



RESEARCH REPORT

Efficacy of osteopathy and other manual treatment approaches for malocclusion – A systematic review of evidence

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KEYWORDS

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Manipulative therapies;
Chiropractic;
Myofunctional therapy

Abstract *Background and objectives:* The osteopathic literature often underlines the need for manual treatment of malocclusion. This literature review will investigate the efficacy of osteopathic and other manual treatment approaches for malocclusion.

Data sources: A systematic literature review was undertaken by searching medical and osteopathic databases (Pubmed, DIMDI, Osteopathic Research Digital Repository, Physiotherapy Evidence Database (PEDro), www.chiroindex.org, www.osteopathic-research.com). Other relevant osteopathic journals that are not indexed (e.g. Osteopathische Medizin, Osteopathic Medicine and Primary Care) were also searched. The keywords 'dental occlusion' and 'malocclusion' were combined with keywords for various manual treatment approaches.

Study selection and data extraction: As few hits were anticipated, the inclusion criteria were fairly wide and not too strict in terms of quality. Identified studies were categorized according to Sackett's levels of evidence, and assessed using Downs and Black's quality checklist for healthcare interventions.

Results: Of 30 articles that met the inclusion criteria, 13 were experts' opinions with hardly any evidence. As such, this review focused on the remaining 17 studies: 12 case series, three case–control studies, one systematic review of case–control studies, and one methodologically weak randomized controlled trial. Most of the studies in this review were of poor quality. By applying Downs and Black's quality assessment tool problems with internal and external validity could be identified. Most of the studies had confounding or selection bias. Only three studies attained more than half of the maximum score on the Downs and Black's quality assessment tool.

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Conclusions: A few studies reported some changes in malocclusion associated with osteopathy and other manual treatment approaches. As such, there is a need for high-quality research in this area.

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Implications for clinical practice

- Since no evidence for change of malocclusion by osteopathy could be shown yet, patients should be informed of that and the question of necessity of orthodontic treatment should be raised.
- In patients with malocclusion treated (additionally) by osteopathy, the parameters overjet and overbite seem to be influenceable most likely.
- The article presents factors influencing craniofacial growth. These factors should be considered in treatment of patients with malocclusion. Furthermore they should be considered in every child treated by an osteopath because the sooner treatment takes place, the easier craniofacial growth pattern might be influenced.

Introduction

The need for interdisciplinary activities between osteopaths and dentists is often voiced in the literature.^{1–12} In particular, relationships between dentistry and manipulative treatment approaches have become closer in the case of temporomandibular disorders. In addition to the manipulative treatment of temporomandibular disorders, the need to treat malocclusions is often mentioned in the osteopathic literature.^{6–8,10,13,14} Although good results are generally achieved by orthodontic treatment, even alternative orthodontists demand multidisciplinary approaches.^{15–25} The lack of stability of long-term outcomes may be the main argument for accompanying manipulative treatment.²⁶

Malocclusion is the misalignment of teeth or incorrect relationship between the teeth and the dental arches. There are various classifications for malocclusions; the best-known and most widely used classification is that by Angle.²⁷ This is determined by the relative position of the rows of teeth to each other.

The aetiology of malocclusion is important for the development of effective treatment concepts, but is not yet entirely understood. Genetic, embryological and functional components play a role. Some of the functional components could serve as a starting point for manipulative treatment approaches, and should be considered in more detail. No evidence exists regarding parafunctional habits (e.g. thumb-sucking) as contributing factors. Orofacial dysfunctions such as an open-mouth posture, pathological tongue position,

visceral swallowing and articulation problems are considered to be of importance as weak, long-term forces have a greater formative influence than strong, short-term forces.^{28,29} A large cross-sectional-study by Stahl et al. found a significant increase in orofacial dysfunction during the change from milk teeth to mixed dentition.³⁰ Self-regulation of disturbed functional processes is unlikely.^{30,31} However, most distal bites are not due to functional disturbance.³¹

Several authors have discussed mouth breathing as a contributing factor to malocclusion.^{4,15,25,27,32} However, as Stahl et al. only found problems with the nasal airways in 1.7% (first dentition) and 3% (mixed dentition) of subjects, they interpreted mouth breathing as a postural problem.³⁰ The relationship between breathing, posture and mouth has also been discussed by others.^{22,23,28,33} In particular, prognathia and protrusion seem to be associated with mouth breathing.^{16,23,34} In terms of tongue function, several theories serve as a basis for myofunctional treatment approaches like Myofunctional Therapy (MFT). One theory is that the altered tongue resting position due to the open-mouth posture³² causes pathological swallowing.^{21,35} Padovan viewed the balance between the centrifugal forces of the tongue and the centripetal forces of the buccinator mechanism as decisive for the resulting tooth position.³⁶ Therefore, the buccinator musculature seems to play a role in the lateral tooth position.³⁷ Pflaum and Pflaum discussed a glossoptosis/posterior displacement or retraction of the tongue in the absence of centripetal forces of the tongue,

which may lead to distal positioning of the mandible and has a negative effect on body posture, tension and mouth closure.³⁸ Tränkmann also concluded that tongue dyskinesia can result in dysgnathia.^{39,40} Although the tongue resting position is pathological in 36.3% of all cases of deciduous dentition, no clear cause and effect relationship has been found between mouth posture, dentition form, tongue size and tongue resting position.³⁰ Turner et al. reported that tongue dysfunction made a minimal contribution to dysgnathia.²⁹

