

Effects of Rapid Maxillary Expansion on Nocturnal Enuresis: A Literature Review

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Rapid maxillary expansion (RME) is a dentofacial orthopedic treatment procedure which has been routinely used to correct transversal maxillary skeletal and/or dental constriction. Application of RME not only expands the constricted maxilla but also results in an increase in nasopharyngeal airway dimensions, improvement in nasal respiration in patients with abnormal breathing patterns, and better blood oxygen saturation. It is known that adenotonsillectomy significantly reduces nocturnal enuresis in patients having upper airway obstruction and/or breathing problems. Some authors have shown that RME was also effective on reducing or ceasing nocturnal enuresis (bed-wetting) in patients with maxillary constriction. The results of these uncontrolled clinical trials showed that the success rate of the treatment varied from 47 percent to 100 percent. The purpose of this article is to review the etiology and pathophysiology of nocturnal enuresis and the studies investigating the effects of RME on nocturnal enuresis in growing children.

Key words: Rapid maxillary expansion, Nocturnal enuresis, Nasal breathing.

Introduction

“Nocturnal” means pertaining to or occurring at night and “Enuresis” is a voluntary or involuntary discharge of urine. The term nocturnal enuresis (NE) is defined as involuntary loss of urine during sleep more than two nights per month after the ages of 5-6 years (1-5), since normal urine flow and bladder control generally occurs before

5 years of age (6, 7). Some clinicians (8, 9) have also added voluntary urination to this definition. NE has been divided into primary and secondary forms according to onset and course of bedwetting. In primary nocturnal enuresis, the child never has a dry period for over 6 months, while the child with secondary nocturnal enuresis can be dry for at least six months (2, 7, 10).

Prevalence of Nocturnal Enuresis

It is difficult to estimate the prevalence of NE because of the variations in its definition and in social standards, but it has been known that prevalence of bedwetting in boys is more common than in girls (8). It is generally accepted that 15 to 20 percent of children by the age of 5 years wet their beds during sleep at night (4, 6, 8, 9). A spontaneous recovery (self-limiting) occurs after this age because bladder control improves with increasing age, and thus the prevalence of children with NE decreases about 15 percent per year (2, 6, 9). The incidence of enuretic children at 8 years reduces approximately 50 percent relative to five years, and this incidence is only 2-3 percent at 12 years of age and 1-2 percent at 15 years (4, 8). Although spontaneous recovery occurs in the juvenile and adolescent periods, 1 to 2 percent of adults still continue to wet their beds (4, 6, 11).

Etiology of Nocturnal Enuresis

Despite extensive research on NE over the past few decades, many questions still remain unanswered regarding its exact pathophysiology (7, 11). Several theories have been proposed to explain the etiology of NE (2, 4, 6, 7, 11). They can be summarized as follows:

1. Genetic factors,
2. Nocturnal polyuria resulting from low antidiuretic hormone (ADH) secretion at night,
3. Reduced nocturnal functional bladder capacity,
4. Delayed maturation of the central nervous system,
5. Stress factors,
6. Sleep disorders and upper airway obstruction,
7. Psychological factors,

8. Organic causes (allergy, infections, and lesions of urinary system).

Pathophysiology of Nocturnal Enuresis

Three main pathophysiological factors that may interact with each other have been suggested to explain the occurrence of NE (11):

1. Nocturnal polyuria (lack of ADH release)
2. Reduced nocturnal functional bladder capacity
3. Impaired arousal response to bladder fullness during sleep

When these factors are taken into consideration, it will be seen that orthodontists have no chance to interfere in the treatment process of the first two factors. Treatment of NE resulting from the first two factors is carried out by child urologists and /or pediatricians.

It has been shown, however, that children with upper airway obstruction and sleep disorder are more susceptible to NE (12-15). In a recent study, Cinar et al. (13) investigated the relationship between nocturnal enuresis (NE) and upper airway obstruction in a pediatric population, and observed that 35 percent of the cases with upper airway obstruction had NE. In the light of their findings, the authors concluded that upper airway obstruction might be a potential etiological factor in NE. It was also shown that surgical relief of upper airway obstruction by tonsillectomy, adenoidectomy or both greatly reduced NE in 76 percent of cases (12-15). Although otolaryngologists have obtained sufficient nasal airflow by these approaches, there are still some difficulties in children with severe maxillary width deficiency and a deep palatal vault. In these patients, nasal airflow can be achieved and/or increased by means of rapid maxillary expansion (RME), and orthodontists can contribute to the treatment of NE by this approach.

