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Orthodontic and dentofacial orthopedic management of juvenile idiopathic arthritis: a systematic review of the literature

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Abstract

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To systematically review the literature published on orthodontic treatment principles in patients with juvenile idiopathic arthritis (JIA). Several electronic databases (PubMed, Medpilot, Web of Science, and DIMDI) and orthodontic and rheumatologic literature were systematically searched for studies published until May 2010. The articles were rated by two independent reviewers and included after three selection steps (title–abstract–full text). Articles had to be studies performed on ≥ 5 patients with a disease onset before the age of 16. The selection process resulted in the inclusion of three publications on dentofacial orthopedics and six on combined surgical orthodontic therapy. The three studies on dentofacial orthopedics aimed to improve the mandibular retrusion by means of removable functional appliances (activator). Whereas these orthodontic approaches comprised relatively large and homogeneous patient samples (14, 22, and 72 subjects, aged 6–16), the surgical studies were basically case series with a large age span of the patients (5–12 subjects, aged 10–44). In these surgical treatment approaches, orthodontics was limited to pre-surgical leveling and post-surgical finishing, while the skeletal discrepancy was treated surgically by a variety of techniques (costochondral grafts, bilateral sagittal spilt osteotomy, Le Fort I, and genioplasty). The treatment goals of both approaches were improvement of esthetics and function and/or pain reduction, and both approaches showed satisfactory results. Because of the heterogeneity of the subject material and the low level of evidence of the papers, it is difficult to draw any conclusions on the orthodontic/dentofacial orthopedic management of JIA. It appears as if removable functional appliances may be beneficial in adolescent patients with JIA.

Key words: arthritis; juvenile idiopathic arthritis; orthodontic treatment; orthodontics

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Introduction

Juvenile idiopathic arthritis (JIA) is one of the most common chronic diseases in childhood, with a reported prevalence of one in 1000 children (1). The prevalence of clinically detectable temporomandibular joint (TMJ) involvement varies between 38 and 72%, depending on the diagnostic method used and the JIA subtype examined (2–7). However,

imaging studies using MRIs or CTs reveal arthritic TMJ changes in up to 93% of the patients with JIA (8–11).

If unrecognized, or left untreated, a TMJ involvement can lead to pain-impaired functional disorders, such as reduced mandibular mobility and bite force as well as tenderness of the masseter and temporalis muscles and head aches (12). From the orthodontic aspect, the TMJ arthritis may cause significant limitations in sagittal and vertical mandibular growth, conditionally resulting in severe micrognathia and anterior open bites with strong esthetic and functional restrictions (13–27).

In healthy children, the common treatment approach to retrognathic mandibles is the use of different class II mechanics (activators, multibracket appliances with class II elastics, Herbst appliances, etc.) to stimulate mandibular growth, thus advancing the mandible sagitally. In the arthritic child, however, some authors advise not to 'strain' the TMJ, as it supposingly would be the case during mandibular advancement procedures, because they fear accelerated skeletal destruction of the TMJ as a result of the increased bone turnover rate (28, 29). On the other hand, because there is no evidence for this accelerated skeletal destruction, it is common clinical practice to use functional appliances that advance the mandible to improve mandibular retrognathia even in JIA children. Therefore, the aim of this paper is to systematically evaluate the published literature on orthodontic and dentofacial treatment principles in children with JIA.

Material and methods

An electronic search strategy was conducted in four main databases (Table 1) with defined key word combinations (Table 2) to systematically search for literature published until (including) May 2010.

Additionally, a hand search of orthodontic and rheumatologic textbooks as well as of the reference lists of all retrieved articles was performed. The inclusion criteria were defined as papers describing the orthodontic treatment of at least five JIA subjects, with a disease onset before the age of 16 and a duration of at least 6 weeks. Studies had to describe the treatment of growing humans or animals and had to be published in one of the following languages: English, German, French, Spanish, Italian, Danish, Finnish, Swedish, or Greek. The three-step selection procedure (title–abstract–full text) was carried out independently by two reviewers. After each step, the cases of disagreement were discussed until a consensus was reached.