Thinking osteopathically, craniofacial dynamics are of great interest as an aetiological factor as there is a good possibility to influence this in a child's early years. Several authors have discussed the effects of the birth process on craniofacial dynamics and the incidence of malocclusion.^{11,12,41–43} In the opinion of Delaire, the position of the maxilla and the mandible is a result of the balance between the neck muscle tone and the skull weight.⁴⁴ This balance is said to be controlled by the tension of the intracranial dura duplicature. Sato reported a connection between flexion of the sphenoid and the development of an Angle Class II malocclusion.⁴⁵ James and Strokon, and Schröter reported that inferior vertical strain of the sphenobasilar symphysis led to distal occlusion.^{3,4,46}

Therefore, the need for manipulative treatment approaches is often mentioned in the literature. However, the concepts for approaching the treatment of malocclusion are built upon aetiological models which are far from being evidence based. The aim of this review was to bridge these gaps by looking at the outcomes of manipulative treatment approaches, and to investigate the efficacy of manipulative treatment approaches in malocclusion of the jaws.

Methods

In order to investigate the efficacy of manipulative treatment approaches in malocclusion of the jaws, a systematic literature search was undertaken based upon the guidelines of the PRISMA Statement.^{47,48} The search was made using the databases PubMed, DIMDI, Osteopathic Research Digital Repository, Physiotherapy Evidence Database (PEDro), Chiroindex and Osteopathic Research Net. For the search on DIMDI, all human medical databases were included (i.e. AMED, BIOSIS Previews, The Cochrane Library, Embase and SciSearch, among others). Other relevant osteopathic journals that are not indexed (e.g. Osteopathische Medizin, Osteopathic Medicine and Primary Care) were also searched. Table 1 shows the databases and journals that were searched for this review. Various keyword combinations were used, and these are shown in Tables 2 and 3. The search and selection process was undertaken by TA and was last updated on 24 November 2011.

As few studies have been published on manipulative treatment approaches, the inclusion criteria were fairly wide (studies on humans published in German, English or French language), and databases including publications with different levels of evidence were used. Unpublished work was also included. The authors of the included studies were not contacted. The inclusion and exclusion criteria are shown in Table 4.

Based on the inclusion and exclusion criteria, all titles and, if available, abstracts found in multiple searches were read to identify potential articles for inclusion. Subsequently, the search was expanded by checking the bibliographies and using the 'Related links' function in PubMed to find other relevant publications. After removal of duplicates,

Table 1 Overview of searched databases and journals.

Searched databases	URL
Pubmed	www.pubmed.com
DIMDI	www.dimdi.de
Osteopathic Research Digital Repository	www.ostmed-dr.com
Physiotherapy Evidence Database (PEDro)	www.pedro.org.au
Chiroindex	www.chiroindex.org
Osteopathic Research Net	www.osteopathic-research.com
Searched journals	URL
Deutsche Zeitschrift für Osteopathie DO, Manuelle Therapie, Physiopraxis, Deutsche Heilpraktiker-Zeitschrift	www.thieme.de/connect/de
Osteopathische Medizin	www.sciencedirect.com/science/journal/16159071
Osteopathic Medicine and Primary Care	www.om-pc.com/

Table 2 Keywords used for searching Osteopathic Research Digital Repository, Osteopathic Research Net, Physiotherapy Evidence Database (PEDro), Chiroindex and selected journals.

Keywords	Total no. of hits
Malocclusion*	17
Malokklusion* ^a	2
Occlusion*	85
Okklusion* ^a	29

^a Only used for the search in German journals on www.thieme.de/connect/de.

the remaining full-text articles were reviewed and a final decision was made regarding inclusion or exclusion.

Two instruments were used to assess the methodological and scientific quality of studies. First, the studies were classified according to Sacketts' levels of evidence (Table 5),⁴⁹ and next, the intervention studies (case series or more) were analysed using Downs and Black's quality checklist for healthcare interventions.⁵⁰ This checklist contains 27 items, with a maximum score of 32 points. It consists of five sections with questions about study quality, external validity, study bias, confounding (selection bias) and power of the study. The validity and reliability of this checklist have been tested previously and met accepted standards.

