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Early orthodontic treatment: a new index to assess the risk of malocclusion in primary dentition

ABSTRACT

Aim *A new index targeted on the risk of malocclusions in primary dentition, called Baby-ROMA (Risk Of Malocclusion Assessment) index, was set up to assess risks/benefits in early orthodontic therapies. The Baby-ROMA index was designed from the observation that some of the malocclusion signs, observed in primary dentition, can worsen with growth, others remain the same over time and others can even improve. Therefore it would be important to classify the malocclusions observed at an early stage on a risk-based scale.*

Methods *The reliability of the index was tested on 200 children, referred by their paediatricians to two different Orthodontic Departments, aged 4-6 years and in full primary dentition. The children were evaluated by two operators, both trained and calibrated on the use of the Baby-ROMA index.*

Results *The K test showed a high reproducibility of the index. It is shown that 50% of patients presented malocclusion and crossbite had the highest prevalence, followed by tooth decay and early loss of deciduous teeth and negative overjet.*

Conclusion *The Baby-ROMA index was helpful to assess the severity of malocclusion and the timing for orthodontic treatment in very young patients (primary teeth).*

Keywords *Baby-ROMA index; Malocclusion risk; Orthodontic treatment need; Primary teeth.*

Introduction

Preventive therapies in orthodontics aim at promoting a physiological development of a good occlusion and avoid the progress of a malocclusion. Interceptive orthodontic therapies are performed in order to restore a normal occlusion once a malocclusion has developed [Sheiham, 1993]. However the majority of malocclusions could be prevented and corrected at an early stage.

Early orthodontic treatments are carried out at the stage of primary and/or early mixed dentition with the aim of reducing the length and the severity of orthodontic treatments with conventional fixed appliances [Proffit, 2006]. Early orthodontic treatments are particularly effective and desirable when the correction of skeletal malocclusions in young children is requested, since more stable results are achievable, less extractions of permanent teeth are needed and the length of orthodontic therapies in permanent dentition is sensibly reduced with low risks of enamel decalcifications and periodontal diseases after treatment, with subsequent increased parental satisfaction [King, 1990; Kluemper, 2000; Musich 2007].

Early treatments of Class III malocclusion due to maxillary hypoplasia have showed better clinical results in primary or early mixed dentition [Ferro, 2003; Ngan, 2005]. However in Class II malocclusions the debate regarding the benefits from a dual-phase treatment is still open [O'Brien, 2006].

An early treatment for the correction of posterior crossbites with jaw shifting is often advisable in order to prevent a facial asymmetry [Marshall, 2005; McNamara, 2006]. However Kurol [1992] found that 45% of the posterior crossbites with lateral mandibular displacement resolves spontaneously with growth.

Early treatments are also recommended when a space discrepancy is due to premature loss of deciduous teeth or crowded primary dentition. Space maintainers prevent the loss of space, allow the eruption of permanent teeth in their natural position and preserve the leeway space when the dental arches are crowded. Orthodontic therapies in primary dentition contribute to oral health and avoid patients more complicated treatments in permanent dentition [SIOI, 2004].

Ideally the process of identifying and assessing the severity of a malocclusion within national health care services should require a simple and reliable method. Several indices based on occlusal parameters are used to assess priority of orthodontic care. Indexes of orthodontic treatment are used in screenings and epidemiological studies with the aim to identify the priority of treatment, especially in the countries where the costs of the orthodontic therapies are funded, wholly or partly, by Health Care Service or private insurances [Järvinen, 2001]. Most of the indexes are targeted on permanent dentition. However the OI [Summers, 1971] is based on primary dentition, but does not consider either skeletal

or functional problems and it is also difficult in terms of data collection [Elderton and Clark, 1983; Tang and Wei, 1990]. The IPION [Coetzee and Muelenaere, 1997] is designed for children aged 6 to 9 years and requires the calculation of a score derived from the sum of each of the values observed. Although the IPION index is a valuable tool of preventing a malocclusion, it is not able to assess the prevalence of a malocclusion: severe malocclusions can find place in a low category due to the uselessness and unsuitableness of carrying on either a preventive or interceptive treatment at the time of the assessment [Karaiskos et al., 2005]. ICON index [Daniel and Richmond, 2000] is only suitable for late mixed and permanent dentition [Solow, 1995].