Table 1. **Electronic databases searched**

PubMed
Medpilot
Medline
Cochrane Database of Systematic Reviews (CDSR)
Cochrane Database of Abstracts of Reviews of Effectiveness (DARE)
Excerpta Medical Database (EMBASE)
EMBASE Alert
Cochrane Central Register of Controlled Trials
Web of science
German Institute for Medical Documentation and Information (DIMDI)
SciSearch
BIOSIS previews
DAHTA database
German Medical Science (gms)
Springer publisher's database
Karger publisher's database

Table 2. **Key word combinations with which systematic literature search was conducted**

Arthritis + orthodontics
Arthritis + TMJ
Arthritis + TMD
JRA + orthodontics
JRA + TMJ
JRA + TMD
JIA + orthodontics
JIA + TMJ
JIA + TMD
JCA + orthodontics
JCA + TMJ
JCA + TMD

TMJ, temporomandibular joint JRA, juvenile rheumatoid arthritis JIA, juvenile idiopathic arthritis JCA, juvenile chronic arthritis TMD, temporomandibular disorder.

Results

The number of studies identified through the search in the different databases and the selection procedure is detailed in Fig. 1. Of the originally 3554 hits in the

databases, 189 abstracts were retrieved, 67 full-text papers were evaluated, and finally nine publications remained, which were included in the present review. It has to be mentioned, however, that one of these studies (30) analyzed a subgroup of another publication (31). The hand search did not deliver any additional material.

The main reasons for exclusion of studies were 1) that the paper was a case report or case series including less than five patients; 2) that the patients were too old at the start of the disease; or 3) had others types of arthritis than JIA; 4) that patients were not treated orthodontically but exclusively using medical therapy or physiotherapy; or 5) that the papers turned out to be overview articles and no scientific studies (Table 3).

The nine remaining papers can be divided into two general treatment approaches: 1) dentofacial orthopedics with functional appliances (17, 30, 31) (n = 3); 2) combined surgical orthodontic treatment (25, 32–36), with orthodontics limited to pre-surgical alignment and/or post-surgical finishing (n = 6). Table 4 gives an overview of the characteristics of all included studies. Most of these papers are case series, and none was on a higher evidence level than of a cohort study. Up to May 2010, no level I or II studies (meta-analysis, randomized clinical trial, and controlled clinical trial) on the orthodontic treatment of JIA children existed.

In the studies using dentofacial orthopedic approaches with functional appliances, activators were used to advance the mandible. Here, the number of patients was 14, 22, and 72, respectively, and the age of the included subjects varied between 6 and 16 years, which means that all were treated during growth as children or adolescents. Nevertheless, the treatment goals were not the same in both studies. The Milan Group (30, 31) aimed to reduce pain and improve function and esthetics through mandibular advancement, while Kjellberg et al. (17) tried to correct the class II to a class I occlusion. In both studies, the authors expressed satisfaction with their treatment results, without clearly specifying their success criteria.

The six articles with combined orthodontic surgical treatment approaches comprised between five and 16 patients with an age span from 9 to 44 years at the time of examination. The orthodontic concepts applied varied greatly, with some authors describing only pre-surgical alignment (35, 36), some applying exclu-