Results

The computer-assisted search of the databases and journals yielded 5763 records. After exclusion of 3425 duplicates, the remaining 2338 records were evaluated using their titles and, if available, abstracts. This resulted in the exclusion of 2278 studies. Fifty-eight full-text articles were checked for eligibility and two eligible studies could not be obtained from the German National Library of Medicine. Only 25 studies met the inclusion criteria. Six other publications were identified by checking bibliographies and using the 'Related links' function in PubMed. One study was found to be published twice,^{51,52} so the second (shorter) publication was discarded.⁵¹ The results of the literature search according to the PRISMA flowchart are shown in Fig. 1. Of the remaining 30 articles, 13 were experts' opinions with hardly any evidence. As such, the remaining 17 articles were analysed using Downs and Black's quality checklist. For one included study,⁵³ only the reprint of a poster presentation had been published. Another included study³² only cited a PhD thesis; the original (dated 1999) was unpublished and written in Spanish.

Most of the studies included in this review were of poor quality. No studies supporting a causal link between treatment and improved occlusion were found. Table 6 shows the levels of evidence of the studies included in this review.

Table 3 Keyword terms used for searching PUBMED and DIMDI, and number of hits.

Keyword terms	Total no. of hits	Keyword terms	Total no. of hits
Malocclusion	62,751	Dental occlusion	51,759
'AND manip*	263	'AND manip*	338
'AND manual*	212	'AND manual*	251
'AND myofuncti*	542	'AND myofuncti*	115
'AND osteopath*	52	'AND osteopath*	30
'AND physical*	1161	'AND physical*	1970
'NOT orthodont*	12,893	'NOT orthodont*	13,218
'NOT surgery	6900	'NOT surgery	9777
'AND therapy	2913	'AND therapy	2394
'AND manip*	14	'AND manip*	16
'AND manual*	12	'AND manual*	9
'AND myofuncti*	59	'AND myofuncti*	12
'AND osteopath*	3	'AND osteopath*	4
'AND physical*	86	'AND physical*	108
'AND treatment	3396	'AND treatment	2961
'AND manip*	18	'AND manip*	22
'AND manual*	13	'AND manual*	11
'AND myofuncti*	62	'AND myofuncti*	12
'AND osteopath*	4	'AND osteopath*	5
'AND physical*	103	'AND physical*	123

Bold value signifies the total no of hits.

Table 4 Inclusion and exclusion criteria.*Inclusion criteria*

1. Article evaluates a treatment approach of any form of malocclusion by either chiropractic, manipulative, manual, myofunctional, osteopathic or physical therapy.
2. The goal described is to change dental relationships/occlusion parameters.

Exclusion criteria

1. Cross-sectional studies.
2. All patients had been treated before or at same time by orthodontic methods (e.g. oral appliances, elastics, plates, splints, headgear). Studies comparing non-orthodontic with orthodontic interventions were not excluded.
3. The article evaluates treatment modalities for lowering pain in patients suffering from temporomandibular disorders/CMD.
4. Patients had previously been treated surgically or teeth/tooth had been extracted.
5. Patients had other severe pathologies (e.g. osteoarthritis, cleft, rheumatoid arthritis, handicaps)
6. Patients had fractures in the craniocervical area.
7. Article only evaluates changes in pain level or kinaesthetic parameters.

It is immediately obvious from [Table 6](#) that nearly half of the 30 articles were experts' opinions with hardly any evidence. Six of these authors claimed that there is a need for, at least, an additional osteopathic-thinking approach.^{1,12,67–69,72,76} Nasedkin mentioned the potentially positive contributions of physical therapy for equilibration

of occlusion.⁷⁴ Rocabado et al. reported the need for physical therapy in cases of malocclusion combined with postural problems.⁷³ Tränkmann⁴⁰ was the only advocate for MFT approaches, while Stöckli et al. and Proffit and Brandt rejected the need for such approaches in cases of malocclusion.^{71,75} The only 'review' without any information on methodology drew the same conclusion.⁵⁵

Most papers with therapeutic approaches were of poor quality and had a low level of evidence. Nevertheless, these studies were analysed more extensively. Various treatment modalities were used: 11 studies applied different forms of myofunctional exercises for strengthening the circumoral muscles [most of these studies used MFT, first mentioned and described by Garliner⁷⁷], two studies used chiropractic techniques, and two studies used an osteopathic approach. [Table 7](#) gives an overview of the intervention studies included in this review, ranked by quality score.

