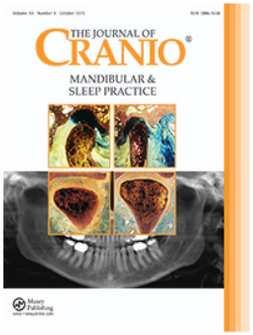

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LITERATURE REVIEW

Applied kinesiology and dentistry – A narrative review

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ABSTRACT

Objective: To investigate the use of applied kinesiology in the field of dentistry.
Methods: A review of the literature was carried out looking for all articles written on the topic. PubMed, Ovid Medline, and The Cochrane Central Register of Controlled Trials (CENTRAL) databases were searched.
Results: Only one study was retrieved on the use of applied kinesiology in temporomandibular disorder patients, and only one study was published on dental material testing. A change in muscle strength associated with changes in dental occlusion has been observed in many of the articles selected.
Discussion: The use of applied kinesiology for the diagnosis and treatment of pathologies in the field of dentistry is not supported by scientific evidence. However, a relationship between dental occlusion or maxillo-mandibular relationship and isometric muscle strength has been noted.

KEYWORDS
Applied kinesiology; muscle testing; muscle strength; dentistry; dental occlusion; vertical dimension; temporomandibular disorders

Introduction

Kinesiology is the study of muscles and their effects on movements; it is widely used to assess neurologic integrity. A more specific type of kinesiology is called "applied kinesiology." The term refers to a discipline that uses manual muscle testing (MMT) to assess a variety of body functions [1]. Applied kinesiology (AK) evaluates a summation of excitatory and inhibitory inputs reaching the motoneurons of the anterior horn of the spinal cord by testing the response of a particular muscle to resistance applied by a trained professional examiner. A conditionally inhibited response is designated as "weak," and a conditionally facilitated response is designated as "strong" [2]. Authors have intended to study alterations in neuromuscular function in response to physical, chemical, or mental stimuli, usually used in combination with a standard physical examination with both diagnostic and therapeutic purposes [1,3].

A particular type of muscle testing is "therapy localization" (TL). This is a technique by which any strong and normally functioning muscle (indicator muscle) will become weak when the patient places his finger on a specific area to be tested [2].

The reliability and validity of MMT have been studied by Cuthbert and Goodheart [2] in a review article, where they concluded that "The MMT employed by chiropractors, physical therapists, and neurologists was shown to be a clinically useful tool, but its ultimate scientific validation and application require testing that employs sophisticated research models in the area of neurophysiology, biomechanics, randomized controlled trials, and statistical analysis." However, their study was criticized by Haas et al. [4], who described many flaws of the article. First, they included in the review trials on MMT used as a standard orthopedic/neurological test to evaluate muscle and neurologic integrity, which is very different from the use of MMT in AK applications. They also carried out a limited review of the literature, excluding from the study trials showing poor interexaminer reliability [5–7], insufficient sensitivity and specificity [6–8], and no test–retest reproducibility [9]. According to the authors, when evaluating only MMT as used in AK, excluding the studies where it is used in standard orthopedic/neurological procedures, the limited trials either refute or cannot support the validity of AK procedures as diagnostic tests. Specifically, MMT for the diagnosis of organic pathologies or presumed pre/subclinical diseases is not supported by scientific evidence [4].

Nonetheless, some authors have suggested the use of AK in the field of dentistry [10–13]. For this reason, the present review tries to summarize the studies on the topic with the purpose to evaluate whether the use of AK is scientifically supported and can be suggested as a diagnostic and therapeutic tool in the field of dentistry.

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Materials and methods

Literature search

A literature search was carried out looking for articles on the use of AK in dentistry, including PubMed, Ovid Medline, and The Cochrane Central Register of Controlled Trials (CENTRAL) databases. After combining the different keywords and limiting the search to human studies, the titles and abstracts were examined to exclude articles not related to the topic. A handsearch of the references of the selected articles was performed looking for additional papers. An outline of the literature search is shown in Table 1.