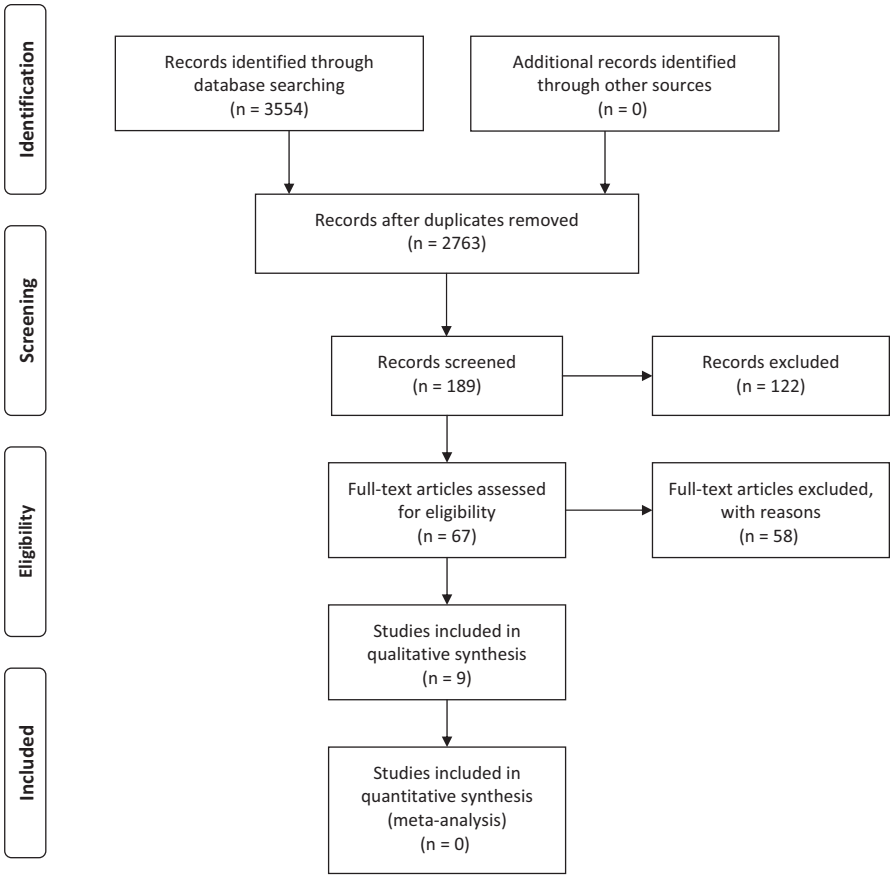

Fig. 1. Flow chart outlining systematic literature search according to PRISMA-Guidelines.

Table 3. **Excluded studies and reasons for exclusion**

Study	Reason for exclusion
Altman et al. (1964)	Case report
Arabshahi et al. (2005)	Medical therapy
Bjornland et al. (1992)	Only 2 patients with JIA
Burden et al. (2001)	Review, no scientific study
Cahill et al. (2007)	Medical therapy
Cavaliere et al. (1967)	Age
Cleary et al. (2003)	Other joints, no TMJ
Feine et al. (1997)	Review, no scientific study
Griffin et al. (1981)	Case series < 5 patients
Grosfeld et al. (1973)	No treatment
Grosfeld et al. (1989)	Treatment unclear
Guyuron et al. (1988)	Case report
Haines et al. (2007)	Other joints, no TMJ
Hanrahan et al. (1989)	Age
Harel et al. (1993)	Other joints, no TMJ
Hoffmann-Axthelm et al. (1954)	No JIA
Horton et al. (1953)	No JIA, case series <5 patients
Ince et al. (2000)	Medical therapy
Kennett et al. (1973)	Case series <5 patients
Kent et al. (1991)	Age, case series <5 patients
Kjellberg et al. (1995)	Review, no scientific study
Kopp et al. (1981)	Age
Kremer et al. (1986)	Age, other joints, no TMJ
Kvien et al. (1985a)	Other joints, no TMJ
Kvien et al. (1985b)	Other joints, no TMJ
Kvien et al. (1986)	Medical therapy
Linder-Aronson et al. (1991)	Case report
Mayro et al. (1991)	Case series <5 patients
Nitzan et al. (2001)	Age
Padeh et al. (1998)	Other joints, no TMJ
Pedersen et al. (1995)	Case report
Pedersen et al. (1998)	Review, no scientific study
Peltola et al. (1995)	No treatment
Port et al. (1966)	Review, no scientific study
Ringold et al. (2008)	Medical therapy
Shah et al. (2006)	Review, no scientific study
Silver et al. (1973)	No JIA
Stoustrup et al. (2008)	Medical therapy
Szymańska-Jagiello et al. (1985)	Treatment unclear
Tasanen et al. (1974)	Age
Tegelberg et al. (1988)	Age
Ueeck et al. (2005)	Review, no scientific study
Vallon et al. (2002)	Age
Wenneberg et al. (1991)	Age
Wenneberg et al. (1996)	Physiotherapy
Willkens et al. (1990)	No JIA/other joints, no TMJ

TMJ, temporomandibular joint.