MFT approach

Five studies compared an exclusively MFT approach with a combined MFT/orthodontic treatment approach. The study by Benkert had the best methodology.⁵⁷ This retrospective study used the treatment records of 100 patients from a pool of 3500 patients. The female:male ratio was 60:40 and mean age was 14.19 (standard deviation 7.87) years. The patients were divided into five groups: one group received MFT before orthodontic treatment; one group had previously received orthodontic treatment and returned due to recurrence of malocclusion; one group received simultaneous orthodontic treatment; one group received orthodontic treatment after MFT; and one group

Table 5 Sacketts' levels of evidence.⁴⁹

Level 1a: Systematic review (with homogeneity) of RCTs
Level 1b: Individual RCT (with narrow confidence interval)
Level 1c: All or none case series
Level 2a: SR (with homogeneity) of cohort studies
Level 2b: Individual cohort study (including low-quality RCT; e.g. <80% follow-up)
Level 2c: 'Outcomes' research
Level 3a: SR (with homogeneity) of case-control studies
Level 3b: Individual case-control study
Level 4: Case series (and poor-quality cohort and case-control studies) ^a
Level 5: Expert opinion without explicit critical appraisal, or based on physiology, bench research or 'first principles'

^a 'Poor-quality cohort study' means one that failed to clearly define comparison groups, and/or failed to measure exposures and outcomes in the same (preferably blinded) objective way in both exposed and non-exposed individuals, and/or failed to identify or appropriately control known confounders, and/or failed to carry out a sufficiently long and complete follow-up of patients. 'Poor-quality case-control study' means one that failed to clearly define comparison groups, and/or failed to measure exposures and outcomes in the same (preferably blinded) objective way in both cases and controls, and/or failed to identify or appropriately control known confounders. RCT, randomized controlled trial.

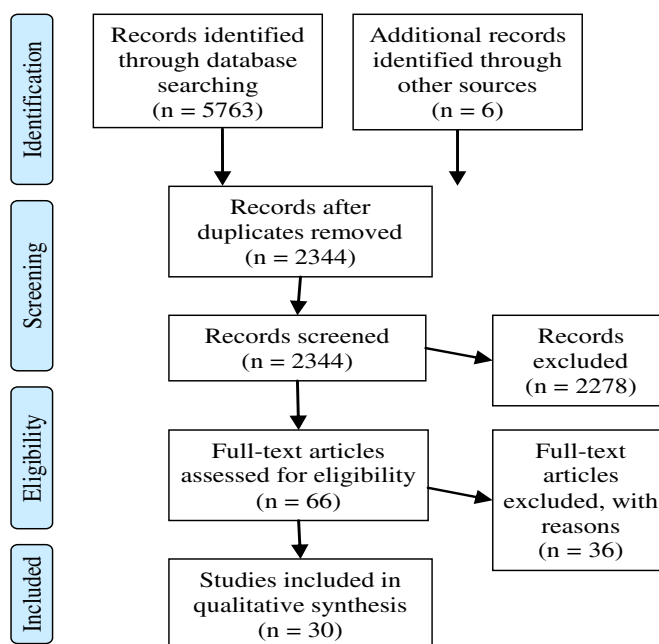


Figure 1 Results of the literature search according to the PRISMA flowchart.

received no orthodontic treatment at all. Independent of the group association, significant changes in overbite and overjet were achieved and backed up statistically. For the groups that had not had orthodontic treatment, the mean value for open bite changed from 2.13 to 0.31 mm, and the mean value for overjet changed from 3.33 to 1.82 mm.

In a pilot study, Daglio et al. treated 28 patients of both sexes between the ages of 8 and 17 years.⁵² One group was treated exclusively with MFT (13 patients), and the other group was treated with a combination of orthodontic treatment and MFT (15 patients). The combination therapy group had greater changes in overjet, ANB angle (anterior–posterior relationship of the maxilla with the mandible) and mandibular plane angle than the

MFT group. For overbite, the results of the MFT group were superior to the results of the combination therapy group. In the MFT group, overbite changed significantly from -2.46 to $+3.06$ mm, and overjet changed, although not significantly, from 3.5 to 2.63 mm.

The other comparison studies were of poor quality. Bennett et al. compared two groups (total 17 patients) with anterior open bite.⁵⁹ The group treated with myofunctional exercises (using a tool named 'Thera-Spoon') had significantly less change in open bite than the group treated with an orthodontic appliance (1 mm vs 2.13 mm, respectively). Garretto reported an efficient dysgnathia treatment when MFT and orthodontic treatment were combined.³² However, for patients treated with MFT alone, orthodontic treatment was still indicated

Table 6 Distribution of the included publications with different levels of evidence. Ranked from highest to lowest level of evidence.