Therefore an index, which assesses the need of orthodontic treatment in primary dentition, when a wide variety of skeletal, dental and functional factors, if unobserved, could adversely influence occlusion and craniofacial growth, is needed. The ROMA index (Risk Of Malocclusion Assessment Index) [Russo et al., 1998], was set up for mixed and permanent dentitions in growing patients and evaluates skeletal and functional aspects of a malocclusion. The ROMA index was validated [Grippaudo et al., 2007] and tested on a large sample of Italian children 9-13 aged [Grippaudo et al., 2008 and 2013]. The authors have now modified the ROMA Index and targeted on the age of primary dentition (Baby-ROMA Index). The aim of the Baby-ROMA Index is early diagnosis and treatment of malocclusion at an early stage of development. This study was designed to determine the prevalence of malocclusions treatable at an early stage in a sample of Italian children in primary dentition (4-6 years).

The Baby-ROMA Index

The Baby-ROMA index is quick and easy to use at the first visit. It measures occlusal parameters, skeletal and functional factors that may represent negative risks for a physiological development of the orofacial region (Table 1), and indicates the need of preventive or interceptive orthodontic treatment in a score scale. The Baby-ROMA Index is divided into four main categories of problems: systemic, craniofacial, dental and functional. Each category has a number which corresponds to the risk severity and an alphabet letter for each different type of malocclusions (Table 1).

Differences between the ROMA Index and the Baby-ROMA Index are the following.

- Postural and auxological problems and possible inheritance of malocclusion are evaluated at a later stage (over 6 years of age). Therefore they are assessed with a low risk score of 2 (instead of 4).
- Maxillofacial traumas with/without condylar fracture: maxillofacial traumas have to be carefully investigated and, if required, treated. They have a high score (5) if they are complicated with condylar fracture, which needs to be diagnosed and treated at this stage to

SYSTEMIC PROBLEMS	Maxillo-facial Trauma	with condylar fracture	5a
		without condylar fracture	2a
	Congenital Syndromes/ Malformations		5b
	Postural/ Orthopaedic Problems		2c
	Medical or Auxological Conditions		2d
	Inheritance of malocclusion		2e
CRANIOFACIAL PROBLEMS	Facial or Mandibular Asymmetries		4f
	TMJ dysfunctions		4g
	Outcomes of trauma or Surgery of the cranio-facial district		5j
	Maxillary Hypoplasia / Mandibular Hyperplasia	OVJ<0	4k
		OVJ>0	2k
DENTAL PROBLEMS	Maxillary Hyperplasia / Mandibular Hypoplasia	OVJ>6mm	3h
		3mm<OVJ<6mm	2h
	Caries and Early Loss of Deciduous Teeth		4l
	Scissor bite		4m
	Crossbite	>2mm or lateral shift	4n
		<2mm or no lateral shift	2n
	Displacement	>2mm displacement	3o
		>1mm - absence of diastema	2o
	Open bite	>4mm	3p
		>2mm	2p
	Hypodontia	up to 2 teeth	3q
		more than 2 teeth	4q
	Supernumerary teeth		4q
	OVB>5mm		2r
	Poor oral hygiene		2t
FUNCTIONAL PROBLEMS	Parafunctions (bruxism, jaw clenching)		2v
	Thumb/finger Sucking Habit		2w
	Oral breathing / OSAS		2x
NONE OF THE PROBLEMS LISTED ABOVE			N

TABLE 1 Baby-ROMA index.

avoid any asymmetric growth of the jaw. With no condylar fracture, the score is 2, but the child needs to be checked routinely by dentist over the following years.

- Sagittal maxillary hypoplasia and/or mandible hyperplasia (Class III malocclusion), assessed by measuring the overjet and not the dental relation, they score 4k (instead of 3k) and 2k.
- Sagittal mandible hypoplasia and/or maxillary hyperplasia (Class II malocclusion), assessed by the overjet and divided into two lower scores of increasing severity, 2h and 3h, instead of 3h and 4h in the ROMA Index. Overjet up to 3 mm is considered within average in young children. Class II malocclusions have a moderate risk factor in this age group and should be re-assessed and treated close to the "pubertal growth spurt" [Jang, 2005].
- High or low FMA angle (vertical skeletal discrepancies) are treated in mixed dentition or in older age stage, therefore, they are not mentioned in this index.
- Crossbite: score 4n for crossbite over 2 mm and crossbite with lateral shift of the jaw, score 2n for crossbite lower than 2 mm or no lateral shift.
- Scissor-bite, score 4.
- Open bite: score 4 is absent because a dental open bite may regress spontaneously or with the use of simple orthodontic devices to quit the bad habits which may have caused the open bite.
- Overbite over 5 mm is scored 2 instead of 3; an overbite observed in primary dentition may change when the first molars have erupted and has to be assessed on adult incisors.
- Displacement is scored 2 and 3, and not 4, because the crowding in primary dentition should not be treated, but it is one of the risk factors of malocclusion.
- Hypodontia in primary dentition (up to 2 teeth) scores 3 instead of 4 because there is no need of therapy at this stage and would require a radiological confirmation. However, when the primary dentition is affected, the permanent dentition is affected in 75% of cases. Also fused, peg-shaped, abnormal shaped teeth are considered signs of possible missing teeth in permanent dentition. Cases of multiple agenesis are often associated with congenital syndromes (score 4) and require early therapies in order to vertically affect maxillofacial growth.
- Supernumerary teeth score 4, as they require a prompt treatment with the aim of avoiding dental malposition.
- Caries and early loss of deciduous teeth score 4 instead of 3, since a premature loss of deciduous teeth can lead to lack of space for secondary dentition and consequently impacted teeth and crowding.
- Anomalies in exfoliation are not considered in Baby-ROMA Index, since it is set only for a full primary dentition.

