

# Analysis of errors in following the rapid maxillary expansion activation protocol: An observational study



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## Abstract

**Aim** The aim of this study is to analyse the correspondence between the reported number of activations and the number of prescribed activations.

**Materials and Methods** A total of 114 subjects with constricted maxillary arches (58 males, 56 females; mean age  $10.26 \pm 1.92$  years) were enrolled in the study. The subjects underwent RME and all the parents were provided with a screw activations report form in order to remind them the number of prescribed activations. At the removal of the expander, the screw was turned back in order to count the effective number of activations applied.

**Results** In 46 cases, out of a total of 114 patients, an involuntary error during the activation procedure was presumably made. A slight statistically significant correlation between the number of activations prescribed, and the number of incorrect activations was found. The errors consisted in added or missed activations, compared to the prescribed number but more frequently in missed activations with statistical significance.

**Conclusions** Errors in following the rapid palatal expansion activation protocol are not uncommon. These errors could consist in missed or added activations to the number prescribed by the orthodontist, more often in missed activations.

## Introduction

Rapid maxillary expansion (RME) is a widely used orthodontic procedure and the most effective one in correct transverse deficiency by opening the midpalatal suture in prepubertal or pubertal subjects [Haas, 1961; Cross, and McDonald, 2000; Lagravere et al., 2005; Lione et al., 2013]. This procedure allows an increase in maxillary width, correcting posterior crossbites, obtaining a consequent maxillary and mandibular arch coordination, reducing the need for extractions and with positive influences on the whole head and neck area [Baccetti et al., 2001; Needleman et al., 2000; Perillo et al., 2014; Mummolo et al., 2018; Tecco et al., 2007; Caruso et al., 2018; Saccucci et al., 2011]. Over 90% of orthodontists offer this procedure as a treatment option [Korbmacher et al., 2005; Baldini et al., 2018a; Lione et al., 2015] in primary, mixed or permanent dentition [Needleman et al., 2000; Santariello et al., 2014; Ortu et al., 2014].

The Hyrax appliance is the most common type of RME appliance, with an expansion screw that is attached to 2 or 4 teeth that is usually activated once or twice daily for about 2–4 weeks [Ramoglu, and Sari, 2010; Ballanti et al., 2009; Needleman et al., 2000]. RME generates large forces to exceed the limits of orthodontic tooth movement producing maximum orthopaedic repositioning and the expansion force could vary depending on the activation protocol. In fact, a single activation of the screw produces approximately 3–10 pounds of force [Zimring, and Isaacson, 1965; Lione et al., 2013; Ballanti et al., 2016; Mummolo et al., 2014].

Being the activation applied with a daily rhythm [Lione et al., 2013; Grassia et al., 2014; Baldini et al., 2015], instructing the parents to activate the expansion screw following the activation protocol as planned by the orthodontist is paramount. Consequently, the importance of the maxillary expander activation protocol on the achievement of the desired dentoskeletal effect on maxillary arch gives to the parents' assiduousness and ability a crucial role on this orthodontic procedure. For this reason it is common to equip parents with a report form to help them to follow the activation protocol chosen by the orthodontist and to confirm the correct progress of the expansion procedure. However, there is no certainty about the matching between the data reported in

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the report form and the reality for the voluntary or involuntary untruthfulness of the data reported by the parents.

At the authors' knowledge there are no studies in literature that directly evaluate the accuracy in following the daily home maxillary expansion activation protocol. A previous study [Huanca Ghislazoni et al., 2011] showed that the expansion screw is unable to spontaneously back-turn after the end of the active expansion phase. The aim of this study is to analyse the correspondence between the reported number of activations and the number of prescribed activations.

**Materials and Methods**

A total of 114 subjects with constricted maxillary arches (58 males and 56 females; mean age 10.26 ± 1.92 years) were enrolled in the study. Their parents signed an informed consent form. The study followed the Helsinki Declaration and was approved by the Ethics Committee of the University of L'Aquila, Italy. Individual skeletal maturity was determined for each subject with the cervical vertebral maturation (CVM) method assessed on lateral cephalograms [Baccetti et al., 2002]. Inclusion criteria were constricted maxillary arches, age younger than 15 years, CVM of cervical stage from CS1 to CS3 (before the growth spurt), no history of periodontal problems, neurological diseases, and/or genetic diseases or syndromes.

The subjects underwent RME with a hyrax stainless steel expander with two bands cemented to the maxillary first molars. The expansion screw, coated with a friction agent, was activated at ¼ or ½ turn per day (0.2–0.4 mm per day) as decided by the clinician. The active expansion phase was stopped when the palatal cusps of upper first molars were in contact with the vestibular cusps of the lower first molars.

All the parents were instructed by the same operator to activate the expansion screw and provided with a screw activations report form, which they had to check mark each day to confirm the activation procedure. Incorrectly filled in form or forms that reported errors or difficulties encountered by the parents during the activation phase were discarded from the study. Weekly appointments were planned in order to repeatedly evaluate the necessary number of prescribed activations by assessing the amount of achieved expansion.

After the end of the retention phase (6 months) the expander was removed and the screw was turned back in order to count and record the effective number of screw activations applied.

**Statistical analysis**

The number of incorrect activations were recorded and summarised as means and standard deviations. The Chi-square test was applied in order to compare the number of incorrectly missed or added activations. The Student's t-test was applied both to analyse the difference between the mean number of incorrectly missed and added activations and the difference in the number of prescribed activations between the subjects who made errors, and those who did not.

The Pearson's correlation coefficient was used to assess a possible correlation between the number of prescribed activations and the number of errors. Significance was set at p = 0.05.