Levels of evidence	Number of studies	Authors and year of publication
2	1	2b: Bombardini et al. (2004) ⁵⁴
3	4	3a: Deschenes (1983) ⁵⁵ 3b: Kopp (2003) ⁵⁶ ; Benkert (1997) ⁵⁷ ; Barber and Bonus (1975) ⁵⁸
4	12	Borili and Dal Bello (2011) ⁵³ ; Garretto (2001) ³² ; Bennett et al. (1999) ⁵⁹ ; Haruki et al. (1999) ⁶⁰ ; Obijou et al. (1997) ⁶¹ ; Bondi (1995) ⁶² ; Daglio et al. (1990) ⁵² ; Tränkmann (1985) ³⁹ ; Garliner (1982) ⁶³ ; Llorens (1982) ⁶⁴ ; Milch (1975), ⁶⁵ Baker (1971) ⁶⁶
5	13	James (2008) ⁶⁷ ; Frymann (2007) ⁶⁸ ; Kellner (2007) ⁶⁹ ; Stimson (2007) ¹ ; Mason (1988) ⁷⁰ ; Stöckli et al. (1987) ⁷¹ ; Libin (1986) ⁷² ; Rocabado et al. (1982) ⁷³ ; Tränkmann (1982) ⁴⁰ ; Nasedkin (1978) ⁷⁴ ; Proffit (1977) ⁷⁵ ; Magoun (1975) ¹² ; Magoun (1974) ⁷⁶

Table 7 Overview of included intervention studies, ranking based on quality score.

Author(s) and year	Study population and dental characteristics	Methodology	Interventions compared	Main results	Quality score as number or grading ($n_{\max} = 32$)
Benkert ⁵⁷ 1997	100 out of 3500 randomly assigned records of patients of a private practice of an orofacial myofunctional therapist. Open bite and overjet of more than 1 mm each	Retrospective study, evaluation of mean values with standard deviation, paired two-sample <i>t</i> -test, ANOVA	MFT vs MFT + orthodontics	All groups showed significant improvement in overbite and overjet. No significant difference was found for either group for overjet. Improvement of overbite was greater for MFT alone	21
Bombardini et al. ⁵⁴ 2004	44 Malocclusion	RCT of moderate quality, unpaired two-sample <i>t</i> -test	Osteopathy	Significant change in overjet and overbite in treatment group	20
Barber and Bonus ⁵⁸ 1975	41 41 Class I 32 tongue thrusters with anterior open bite and protrusive incisors and 9 non-tongue thrusters	Case series, ANOVA and <i>t</i> -test	Myofunctional exercises for circumoral muscles	Circumoral muscles were strengthened, no change of axial inclination and no positional change of dental arches were found	18
Daglio et al. ⁵² 1990	28 7 Class I, 18 Class II, 3 Class III, 5 cases overbite; 3 cases deep bite, 3 cases open bite with anterior gaps, 3 cases open bite and crossbite, 4 cases gap position of anterior teeth, 3 cases deep bite	Case series, pilot study, evaluation of mean values and standard deviation, <i>t</i> -tests and ANOVA	MFT vs MFT + orthodontics	Significant change in overbite, ANB angle and jaw base angle for both groups In overbite, MFT alone was more efficient than MFT + orthodontics	16
Obijou et al. ⁶¹ 1997	45 children with dyskinesia of tongue (and lips) 22 Class I 20 Class II, 1 2 Class II, 2 1 Class III	Case series, retrospective study, evaluation of mean values and standard deviation, Fisher's and Wilcoxon's test for significance	MFT	No significant change in overjet, significant change in overbite	16

(continued on next page)

Table 7 (continued)

Author(s) and year	Study population and dental characteristics	Methodology	Interventions compared	Main results	Quality score as number or grading ($n_{\max} = 32$)
Kopp and Plato ⁵⁶ 2003	19 (12 probands, 7 controls) dental characteristics n/a	Case–control, no statistics	Chiropractic treatment	The position of the mandibular condyle changed in all patients in anterior and caudal direction. The change in the lateral direction was indifferent	16
Bennett et al. ⁵⁹ 1999	17 Anterior open bite	Case series, evaluation of mean values and standard deviation	Appliance vs myofunctional exercises with a tool named Thera-spoon	Change of open bite was significantly lower in patients treated with Thera-spoon (1.00 mm) compared with patients treated with appliance (2.13 mm). Change of other cephalometric parameters was significantly lower too	14
Llorens ⁶⁴ 1982	5	Case series, experimental study, no statistics	Osteopathy	Under manipulation of the skull, a change in intermolar distance was measured	12
Garretto ³² 1999	129 dental characteristics n/a	Case series, ANOVA and Tukey–Kramer’s test	MFT vs orthodontics vs MFT + orthodontics	All patients treated with MFT + orthodontics showed an integral rehabilitation of the stomatognathic system. In 81.25% of patients treated with MFT alone, orthodontics were still indicated. In 70.59% of patients treated with orthodontics alone, MFT was still indicated.	11