Results

A total of 23 articles were identified on the topic through the database search, and 21 additional papers were found after examining the references. Three of them, which were very old, could not be obtained (Table 1).

Table 1. Literature search.

Searches	Keywords	Results
1	Applied kinesiology	44,325
	Kinesiology	
	Muscle testing	
	Manual muscle testing	
	Muscle strength	
	Isometric strength	
2	Dentistry	53,7008
	Dental	
	Dental occlusion	
	Temporomandibular joint	
	Temporomandibular joint disorders	
	Temporomandibular disorders	
	Craniomandibular disorders	
	TMJ	
	TMD	
	CMD	
	Myofascial pain	
	Myofascial pain syndrome	
	Myofascial pain dysfunction syndrome	
	Face pain	
	Facial pain	
	Toothache	
	Tooth pain	
	Tooth pathology	
	Tooth cavities	
	Tooth decay	
	Periodontitis	
	Pulpitis	
	Dental abscess	
	Dental materials	
	Composite resin	
	Dental composite	
	Dental composite resin	
	Dental amalgam	
	Amalgam	
	Mercury amalgam	
3	1 AND 2	316
4	Limit to humans	170
5	Title and abstract selection	23
6	From references	21
7	Unobtainable	3
8	Total of articles obtained	41

Several articles, especially the less recent ones, were not clinical trials, rather they represented experts' opinions on the applications of AK in the field of dentistry [10–17]. Five of them were review articles [1,18–21], and the rest were clinical trials [22–50]. Most of the clinical trials included only one group of subjects, who were tested in different conditions (the same subjects were used as their own control) [22,23,25–32]. Only two trials included a placebo [24,25], and only 6 were single- or double-blind studies [24–28,33].

The specific topics of AK described in the articles were: 1) application of AK in dentistry; 2) evaluation of dental occlusion; 3) temporomandibular disorders; and 4) dental material testing. They are shown in the respective sections. No trials were identified on therapy localization.

Application of applied kinesiology in dentistry

Goodheart [11–13], in three papers, promotes the use of AK for the evaluation of dental health, especially for the assessment of proper mandibular and temporomandibular joint (TMJ) function, by the use of MMT and TL. The use of MMT was also encouraged by Eversaul [10], especially for the determination of correct vertical dimension of dental occlusion (VDO), and by Glassley [14], to identify TMJ disorders before the occurrence of signs and symptoms, to distinguish which TMJ and neuromuscular mechanism is altered, to recognize the necessity of preventive procedures in children, to identify cellular energy deficit and nutritional deficiencies, to establish proper VDO, to detect the degree of TMJ degeneration and discover whether complete resolution is achievable, and to comprehend the cause-and-effect relationship between TMJ pathology and other general health conditions. Moreover, Nahmani [15] supports the use of AK MMT for the examination of TMJ disorders and dental occlusion. The only experts' opinions dismantling the use of AK were written by Schissel [16] and Jakush [17] while examining the use of alternative medicine in dentistry and questioning the placebo effect of dental appliances.

In addition, two reviews, by Deogade et al. [1] and Singh et al. [20] promote the use of AK in different fields of dentistry, such as orthodontics, detection of neuralgia-inducing cavitational osteonecrosis (NICO), dental material tolerance, and temporomandibular disorders (TMD). Nonetheless, no evidence was described to support those hypotheses, and the studies cited do not corroborate such suppositions.

Evaluation of dental occlusion

When specifically looking for AK evaluation of dental occlusion by the use of MMT, no clinical trials were

identified. Nonetheless, a change in muscle strength associated with changes in dental occlusion has been observed in many of the articles selected. Specifically, some of them described the effect of dental occlusion on isokinetic and isotonic muscle strength, which is not the muscle strength evaluated with MMT used in AK; therefore, they were not included in the results [34–50]. Some others reported the effect of dental occlusion on isometric muscle strength, which instead represents the muscle strength evaluated with MMT used in AK [22–32].