sively post-surgical orthodontics for growth control (25, 34), one using fixed orthodontic appliances pre- and post-surgically (32), and one paper specifying neither the time period of orthodontic intervention nor the type of appliances used (34). The type of surgical approach also varied greatly, with different methods even being applied within one single paper. Three authors (32, 34, 35) advanced the mandible and/or adjusted the maxilla sagitally, sometimes combined with a genioplasty. The other three authors (25, 33, 36) used costochondral grafts to normalize mandibular growth, one of the studies (36) additionally performing Le Fort I osteotomies and genioplasties. The large age span of the patients reduces the comparability of the results even more, because some patients were treated during growth and others after growth was completed. The treatment goals were defined very vaguely as improving function, esthetics, and/or occlusion (no clear criteria specified), and all authors expressed satisfaction with their results, even though some patients underwent surgery more than once.

Discussion

To minimize the risk of exclusion of a potentially interesting paper, the inclusion criteria were not too strict, there were no limitations to publication years, and nine publication languages were included. Despite an initially large number of hits in the different databases, only nine papers were found suitable for providing advice on how to treat JIA children orthodontically. The evidence level of all of these was rather low, with only Kjellberg et al. (17). appearing to have a standardized treatment protocol (activator) with clearly defined inclusion criteria (JIA children with class II malocclusion), a clearly defined study parameter (improvement of occlusion) and a control group (healthy class II children). It should be taken into consideration, however, that it is already difficult to produce studies with a high level of evidence in healthy orthodontic patients, and this becomes extremely critical in JIA children, where certain general medical treatment is mandatory and cannot be anticipated.

Although Kjellberg et al. (17). demonstrated that an improvement in the sagittal occlusion could be achieved in JIA children, they unfortunately did not report on the TMJ functional condition, which leaves

Table 4. **Characteristics of included studies**

Study 1 (31)	Bellintani et al. (2005)
Subjects	72 patients (22 boys, 50 girls), age 6–16 years
TMJ involvement	28 unilateral, 44 bilateral
JIA type	30 pauciarticular, 36 polyarticular, 6 systemic
Pre-treatment occlusion	n.s.
Control group	None
Methods	
Orthodontic	Activator therapy
Surgical	None
Outcome measures	Reduction of inflammation/pain (steroid administration), improvement of function and esthetics
Results	Pain reduced, function and esthetics improved
Study 2 (30)	**Farronato et al. (2009)**
Subjects	22 patients (out of Study 1) (4 boys, 48 girls), age 6–16 years
TMJ involvement	8 unilateral, 14 bilateral
JIA type	7 pauciarticular, 15 polyarticula
Pre-treatment occlusion	n.s.
Control group	Historic: Stabrun (37)
Methods	
Orthodontic	Activator therapy
Surgical	None
Outcome measures	Improvement of cephalometric values
Results	Neither clinically relevant improvement or deterioration compared to untreated control
Study 3 (18)	**Kjellberg et al. (1995)**
Subjects	14 patients (gender n.s.), age 7–16 years
TMJ involvement	n.s.
JIA type	n.s.
Pre-treatment occlusion	Class II
Control group	23 healthy class II children
Methods	
Orthodontic	Activator therapy
Surgical	None
Outcome measures	Improvement of occlusion
Results	Occlusion improved in 79% of JIA children (78% control) Class I after retention: JIA 61.5%, control 72.7%
Study 4 (32)	**Myall et al. (1988)**
Subjects	7 patients (2 male, 5 female), age 9–23 years
TMJ involvement	Bilateral
JIA type	1 pauciarticular, 6 polyarticular
Pre-treatment occlusion	n.s.
Control group	None
Methods	
Orthodontic	Pre- and post-surgical alignment (appliances n.s.)
Surgical	BSSO (n = 7), genioplasty (n = 7), Le Fort I (n = 2)
Outcome measures	Improvement of esthetics and function
Results	Satisfactory esthetic and functional results (6/7)
Study 5 (25)	**Svensson et al. (1993)**
Subjects	7 patients (all girls), age 10–14 years
TMJ involvement	2 unilateral, 5 bilateral
JIA type	3 pauciarticular, 4 polyarticular
Pre-treatment occlusion	5 class II open bite, 2 class I normal OJ and OB.
Control group	None
Methods	
Orthodontic	Post-surgical Fränkel II appliances, 1 patient plus fixed appliances
Surgical	Costochondral grafts
Outcome measures	Improvement of function, occlusion and cephalometric values
Results	Function improved, class I in 6/7 patients, ANB reduced, SnPg increased, ML/NSL reduced
Study 6 (33)	**Svensson and Adell (1998)**
Subjects	12 patients (1 boys, 11 girls), age 11–16 years
TMJ involvement	3 unilateral, 9 bilateral
JIA type	n.s.
Pre-treatment occlusion	Class II
Control group	None