Tränkmann ³⁹ 1985	65 Class II and III, frontal and lateral infra-occlusions	Case series, no statistics	MFT vs orthodontics vs. MFT + orthodontics	Before–after photographs show change of occlusion in patients treated only with MFT. Orthodontics still indicated in all cases	8
Baker ⁶⁶ 1971	1 Open bite	Case report, no statistics	Osteopathy	Measurements on alginate impressions made after each of 20 osteopathic treatment sessions showed a maximum change of 0.0276 inches in maxillary second molar distance '...symptoms disappeared and new occlusion remained stable...'	n/a
Bondi ⁶² 1995	1 Abnormal swallowing, posterior rotated mandible	Report of 2 cases (only 2nd case relevant), no statistics mentioned	Exercises for lip, tongue, posture, breathing, swallowing; Shiatsu, phonetic exercises		n/a
Borili and Dal Bello ⁵³ 2011	n/a ^a Malocclusion	Case series, no statistics	Chiropractic treatment	66% of all cases showed a positive relationship with chiropractic treatment and patients reduced malocclusion	n/a
Deschenes ⁵⁵ 1983	n/a ^b	Review	MFT	Although MFT may induce short-term changes in swallowing patterns, there is no evidence that these changes have any beneficial effect on occlusal relationship	n/a
Garliner ⁶³ 1982	1 Open bite	Case report, no statistics	MFT	Circumoral muscles were strengthened, before–after photographs show reduction of open bite	n/a

(continued on next page)

Table 7 (continued)

Author(s) and year	Study population and dental characteristics	Methodology	Interventions compared	Main results	Quality score as number or grading ($n_{\max} = 32$)
Haruki et al. ⁶⁰ 1999	2 children with digital sucking habit Open bite and overjet	Report of 2 cases, no statistics	Educational programme for stopping the digital sucking habit based on MFT principles MFT	Reduced open bite and overjet	n/a
Milch ⁶⁵ 1975	1 Open bite	Case report, no statistics		'...improvement in tooth alignment...' shown by before–after photographs	n/a

RCT, randomized controlled trial; MFT, myofunctional therapy; ANOVA, analysis of variance; n/a, not applicable.

^a Size of study population not mentioned.

^b As the article was a poor-quality review, only a few fields of the table could be completed.

afterwards in 81.25% of cases. As only the citation of the original study was available, information about the methodology was poor. No valid measurement methods or the extent to which the bite had changed were mentioned. This study only addressed whether or not orthodontic treatment was necessary after MFT. Tränkmann showed a change in occlusion following MFT alone and in combination with orthodontic treatment using before–after photographs.³⁹ As no measurable parameters were collected, the evidence was lacking.

Six other studies used different MFT approaches, but only three of them had some evidence. Barber and Bonus selected 41 children aged 7–19 years from a pool of 500 patients, all with Angle Class I.⁵⁸ Thirty-two of these children were tongue thrusters with an anterior open bite and protrusive incisors. Two groups of tongue thrusters were treated with myofunctional exercises for the buccal muscles, and one group of tongue thrusters and one group of non-tongue thrusters served as controls. An increase in pre-exercise muscular strength was found in the treated groups, but none of the groups showed a change in cephalometric analyses or tooth position. Obijou et al. studied 45 patients (23 females, 22 males) with orofacial dyskinesias and an average age of 14 (standard deviation 1.7) years; no significant change was found in overjet (4.7 vs 4.6 mm), but a small and significant change was found in overbite (1.9 vs 2.4 mm).⁶¹ Haruki et al. reported two cases of open bite: a change in overbite from 0 to 2.5 mm was seen in the first case, and a change in overbite from –6.5 to –1.5 mm and a change in overjet from 8 to 3 mm was seen in the second case.⁶⁰

The other three studies with an MFT approach were of poor quality and had a lack of significance: Bondi⁶² reported one case of a posterior rotated mandible, and both Garliner⁶³ and Milch⁶⁵ reported one case of open bite. All of them reported successfully treated cases without any valid and reliable measurements.

Chiropractic approach

The two studies with a chiropractic approach were of medium to poor quality. The better of the two studies was by Kopp and Plato.⁵⁶ They reported an anterior, caudal change in the position of the mandible after C1 manipulation. However, as their study aimed to investigate the interaction between the temporomandibular joint and the cervical spine, no information was provided about the participants (either general data or data about their dental status). The published reprint of the poster presentation of a study by Borili and Dal Bello reported that 66% of their subjects with

malocclusions responded positively to chiropractic treatment, with a reduction in malocclusion.⁵³ However, the number of participants, the types of malocclusion, and any valid or reliable measurements were not reported.