The Baby-ROMA index gives indications regarding timing for orthodontic therapy:

- Scores of 4 and 5 require an immediate orthodontic treatment.
- Score of 3 indicates the presence of a malocclusion which can persist or worsen, therefore patients will be assessed again before the growth spurt.
- Scores of 1 and 2 need only routine check-ups to monitor the occlusion, score 2 is more exposed to the action of risk factors.

Aim of the study

The aim of the study was to test the Baby-ROMA index, a modified ROMA index for primary dentition, in a sample of 4- 6 year aged children, never treated before with orthodontic appliances, and referred by paediatricians or parents to Hospital-based Orthodontic Departments. The study also aimed at evaluating:

1. the ease of use and the reproducibility of the index;
2. an epidemiologic evaluation of the main orthodontic problems of children referred for orthodontic assessment.

Material and methods

The study is cross-sectional and was carried out by applying the Baby ROMA index on a sample of children undergoing orthodontic visit at the Gemelli Hospital in Rome and at the UOS, Dentistry Paediatric Hospital Bambino Gesù in Rome, Italy. The sample included 200 children, 4-6 years old and in full primary dentition, who had been referred by pediatricians for orthodontic assessment. The visits were provided by a postgraduate student in orthodontics and by a student in dentistry, both at the last year of their training. They were trained and calibrated on how to use Baby-ROMA index. To verify the reproducibility of the index, the intra-examiner and inter-examiner reproducibility were calculated. The intra-examiner reproducibility was tested comparing the data of 20 children examined by the same operator twice at one month interval. The inter-examiners reproducibility was tested with the data of the same group of 20 children collected by another operator. The statistical evaluation of the reproducibility of the index was performed using Kappa test to correlate the data [Cohen, 1960]. The risk prevalence and the prevalence of each risk factor were then calculated. Furthermore the prevalence of treatment need for each degree of risk and for each index value was calculated.

Results

Data collection for the Baby-ROMA Index has proved to be quick and easy.

At the K Test a high correlation between operators was observed. The K values of intra-examiner correlation

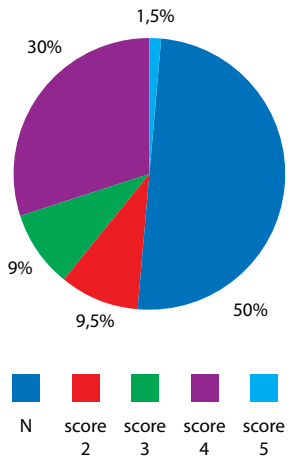

FIG. 1 Prevalence in percentage of the risk score in the sample.