Table 4. **Continued**

Methods	
Orthodontic	Post-surgical Fränkel II appliances, modified to Fränkel III appliances (n = 4), chin cup (n = 2), fixed appliances (n = 1)
Surgical	Costochondral grafts
Outcome measures	Improvement of mandibular growth, function and occlusion, pain reduction
Results	Function improved, class I in 5/12, class III in 7/12 (because of excessive mandibular growth, second surgical intervention necessary), ANB reduced, SnPg increased, ML/NSL reduced
Study 7 (34)	Oye et al. (2003)
Subjects	16 patients (4 men, 12 women), age 16–53 years
TMJ involvement	n.s.
JIA type	n.s.
Pre-treatment occlusion	n.s.
Control group	None
Methods	
Orthodontic	n.s.
Surgical	BSSO (n = 10), Le Fort I (n = 1), genioplasty (n = 12)
Outcome measures	Improvement of occlusion and esthetics
Results	Mandibular lengthening = 5.3 mm, relapse = 2.3 mm (43%) at follow-up
Study 8 (35)	Leshem et al. (2006)
Subjects	8 patients (3 men, 5 women), age 17–22 years
TMJ involvement	n.s.
JIA type	n.s.
Pre-treatment occlusion	n.s.
Control group	None
Methods	
Orthodontic	Pre-surgical alignment (appliances n.s).
Surgical	BSSO (n = 8), Le Fort I (n = 6), genioplasty (n = 4)
Outcome measures	Improvement of occlusion and esthetics
Results	Mandibular lengthening = 9.6 mm, overjet reduction = 4.1 mm, mandibular relapse post-surgically = 2.1 mm
Study 9 (36)	Stringer et al. (2007)
Subjects	5 patients (all girls), age 14–18 years
TMJ involvement	n.s.
JIA type	4 polyarticular, 1 systemic
Pre-treatment occlusion	Class II open bite
Control group	None
Methods	
Orthodontic	Pre-surgical alignment (appliances n.s).
Surgical	Mandibular advancement through inverted-L-osteotomy with iliac crest bone graft plus costochondral grafts, Le Fort I and genioplasties in all patients
Outcome measures	Improvement in occlusion and esthetics
Results	Class I in 4/5 patients, satisfactory esthetic results

n.s., not specified; BSSO, bilateral sagital split osteotomy; OJ, overjet; OB, overbite; TMJ, temporomandibular joint.

the question unanswered, whether mandibular advancement results in increased TMJ stress/strain or possible skeletal destruction. In this context, it should be kept in mind that even in healthy class II patients, activator therapy can cause a subclinical TMJ capsulitis during the first year of treatment (37). Whether this might lead to skeletal destruction in JIA children is unknown, but seems, however, to be very unlikely, because the observed advancement of the mandible would not have been possible in case of a progression of TMJ destruction. It also has to be remarked that it has recently been demonstrated and that JIA patients with normal TMJ morphology (who can naturally exhibit a class II malocclusion because of other causes than temporomandibular disorder) generally show a growth pattern similar to healthy controls (38). Therefore, it remains unclear whether the positive effect of activator therapy in the above-mentioned study would also have been reached and whether the JIA children clearly had evident TMJ involvement.

The other study proposing dentofacial orthopedic treatment (31) used the same approach (activator) in all cases and had the largest subject material of all included studies (n = 72), but does not report what degree of improvement was achieved, because most evaluated parameters (improvement of esthetics and function) were only assessed subjectively. The only item mea-

sured quantitatively was pain reduction by means of necessary steroid administration, which was significantly reduced during activator therapy. However, it was not specified whether the anti-inflammatory medication was prescribed owing to TMJ pain or disorders of any other affected joint. Unfortunately, the authors did not comment on the sagittal occlusion, neither before nor after treatment, which leaves the questions unanswered, whether or not mandibular advancement was possible and whether despite subjectively improved function, activator therapy resulted in accelerated skeletal destruction in patients with JIA.

