were excluded from the study. The study protocol was approved by the local ethics committee. Before the study was begun, for each child an informed consent form was signed by the guardians after receiving a full explanation of the
aim and design of this study. All patients underwent complete orthodontics and cardiologic examination.

An acrylic-bonded full tooth and a tissue-borne RME appliance containing a Hyrax screw (Dentaurum, Pforzheim, Germany) were positioned parallel to the second premolars and were used to correct the posterior cross bite. All the patients were instructed to activate the screw once a day (0.25mm). The expansion was completed when the occlusal aspect of the maxillary lingual cusp of the upper first molars contacted the occlusal aspect of the facial cusp of the mandibular first molars.

Pre-treatment period, complete blood cell count, routine biochemical blood tests, chest X-ray, ECG and echocardiography analysis were carried out. All measurements were performed by two experienced investigators, who were unaware of the subject’s clinical status.

Holter analysis

All children were assessed pre-operatively and at 6 month post-treatment with 24-h Holter monitoring of electrocardiography. All patients were in sinus rhythm throughout the recording period. Holter ECGs were analyzed by using the Del Mar Reynolds Pathfinder Holter system. In addition to the prevalence analysis of arrhythmias, mean heart rate (MHR) and ventricular premature contraction (VPC) analysis was assessed over a 24-h period and was performed according to European Society of Cardiology/ North American Society of Pacing and Electrophysiology guidelines.

Cast Analysis

Dental casts were taken before treatment (T1), 6 months after successful expansion (T2). Direct measurements of the maxillary casts were taken to the nearest 0.1 mm with Vernier calipers. Measurements were performed by one clinician (O.S.). The intercanine width was measured between the incisal tips of the canines and intermolar width is the distance between the mesiolingual cusp tips of the upper molars.

Statistical Analyses

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS, Chicago, Illinois, USA), version 15.0 software for Windows. Descriptive statistics were made and all data were expressed as mean standard deviation and % ratio. The qualitative values were compared by x2 test, the significance of difference quantitative values of pre- and post-operative groups were estimated by means of independent paired-sample t test. P-value of <0.05 was considered as statistically significant in all cases.

Table 1. ECG abnormalities of patients in pre- and post-treatment.

<table>
<thead>
<tr>
<th>ECG abnormalities</th>
<th>Pre-treatment number of patients</th>
<th>Post-treatment number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right axis deviation</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Right ventricular hypertrophy</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Right atrial hypertrophy</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Sinusal tachycardia</td>
<td>9</td>
<td>1</td>
</tr>
</tbody>
</table>

Results

Twelve patients (4 male and 8 female) were included in the study. Pre-treatment period ECG abnormalities detected were as follows: right axis deviation in three patients, right ventricular hypertrophy in one patient and right atrial hypertrophy in one patient, sinusal tachycardia in nine patients during 24-h ambulatory echocardiography. 3 patients did not have any ECG abnormalities. 6 months after RME it was seen that the sinusal tachycardia in one patients and right axis deviation in one patient. ECG abnormalities of patients in pre and post-treatment were presented in Table 1.
When VPC count per day and MHR, detected on 24 h ambulatory electrocardiography, were compared, significant statistical difference was present in pre and post-treatment periods (VPC, 54.25±69.56/day, 6.50±5.98/day p<0.05; MHR, 108±12/day, 82±8/day p<0.05: respectively) (Figure 1).

The mean intercanine expansion was 5.02±1.52 mm and the mean intermolar expansion was 3.65±1.02 mm after RME application. The mean duration of expansion was 27.7±4.6 days.

**Discussion**

RME is an effective orthopedic procedure used in orthodontics on correcting the maxillary transverse dimension (2). Although, the influence of RME is not limited in the maxillofacial anatomy, some medical problems are related to this procedure as, nocturnal enuresis (9), mouth breathing (10), conductive hearing loss (11), sleep apnea (12) and head posture (13).