Rapid Maxillary Expansion (RME)

Rapid maxillary expansion (RME) has been used as a routine clinical procedure in orthodontics, with its main purpose to expand the maxilla in young patients who had transversal maxillary constriction and a deep palatal vault. RME has also a positive effect on breathing pattern, conductive hearing loss and nocturnal enuresis in some growing children. This treatment procedure is carried out with an appliance with an expansion screw welded to the bands on the first premolars and first molars (Figure 1). The expansion screw was periodically activated per day, and the resulting force (0.9–4.5 kg) causes the mid palatal suture to open and the maxillary bones to diverge from each other. Vertical opening of the suture is triangular, with the greatest width at the nasal floor (16).

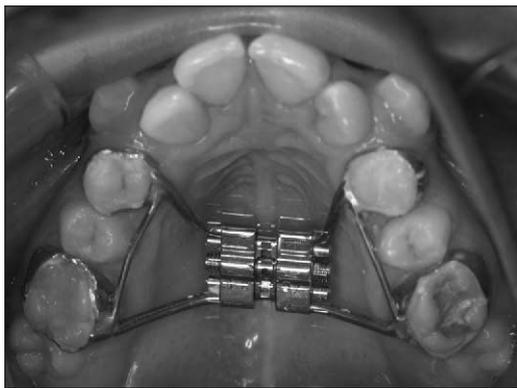


Figure 1. RME appliance cemented to teeth

Studies Regarding the Effects of RME on NE

There are a few studies investigating the effects of RME on NE in literature (17-21). In these studies, it has been shown that nocturnal enuresis was greatly reduced or completely ceased within a few months of maxillary expansion. The relevant data are summarized in Table 1.

The first relevant study was published in 1970 by Freeman (17). In this article, cessation of NE was an unexpected finding, because the observer was trying to assess the effect of RME on the basal metabolism of mentally retarded children aged 9 to 14 year olds. Freeman (17) related this beneficial effect to improved lymph circulation and the increased antidiuretic function of the pituitary gland due to RME. Another important clinical study on this topic was performed by Timms (18), which was published 20 years later than Freeman's study. In this retrospective study, Timms evaluated ten cases aged between 6.5 and 15.5 years old. Timms (18) reported that NE ceased within 1 to 4 months of maxillary expansion in all 10 cases. Kurool et al (19) published a prospective study in 1998, which was carried out on 10 children, aged between 8 and 13 years old, who had not responded to conventional medical treatment for bed-wetting. The authors observed that 4 of 10 cases became completely dry, 3 of them showed considerable reduction in bedwetting nights per week, and the remainder did not respond to the treatment. They also reported that 2 of the 3 non-responders showed better sleeping, improved school performance, and felt more alert in the daytime. The last study was performed by Usumez et al (20) in 2003 on eight subjects. These authors observed that the rate of improvement in bedwetting was 74.2 percent at end of the eight-month observation period. However, none of the children they observed became completely dry at end of this period. Recently, Schütz-Fransson and Kurool (21) conducted a clinical study to assess the effects of the treatment in children who had long-standing resistance to medical therapy and to evaluate the long-term success rate after 10 years. These clinicians reported that positive effects of RME were observed in 11 of 23 patients within 1 month of treatment: six were completely dry and five had notable improvements, the results

Table 1 The studies investigating the effects of RME on NE.

Study	Year	Treated cases	Evaluation method	Reduce of NE after RME
Freeman ¹⁷	1970	-	Subjective	YES
Timms ¹⁸	1989	10	Subjective	YES
Kuroi et al ¹⁹	1998	10	Subjective	YES
Usumez et al ²⁰	2003	8	Subjective	YES
Schütz-Fransson and Kuroi ²¹	2008	23	Subjective	YES

were stable at the 10-year follow-up, and no adverse reactions were noted.

Discussion

NE can cause significant frustration for parents and affected children. This problem can also be stressful for parents and other family members. The fact that NE may be a negative potential factor on the self-esteem and attitudes of children (2) is the most important issue that must be taken into consideration.

General behavioral and medical treatment of NE generally includes proper counseling, reward systems such as star charts, a regular voiding habit during the daytime, fluid restriction at night, voiding before retiring, waking the child at night for voiding, drug prescription such as desmopressin which has a profound antidiuretic activity, and enuresis alarms (2, 3, 5, 7, 9, 11, 22).