Of the subject material above, Farranato et al. (30). extracted a subgroup of 22 growing patients with good cooperation treated with activators for at least 4 years. Lateral cephalograms of before and after activator therapy were analyzed and compared to the data of Stabrun et al. (39), who described the skeletofacial development of untreated JIA children during an observation period of 4 years. Although the authors report a decrease in mandibular retrognathia compared to the untreated historic control group, this was not statistically verified and – on the basis of the measured values – appears very questionable. Again, the sagittal occlusion was not reported, so it remains unclear whether this was improved through treatment. It is mentioned that patients describe 'reduced pain and less frequent pathologic noise from the TMJ,' but these items were only assessed subjectively, and thus are difficult to judge.

The six studies describing combined orthodontic/orthognathic treatment approaches provide even less evidence. These studies basically have to be considered as case series or case observations with a large age range of patients, which makes the comparability difficult, especially as orthodontic treatment aspects are scarcely described, and the approaches used vary greatly. Whereas pre- and/or post-surgical alignment of the teeth most likely has little influence on the temporomandibular joint, functional appliances such as the Fränkel II have comparable effects to those described by the two papers using dentofacial orthopedics, where the mandible is positioned forward, thus placing it an anterior position relative to the fossa, hoping to stimulate mandibular growth. Appliances such as the Fränkel III or the chin cup, however, produce the opposite effect: The mandible is held back, thus placing the condyle in a retrusive position within the fossa, hoping to restrain mandibular growth, which, in the present studies, was needed to counteract excessive growth of the costochondral grafts. The three authors advancing the mandible by means of bilateral sagittal spilt osteotomy (BSSO), adjusting the maxilla using Le Fort I osteotomies and/or performing genioplasties (32, 34, 35), all aimed to improve occlusion and esthetics. All three studies comprised both adolescents and adults, and for two of the three studies, neither the degree of TMJ involvement nor the type of JIA was defined. This would, however, have been of major interest, because without the knowledge about a possible TMJ affection, the retrognathic mandible might have been owing to other causes than JIA. The other three surgical orthodontic studies (25, 33, 36) aimed at removing the affected condyle and replacing it with costochondral grafts to normalize function and occlusion as well as to improve mandibular growth and facial esthetics. All patients were treated as adolescents and had a class II malocclusion pre-surgically, but not all authors specified if the condyles were affected by JIA. In one paper (36), all five patients additionally received a Le Fort I osteotomy and a genioplasty, which means that this study is not completely comparable to the two studies by Svensson et al. (25, 33), who only performed costochondral grafts followed by Fränkel II appliances. In the majority of the cases, satisfactory results were reported, but excessive mandibular growth following surgery appears to be challenging, which led to some adaptations of the original protocol (Fränkel III appliances, chin cups, or multibracket appliances). In the paper by Svensson and Adell (33), the authors describe that despite adaptations of the functional appliances, 7/12 patients ended in a class III occlusion, which in one case made a second surgical intervention necessary.

Because of the heterogeneity of the subject material (different JIA subtypes, unclear general medication, etc.), it is difficult to draw any conclusions on the orthodontic management of JIA. This is especially true for the surgical orthodontic approaches, where the only studies found were case series with large age range of the subjects and a large variety of surgical methods. Nevertheless, in all of the above-mentioned studies, the authors attempted to treat the retrognathic mandible by means of mandibular advancement, either through dentofacial orthopedic measures or by a variety of combined orthodontic surgical approaches. None of these studies described a deteriorating functional

condition of the involved TMJs or accelerated skeletal destruction in these joints because of the orthodontic measures.

Conclusions

Overall, the evidence on orthodontic treatment principles for JIA children with temporomandibular joint involvement is very low. However, there is limited evidence that dentofacial orthopedic treatment using functional appliances can improve mandibular retrognathia and reduce pain in adolescent patients with JIA. To which extent this might prevent much more complex and expensive orthodontic surgical approaches in later life remains unclear. Up to today, no clinical recommendation can be derived from literature regarding combined surgical orthodontic treatment approaches.

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