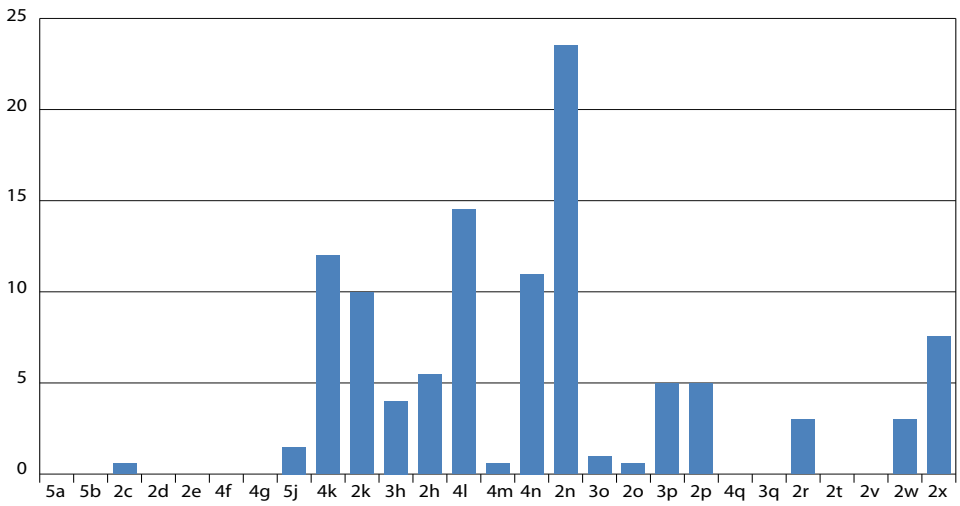

FIG. 2 Prevalence of the Baby-ROMA index values in the sample.

ranged between 0.643 and 1.00 and the K values of inter-examiners correlation were between 0.773 and 1.00. Therefore the index is highly reproducible.

Results showed that 50% of patients are affected by malocclusion: 1.5% had a score of 5; 30% had a score of 4; 9% had a score of 3 and 9.5% had a score of 2 (Fig. 1).

The risk factors with higher prevalence (> 10%) were crossbite up to 2 mm (24.5%) and greater than 2 mm with lateral shift of jaw (11%), tooth decay and early loss of deciduous teeth (14.5%), Class III malocclusion with negative (12%) or positive (10%) overjet.

The prevalence of oral breathing was 7.5%; the prevalence of Class II malocclusion with overjet between 3 and 6 mm was 5.5% and overjet greater than 6 mm was 4%; the prevalence of open bite more than 2 mm was 5% and more than 4 mm was 5%. Also, bad habits and increased overbite were found in 3% of children.

The remaining scores in the index have a prevalence of less than 2% (Fig. 2).

Discussion

The passage from primary to early mixed dentition is often susceptible to changes which can be caused by a variety of factors and may interfere with a normal occlusion. A correct timing when to start an orthodontic therapy is essential for the treatment to be most effective in the shortest time and with the lowest cost possible.

Longitudinal studies indicate that a malocclusion observed in primary dentition can fairly predict the malocclusion developing in mixed and/or permanent dentition [Keski-Nisula et al., 2006]. According to literature, some of the occlusal characteristics on primary dentition persist in mixed dentition: children with a malocclusion in primary dentition (posterior crossbite, increased overjet, etc) present higher risks of having a malocclusion in early mixed dentition [Góis, 2012]. However an anterior open bite may spontaneously improve [Bowden, 1966; Heimer et al., 2008; Worms et al., 1971; Cozza et al., 2005; Warren and Bishara, 2002]. Some authors suggest that an early treatment may reduce the severity of the malocclusion at a later stage [Bhayya, 2011]. Preventive and early treatments in orthodontics are still object of debate on cost-effectiveness [Tschill et al., 1997; Kurol, 2006; Proffit, 2006]. Viazis [1995], Kurol [2006], Ngan [2006] and Proffit [2006] considered that the ideal time for a treatment is in late-mixed dentition stage, while other authors [Thilander et al, 1984; Farčnik et al., 1988; Korpar et al., 1994; Trottman and Elsbach, 1996; Tschill et al., 1997; Thilander et al , 2001; Ovsenik et al., 2004] concluded that early orthodontic treatments would be beneficial and desirable especially to enhance skeletal and dental discrepancies and correct habits, dysfunction and malocclusion in their early stages, and especially transverse discrepancies which may cause temporo-mandibular joint problems or facial asymmetry [Franchi et al., 2004; Kurol, 2006; Proffit, 2006].

According to Jacobson [1979], a good occlusion in primary dentition helps a more harmonious and balanced facial growth; an early treatment is psychologically beneficial for those patients whose self-esteem is reduced by the derision of their peers; early treatment can correct malocclusions by acting on the dental-alveolar compartment.

Ricketts [1979] supports the theory that an early treatment is easier and guides the physiological dental exfoliation; a functional/orthopaedic treatment is advisable in deciduous and/or early-mixed dentition; an early treatment can reduce the need for extractions of permanent teeth and corrects bad habits, helping the normal development of mixed and permanent dentitions; early orthodontic therapies also help to prevent traumatic dental injuries of maxillary incisors when they are protruding and can reduce the severity

of a skeletal malocclusion and therefore the need of orthognatic surgery in adult age.