The cardiac complications of upper airway obstruction have been investigated by many scientists by using supplemental diagnostic modalities (4). Cardiologist accepted that mechanical airway obstruction due to maxillary deficiency along with hypoxia, hypercapnia, and the dramatic changes in intrathoracic pressures may result in diverse autonomic, humoral, neurohumoral, and hemodynamic responses (4). These may lead to cardiopulmonary complications such as pulmonary hypertension, right heart failure, cor pulmonale, left ventricular dysfunction, or even sudden cardiac death (14). Previous studies showed that children with upper airway resistance can manifest with secondary growth impairment, neurocognitive deficits, and less often cardiovascular sequelae (8, 12). On the aspects of orthodontics many literatures focused on the increase on nasopharyngeal airway dimension and improvement on nasal breathing after RME (15, 16). This may have positive affect on the cardiac parameters. Therefore we aimed to obtain the cardiac parameters on 12 patients with maxillary deficiency and compare the six months follow up data’s.

We detected right axis deviation in three patients, right ventricular hypertrophy in one patient and right atrial hypertrophy in one patient, and sinusal tachycardia during 24-h ambulatory echocardiography in nine patients. Only three patients did not have any ECG abnormalities. It is interesting the results showed that the incidence of pathological parameter was more than normal population’s incidence. The anamnesis of patient’s record did not show any risk factors because of the parents. Six months after expansion showed impairment on cardiological parameters. After second measurement one sinusal tachycardia and one right axis deviation was observed in the study group. The expansion procedure reduced right axis deviation from three to one person. Other two patients have normal axis.

In a recent study by Tatlipinar et al (17) showed that mean pulmonary artery pressure and right ventricle myocardial performance index were higher in patients with adenoid hypertrophy and adenoid and tonsil hypertrophy in comparison with the normal group. Also, Koc et al (15) demonstrated that adenotonsillectomy improved right ventricle performance and reduced mean pulmonary artery pressure in children with adenotonsillar hypertrophy. The expansion improved right ventricular hypertrophy on one patient. The occurrence of right axis deviation means that there is an overload on right part of heart. Expansion may reduce the overload on this part and return to the acceptable values. Our study result was similar with the patients after treatment of adenoid hypertrophy studies (12, 18).

VPC and MHR are independent predictors for sudden cardiac death and cardiac arrhythmias (5). VPC are characterized by the premature occurrence of a QRS complex that is abnormal in shape and duration. They can be produced by direct mechanical, electrical, and chemical stimulation of the myocardium (12). VPC is also important risk factor for cardiovascular problem in child (19). VPC leading to ventricular tachycardia (VT), which, in turn, can degenerate into ventricular fibrillation, is one of the common mechanisms for sudden cardiac death. The decrease of the VPC would improve the ventricular function and sudden cardiac death during the clinical follow-up (20). Frequent VPC are rare in healthy children and young adults. They are extremely rare in children below the age of 9 years, but also only 2–6% of older children and young adults have more than 50 VPC/24 h (21, 22).

Before application of RME the frequency of VPC was higher on patients with maxillary deficiency. (54.25±69.56/day) and there is no sign of VPC on only 2 patients. Rest of 10 patients has VPC between 12 and 234 number/day. Three of the patients’ VPC score was higher than 100.

Post treatment records showed noticeably decrease on VPC scores (54.25±69.56/day). Although on four patients VPC did not observed, the VPC was observed on 8 patients between 4 and 18 days after expansion. The VPC was observed 234 and after patients this score significantly reduced to only 10.
MHR is also important risk factors for cardiovascular death. Some studies showed that mortality rises as resting heart rate increases (14, 23). A number of epidemiologic studies and several experimental lines of research point to high heart rate as a main risk factor for cardiovascular disease. In our study, the MHR value was found 108±12/day, after RME this value significantly decreased till 82±8/day. It is interesting that the cardiologic abnormalities are higher than the incidence of normal population. The VPC and MHR parameters have changed significantly in post-treatment period in our study. We thought that RME may decrease the arrhythmias and favorably impacts cardiovascular which causes mortality and morbidity.

Conclusion

The result of our study showed that the incidence and prevalence of arrhythmias in the setting of maxillary width deficiency, whether treatment with RME consistently decreases arrhythmias and maybe effect cardiovascular mortality and morbidity.

References

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