The use of a dental appliance, or, more specifically, a mandibular orthopedic repositioning appliance (MORA), was generally associated with an increase of isometric muscle strength when compared to biting without an appliance and biting on a placebo appliance [22,23,25–30,32]. The results are summarized in Table 2.

Schwartz et al. [22] describe the effect of a tailored designed and properly adjusted mouthguard worn by 8 Junior Olympic boxers, in place of standard mouthpieces, on different athletic performances and isometric deltoid strength. Muscle strength subjectively increased in all the subjects examined, while undergoing a deltoid resistive test by their coach. The same results were achieved by Smith [23] in professional football players. In this case, the measurement of isometric deltoid strength was performed by the use of a kinesiometer. The opposite outcome was reported by Burkett et al. [24]; the results do not confirm an increase in muscle strength when wearing a MORA. They randomly selected two groups of 15 subjects each from volunteers and tested muscle strength in different performances. Among them, isometric muscle strength of hamstrings and quadriceps did not differ between subjects wearing a MORA built in the myocentric position and subjects wearing a placebo appliance.

Abduljabbar et al. [25] carried out a double-blind placebo-controlled study to test the isometric strength of the shoulders and limb muscles in different occlusal conditions. Twenty female patients with TMD and loss of VDO were examined in each of the following conditions: 1) biting on habitual occlusion; 2) biting on a bite-elevating appliance; and 3) biting on a placebo appliance. Muscle strength of elbow flexors and extensors, shoulder flexors and extensors, and knee flexors and extensors was measured with a system of pulley and electronic strain gauges to attain an objective measure. The results show an increase of muscle strength when biting on the bite-elevating appliance compared to biting on habitual occlusion and biting on the placebo appliance. The percentage of strength increase varied from 12.5% to 21.5% for the top responders and from −0.3% to 6.1% for the lower responders.

In an analogous study, Al-Abbasi et al. [26] examined 15 subjects with TMD and loss of VDO and measured muscle strength of the cervical flexors using a hand-held strain gauge. The patients were tested under four bite positions: 1) habitual occlusion; 2) retruded mandibular position; 3) edge-to-edge incisal contact; and 4) lateral shift mandibular position. Each of these positions was tested under two different VDOs: biting without bite plate on natural dentition and biting with a bite-elevating appliance (BEA) inserted. Muscle strength of the cervical flexors was significantly higher when biting on the BEA compared to biting on natural dentition; the range of strength increase was calculated between 24% and 42%.

A different approach was followed by Chakfa et al. [27], who also evaluated muscle strength of the cervical flexors and deltoid muscles in a sample of 20 asymptomatic females with loss of VDO using a hand-held strain gauge but measured the strength at gradually increasing values of VDO. This was achieved by testing the muscles in the subjects' dental occlusion and having the subjects bite on 4 different dental appliances of 2, 4, 6, and 12 mm thickness. It was observed that, as the VDO is increased from habitual occlusion, muscle strength tends to increase, reaching a peak of 24% increment for the cervical flexors and 29% increment for the deltoids. A reduction in muscle strength follows as the VDO is further elevated.

In a very similar study by Abdallah et al. [28], 16 asymptomatic female dental students with loss of VDO were evaluated. Isometric muscle strength of the deltoids was tested in four different conditions: 1) habitual occlusion; 2) mandibular rest position; 3) biting on a BEA; and 4) biting on a placebo appliance. The results showed that isometric deltoid strength in habitual occlusion was lower than in the mandibular rest position. Muscle strength with the BEA was greater than in habitual occlusion and in the mandibular rest position. Isometric deltoid strength in habitual occlusion and biting on a placebo appliance did not differ.