Many studies have described the distribution of malocclusions in populations, reported differences in the prevalence that may depend on ethnicity, methods of data collecting and characteristics of the sample [Viggiano, 2004; Bhayya, 2011; Thilander et al., 2001; Hassan and Rahimah, 2007]. The results of our study show that 50% of the sample is not affected by malocclusion, according to what was observed in a previous epidemiological survey in Brazilian preschool children [Carvalho, 2011]. The 31.5% of children needed orthodontic therapy (score 4 and 5) and 18.5% had a malocclusion that might persist or worsen with growth (grades 2 and 3). The most frequent malocclusions detected in the sample are crossbite, Class III malocclusion, Class II malocclusion and open bite. A crossbite, if not treated, may cause asymmetrical cranio-facial growth [Pirttiniemi et al., 1990; Kurol and Berglund, 1992; Sonnesen et al., 2001; Thilander and Lennartsson, 2002; Ovsenik et al., 2004]. It has also been suggested that the later a crossbite is treated, the higher is the risk of damage to the temporo-mandibular joints [Pirttiniemi et al., 1990; Sonnesen et al., 2001; Kurol, 2006]. Furthermore it is also advisable to detect a Class III malocclusion at an early age in deciduous or early mixed dentitions [Baccetti et al., 1998]. Because, the earlier the treatment is carried out, the greater the chances of success, which are the results of skeletal changes rather than dental compensations [Franchi et al., 2004], with increased long-term stability [Masucci et al., 2011]. A Class II malocclusion should not be treated in primary dentition, but should be assessed and resolved at a later stage with a single or two-staged treatment [Tulloch, 1997].

Early treatment of an open bite is very controversial, probably because it is multifactorial. It is important to identify if the open bite is determined by a skeletal base or a dental base in order to choose the correct treatment option. In children with average vertical patterns the open bite is determined just by environmental factors and can be treated more successfully during growth, whilst in subjects with malocclusion associated with increased skeletal vertical patterns the prognosis is less favourable [Ngan et al., 1992, Grippaudo et al., 2009]. The 7.5% of the sample shows mouth breathing and the 3% reports bad habits. Some studies have shown that bad habits, such as persistent dummy or fingers sucking, can cause alterations of the occlusion [Brin et al., 1998; Vazquez-Nava et al., 2006] and oral breathing associated to respiratory obstructions may cause alterations to the physiological patterns of the craniofacial growth [Harvold et al., 1981].

Conclusion

The Baby-ROMA index assesses the risk that a malocclusion observed in very young children may worsen over time and affect oral health and function. It is important to identify the risk of developing a malocclusion with the aim to determine if the patient needs an interceptive orthodontic treatment at early age or if it is possible or necessary to wait till when the maxillofacial growth and the dentition are fully developed.

There are many indexes of orthodontic treatment need, but only the OI assesses the primary dentition. However the OI does not consider the skeletal or functional problems and it is not practical on a large scale, as data collectiong is time cnsuming. The Baby-ROMA index includes also skeletal and functional problems and is quick and easy to achieve. Our study shows that 31.5% of the population needs an immediate orthodontic treatment (score 4 and 5) and 18.5% requires periodic follow-ups and is likely to commence an orthodontic therapy at a later stage, when the skeletal growth is more favourable (scores 3 and 2); 14.5% has caries and early loss of deciduous teeth; 3% has bad habits, and 7.5% is affected by mouth breathing with obstructive sleep apnea. Therefore we believe that it is necessary a programme for the education of parents on the importance of periodic follow-ups and sessions of oral hygiene, as well as of the treatment of deciduous teeth affected by caries and the correction of bad habits (persistence of thumb or dummy sucking habit and use of baby bottle), in order to avoid problems in the exfoliation of primary teeth or in the eruption of permanent ones, such as ectopic teeth. Early orthodontic treatment could be advisable in the following cases.

- Malformation syndromes.
- Maxillofacial trauma (e.g. condylar fractures).
- Facial asymmetries .
- Skeletal Class III malocclusion with anterior crossbite.
- Severe crossbite (which could lead to asymmetric development of the jaw).
- Scissor bite.
- Early loss of deciduous teeth due to caries (space maintainer).

These orthodontic treatments are not expensive, often have a short duration and use simple devices: besides the lower therapeutic costs they provide important advantages in terms of children oral health.

The new index proposed, the Baby-ROMA index, can be used by pediatricians with the aim of detecting the malocclusions which may need an early interception. The Baby-ROMA index can also be used for epidemiological purposes when surveying the prevalence of early malocclusions and planning the care on a national scale, but also with the aim of limiting early orthodontic treatments only to those cases that really can take most advantages from the therapies.

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