Nocturnal enuresis is significantly more common in patients with upper airway obstruction and sleep disorders (12, 13), and many of these children are deep sleepers, and have a lower arousal response to stimulus than age-matched controls (11).

Literature review regarding RME has revealed that this treatment approach causes an increase in nasal cavity width and volume (23-25), a lowering of the palatal vault (26), a straightening of the nasal septum (26), a reduction in nasal resistance (27), and an improvement in nasal respiration.

There is a small number of studies in literature, in which the medical effects and

benefits of RME on NE were evaluated (23, 28, 29). Timms (24, 28) in 1974 and 1987 and Gray (29, 30) in 1975 and 1987 showed that RME caused a significant increase in nasal respiration, resulting in a reduction in respiratory diseases and improvement in hearing and speech. These authors also stated that RME has positive effects on improving social relationships, increasing self-confidence and improving the behavioral and psychological standing of children. It is generally accepted that social, behavioral and psychological factors play an important role in the etiology of NE (4, 6). It was clearly shown by some clinicians (31, 32) that RME was a useful approach in children with abnormal breathing and sleep patterns. Cistulli et al (31) applied RME to 10 children with maxillary constriction and obstructive sleep apnea (OSA), and marked improvements were observed in 9 of them. Pirelli et al. (32) evaluated the effects of RME in 31 children with maxillary constriction, nasal breathing, and obstructive sleep apnea syndrome. They found that RME not only proved normal anterior rhinometric values, but also reduced the mean apnea-hypopnea index from 12.2 events to lower than 1 event per hour during a four-month follow-up period after maxillary expansion. Guilleminault and Li (33) reported that maxillomandibular expansion increased the lowest blood oxygen saturation in patients having transversal maxillary and mandibular constriction.

Basha et al. (12) and Cinar et al. (13) revealed that adenotonsillar and tonsillar sur-

gery cured or at least markedly improved NE in most cases with upper airway obstruction and obstructive sleep apnea. Weider and Hauri (15) and Weider et al. (14) also reported that removal of upper airway obstruction by surgical intervention led to complete recovery of NE in approximately 75 percent of the treated cases with upper airway obstruction. These surgical approaches have significant potential to resolve breathing and sleep problems most effectively. It has been shown that blood oxygen saturation of children with OSA and adenotonsillar hypertrophy markedly increased after adenotonsillectomy operation (34, 35). These authors have also reported that breathing and sleep problems reduced remarkably after the surgery.

Robertson (36) evaluated the effect of mandibular advancement by means of a functional orthopedic appliance on nocturnal enuresis of a child who did not respond to medical therapy. Although it is not related with RME, this treatment approach also increases the oropharyngeal size and regulates the breathing pattern. The bedwetting days of the patient reduced from every night to 1-2 nights a week after the first month of the therapy. Complete dryness was achieved at the end of 20-month treatment.

The recovery rate of NE after RME was reported as 47 percent or more in literature (18-21). According to these studies, RME shows its healing effect on NE by the following mechanisms:

1. RME causes an increase in nasal and nasopharyngeal airway dimensions, resulting in improvement in breathing and blood oxygen saturation (18-21).

2. RME results in improvement in nasal breathing and reduction in apnoic episodes which relate to RME improved lymphatic circulation and increased the antidiuretic function of the pituitary gland (17).

3. Improved breathing capacity and better oxygen saturation after RME might have a beneficial effect on sleep and it may cause

the children to wake up more easily because of bladder fullness (19, 21).

4. Better blood oxygen saturation may have a positive effect on neuromuscular coordination and control of bladder sphincter during sleep (18, 21).

5. RME may also have a placebo effect. Referral to orthodontic clinics for treatment and coming to orthodontists several times may positively affect the psychology of children (19, 20). In addition, the placement of a rigid orthodontic appliance to the palate may affect and irritate the tongue, and this event may alter the degree of arousal response and wakefulness during sleep (19, 20).

Conclusions

It has been stated by several authors that RME had a positive effect on reducing and/or ceasing NE in 70 percent of the children. It should be noticed, however, that only one hypothesis such as the increase in nasopharyngeal airway was assessed in RME studies, and that the observed effects were subjectively quantified. In order to reveal and to explain the efficiency of RME on NE, further studies assessing polysomnographic records, blood oxygen saturation, respiratory changes, and placebo factors during and after RME must be conducted.

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