Osteopathic approach

The three intervention studies with an osteopathic approach were of differing quality. In the only randomized, controlled trial (RCT) included in this review, Bombardini et al. examined 21 girls and 23 boys.⁵⁴ There was no homogeneity in the type of malocclusion, because malocclusions in general were included. Twenty-seven children were in the treatment group and 17 children were in the untreated control group. In the treatment group, significant changes in the sagittal and transverse jaw dimensions, overjet (right side 2.64–2.37 mm, left side 2.82–2.41 mm) and overbite (right side 3.07–2.1 mm, left side 2.95–2.1 mm) were found. Differences in the control group were also significant. No improvement was found for deep bites.

The other studies on osteopathic approaches for malocclusion were of poorer quality. In a case report, Baker reported a change in the maxillary width between the second molars of up to 0.7 mm after 6 months of osteopathic treatment.⁶⁶ The difference between the largest and smallest of 20 measurements was given as the change in the intermolar distance of 0.0276 inches (approx. 0.7 mm). In a case series of five patients, Llorens demonstrated minimal mobility of the SBS and the frontomaxillary suture, which decreased markedly with increasing age.⁶⁴ In contrast to Baker,⁶⁶ no information on the validity and reliability of measuring tools was given.

Figs. 2 and 3 give an overview of changes in overjet and overbite from these studies.

Discussion

None of the studies included in this review were methodologically strong. Downs and Black's quality checklist found that most insufficiencies were external and internal validity. The main methodological problem was the inhomogeneity or lack of information on subjects' characteristics (e.g. form of malocclusion, gender, age).^{32,39,52–54,56–59,61,64} Benkert, at least, evaluated the differences between the age groups, but no significant differences were found.⁵⁷

Another weakness was the lack of information about recruitment and the assignment of patients to different groups.^{52,56,58} Follow-up and long-term outcomes were not of interest in most studies. Benkert included a form of long-term stability as the measurement values used had been determined at least 1 year after the end of therapy.⁵⁷

A further criticism of most studies included in this review is that schemes concerning duration, order and type of treatment technique were not given. However, to qualify this, Herrmann stated that the power of such approaches is based on accommodating the individual circumstances of each patient.¹⁷ Otherwise, the advantage of such individual approaches over others is lost.

Several other methodological insufficiencies were found. Benkert did not appear to adhere strictly to the inclusion criteria of overjet and overbite of >1 mm each: 'The open bite and overjet were compared independently, since not all subjects in the study had both measures.'⁵⁷ Bombardini et al. reported a change in overbite in relation to standard values,⁵⁴ but these standard values were not given. Furthermore, their patients originated from personal relationships or were selected by an orthodontist. Although this study had an acceptable age range (4–7 years), this age distribution has problems in terms of comparability

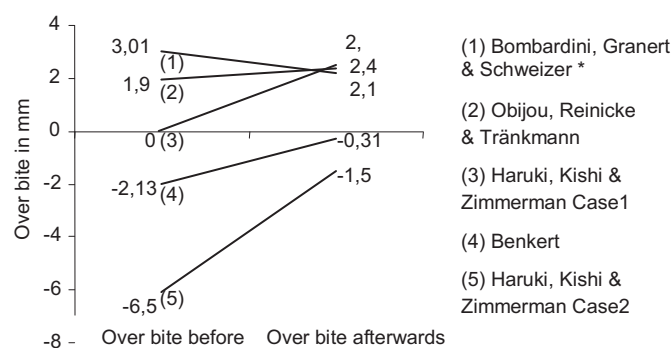


Figure 2 Overview of changes in overbite. *For Bombardini et al.,⁵⁴ the average was calculated from the separately measured values for left and right sides.

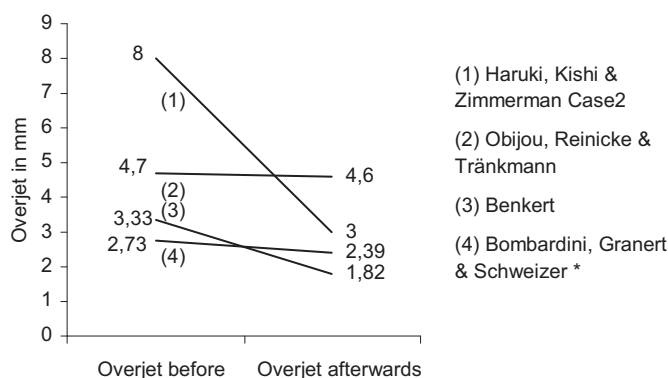


Figure 3 Overview of changes in overjet. *For Bombardini et al.,⁵⁴ the average was calculated from the separately measured values for left and right sides.

due to differences in the progress of dentition. For this reason, an age limit based upon the stage of development of the dentition would have been better. For Baker's report,⁶⁶ two independent investigators used reliable and valid measurement methods. However, the values that were used to prove the effects were not the values comparing the first and last examinations; the difference in these values was much smaller.