**Results**

In 46 cases, out of a total of 114 patients (40% of the sample), an involuntary error during the activation procedure

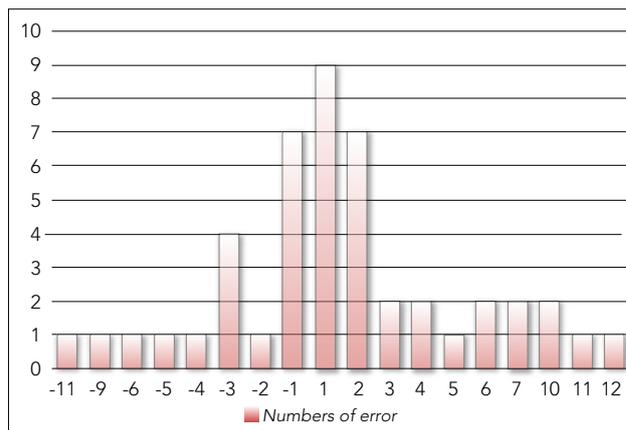


FIG.1 Patient's laterals and frontal intraoral occlusal view before orthodontic treatment.

	Frequency (at patient level)	Statistical analysis
Patients with AA	17 over 46 patients (36.9%)	Chi-square = 57.4p<0.01
Patients with MA	29 over 46 patients (63.1%)	

TABLE 1 Frequencies of AA (added activations) and MA (missed activations).

was presumably made. The number of incorrect activations ranged from 1 to 12. The errors consisted in added activations (AA) or missed activations (MA), compared to the prescribed number but more frequently in MA with statistical significance (63.1% of cases with MA, i.e. 29 cases over 46) (Table 1).

The mean number of AA was 3.3±2.9 (range from 1 to 11 AA).

The mean number of MA was 3.8±3.4 (range from 1 to 12 MA).

The statistical analysis by means of Student's t-test showed that the difference between the mean numbers of AA or MA activations was not statistically significant (p=0.59).

The distribution of the total number of incorrect activations is shown in Figure 1.

In 65.2% of cases (30 cases over 46 cases of errors), the incorrect activations concerned no more than 3 activations, totally. In the remaining cases, the errors ranged from 4 to 12 activations, totally.

It was highlighted a slightly statistically significant correlation between the number of activations prescribed, and the number of incorrect activations (regardless of whether the error consisted in AA or MA, with respect to the initial prescription) (Pearson's correlation coefficient = 0.28; p = 0.05).

On average, approximately the same number of activations was prescribed to parents who have made an error and to those who have not made any (respectively 22.8±6.1 prescribed activations, and 21.9±6.7 prescribed activations; p=0.69).

**Discussion**

RME typically requires a daily activation of the expansion screw and thus it is necessary to designate and instruct the parents to activate the expansion screw and follow the activation protocol planned by the orthodontist. Consequently, the parents' compliance and ability could have a crucial role

on this orthodontic procedure.

The aim of this study is to analyse the correspondence between the reported number of activations and the effective number of activations during the RME procedure, in a sample of 114 patients.

Although in most cases the entity is slight, it is not uncommon to deal with errors in following the rapid palatal expansion protocol of activation, mostly MA ( $p < 0.01$ ). In fact, in the 40.86% of the cases a discrepancy between the number of prescribed activations and the effective number of activations applied was observed. Thus, approximately 2 subjects out of 5 presents an error in the activation phase. This result disagrees with the only similar study in literature by Huanca et al. [2011] that roughly found a perfect matching between the number of activations and post-removal deactivations in a sample of 48 subjects. Unfortunately, the study design of this study is poorly described and it is even not clear how the authors recorded the number of activations.

It should be observed, that approximately in 2 cases out of 3 the error could probably be considered without clinical significance consisting in a maximum discrepancy of 3 activations compared to the prescribed number. In fact, the clinician will unconsciously continue anyway the expansion phase until reaching the desired expansion. This study showed that the discrepancies could both be positive or negative with a slightly higher frequency for MA and the number of errors consists in a mean of respectively 3.3 and 3.8; this difference is without statistical significance.

A higher discrepancy between the prescribed number of activations and the effective number of activations, especially negative discrepancies, could determine an alteration of the expansion protocol with possible dentoskeletal side effects, being the expansion force and the consequent balance between orthodontic tooth movement and orthopaedic repositioning strictly dependent from the activation protocol [Baldini et al., 2015; Perillo et al., 2014; Grassia et al., 2015; Baldini et al., 2018b; Baldini et al., 2018c; Mummolo et al., 2014]. Looking at the results of this study this kind of problems could happen in about the 15% of the treated subjects.

This study shows a slight statistically significant correlation between the number of activations prescribed, and the number of incorrect activations, regardless of whether the error consisted in MA or AA, with respect to the initial prescription.

On average, approximately the same number of activations was prescribed to parents who have made errors and to those who have not made any. This suggests that, although the number of activations is related to the number of errors, the absence of errors during the expansion procedure seem to be associated only with the patient and not with the total number of activations. Consequently, the number of errors appears proportional to the number of prescribed activations.

## Conclusion

Errors in following the rapid palatal expansion activation protocol are not uncommon. These errors could consist of missed or added activations to the number prescribed by the orthodontist, more often in missed activations. A higher number of prescribed activations seem to be related with a higher number of errors. In 15% of the treated subjects the number of errors could influence the ratio between dental and skeletal RME effects. A weekly monitoring of the active RME phase should be strongly encouraged to achieve a better

control of the orthodontic procedure and activation errors.

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