The present review has several methodological weaknesses, too. A single author selected, rated and extracted the data, and this could have introduced bias. However, it is unlikely that an important randomized trial was missed, as numerous databases were searched with multiple keywords. Therefore, a second assessor would not have changed the conclusions. The inclusion criterion of publication in English, French or German literature did not introduce a large bias, as most scientific papers are published in these languages.

Systematic reviews on more heavily researched topics only include double-blind RCTs. However, in the present review, only one methodologically weak RCT was found. Blinding is more difficult in RCTs for manual treatments, surgery, psychotherapy, etc. than RCTs for drugs or vaccines. Social desirability bias can often not be excluded unless objective measures are taken. For the present research, overjet and overbite were considered to be objective, and therefore there was no need for patients to be blinded to their treatment if observers were blinded to their group allocation. No limitations were made concerning the level of evidence, as experts' opinions with a low level of evidence can also contribute to the generation of new ideas and hypotheses.

From the 30 studies identified, only one had Level 2 evidence,⁵⁴ and this was the only unpublished study. Only three studies attained more than half of the maximum score on the Downs and

Black's quality assessment tool.^{54,57,58} Nearly half of all contributions (13 out of 30) were experts' opinions.^{1,12,40,67-76} Interestingly, the more expert opinions that existed, the smaller the number of intervention studies: seven experts were 'pro' osteopathy^{1,12,67-69,72,76} in contrast to three intervention studies,^{54,64,66} and three experts were against MFT for the treatment of malocclusion^{70,71,75} in contrast to 11 intervention studies.^{32,39,52,57-63,65} Only one expert was 'pro' MFT.⁴⁰

Finally, it is obvious that there is a large gap between scientific evidence and expert opinions or textbooks on the need for additional manual treatment approaches. There is little evidence that the shape of the dental arches and their relationships with one another could be influenced, to a certain degree, by manual treatment approaches. In terms of the efficacy of the various treatment approaches, it was not possible to evaluate the differences statistically, as the studies dealt with groups that were not comparable in terms of the form of malocclusion or the state of dentition. It was not possible to determine which manual treatment approaches could be considered (at least additionally) for which dentition ages from the analysed literature. Regarding osteopathy, the same applies with respect to the type of malocclusion. For MFT, some case reports and case series suggested some efficacy in the treatment of open bite.

In summary, evidence is lacking regarding whether osteopathy and other manual treatment approaches have a positive, negative or no effect on malocclusions. However, as some promising results were found in this review,^{52,54,57,60,61} there is a need for high-quality research to prove or refute the efficacy of such approaches in the treatment of malocclusion.

This review also found other points of interest. Bombardini et al. showed that, in orthodontic

treatment, the correction is primarily effected through the maxilla.⁵⁴ Allopathic medicine argues that the growth pattern of the mandible is difficult to influence. However, Bombardini et al. suggested that changes primarily occur in the mandible.⁵⁴ Although the evidence from their study is moderate, this is an interesting starting point to challenge thinking patterns in traditional orthodontic treatment. Aetiology and pathophysiology should no longer be virtually ignored in the identification of more effective and long-lasting treatment approaches. Stahl et al. stated that current orthodontic treatment goals are based increasingly on the correction of malaligned teeth. The possibility of using technological aids to acquire perfect teeth positioning often leads to the aetiological factors of disturbed dental development being disregarded.³⁰ One of these factors could be general hypotonia with open-mouth posture for Angle Class II, 1.^{30,34,78} Also, in Sato's opinion, the occlusion contact is of enormous importance in guaranteeing the correct positional relationship between the maxilla and the mandible.⁴⁵

Thinking osteopathically, birth-induced compression of the XII cranial nerve^{79,80} or skull asymmetries may also play a role. Regarding development,⁸¹ an inferior vertical strain lesion of the SBS is suggested to be a contributing factor in overjet.³¹ As a holistic therapy, it is conceivable that osteopathy, in particular, could affect the orofacial myofunctional status and could influence developmental processes.

With this idea, a basis for supporting the interdisciplinarity of standard medicine and complementary medicine is provided. Stimson noted that only particular hypotheses circulate among certain experts, and they seldom leave these circles.¹ What is missing is the courage not to be restricted in one's thinking. James stated that the greatest difficulty and challenge for future research is to re-examine old paradigms.⁶⁷ This is absolutely necessary. Thinking reductionistically has predominated long enough in medicine, from which only knowledge of closed systems can be won. Slavicek described this as the false path of modern medicine.²² James added that for an open system such as the human being, only probabilistic, rather than certain, statements can be made.⁶⁷ The absence of evidence does not mean that there must be evidence of absence.

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