Increase in muscle strength was also evaluated by the use of electromyography (EMG) by Lee et al. [29,30] in two different studies. Trunk, upper limb, masseter, and forearm muscles showed greater muscle activity while wearing a MORA. Limonta et al. [32] report similar results assessing the subjects in 3 different conditions: 1) habitual occlusion; 2) biting on a 1 mm-thick self-adapted occlusal appliance; and 3) biting on a 3 mm-thick self-adapted occlusal appliance. Maximum voluntary contraction was significantly higher when biting on either the 1-mm-thick or the 3-mm-thick appliance compared to habitual occlusion.

Conversely, Isselee et al. [31] report the opposite results. They measured isometric strength of the abductors of the shoulder and the quadriceps muscles using

Table 2. Dental occlusion and isometric muscle strength.

Articles	Number	Subjects	Appliance	Placebo	Muscle tested	Measurement	IMS
Swartz et al. [22]	8	Junior Olympic boxers	Non- specified	No	Deltoid	Resistive test by the coach	With appliance > without appliance
Smith [23]	16	Professional football players	Maxillary- adjusted mouthguard	No	Deltoid	Kinesiometer	Adjusted mouthguard > non-adjusted mouthguard
Burkett et al. [24]	30	Volunteers	MORA in myocentric	Yes	Hamstrings, quadriceps	Dynamometer	MORA = placebo
Abduljabbar et al. [25]	20	TMD patients with deep bite	Mandibular BEA set with MMT	Yes	Elbow flexors/extensors, shoulders flexors/extensors, knee flexors/extensors	A system of pulleys and electronic gauges	BEA > placebo = MI
Al-Abbasi et al. [26]	15	TMD patients with deep bite	Mandibular BEA set with MMT	No	Cervical flexors	Strain gauge	BEA > rest position > MI
Chakfa et al. [27]	20	Asymptomatic females with deep bite	2-, 4-, 6-, and 12-mm mandibular BEAs	No	Cervical flexors, deltoid	Strain gauge	BEA > MI
Abdallah et al. [28]	16	Asymptomatic females with deep bite	Mandibular BEA set with MMT	No	Deltoid	Strain gauge	BEA > rest position > MI
Lee et al. [29]	20	Asymptomatic volunteers	3-mm MORA	No	SCM, cervical and lumbar erector spinae, trapezius, biceps, triceps, rectus abdominis, internal oblique, external oblique	EMG	MORA > without appliance
Lee et al. [30]	28	Asymptomatic volunteers	3-mm MORA	No	Masseter, forearm flexor bundle, forearm extensor bundle	EMG	MORA > without appliance
Isselee et al. [31]	21	Asymptomatic volunteers	2–4-mm hard wax bite	No	Quadriceps, shoulder abductors	Dynamometer	MI = mouth opening = wax bite
Limonta et al. [32]	9	Asymptomatic males	1-mm mandibular appliance, 3-mm maxillary appliance	No	Elbow flexors	EMG	1-mm appliance = 3-mm appliance > without appliance

IMS: isometric muscle strength; MORA: mandibular orthopedic appliance; TMD: temporomandibular disorders; BEA: bite-elevating appliance; MMT: manual muscle testing; MI: maximum intercuspation; SCM: sternocleidomastoid; EMG: electromyography.

a dynamometer in three different mandibular positions: 1) mouth closed in maximal occlusion; 2) maximal active mouth opening; and 3) mouth closed on a wax bite in maximal occlusion. The tests were repeated after 1 week to assess the repeatability of the procedure. No significant difference in muscle force was found between the different mandibular positions, and a good repeatability of the procedure was demonstrated.

Temporomandibular disorders

Although some authors encouraged the use of AK for the diagnosis and treatment of TMD [11–14], as already mentioned, only one old trial was published. Glassley et al. [14] remarked on the use of AK for the diagnosis and treatment of TMD based on the author's personal opinion and two case reports cited. However, their description was severely inadequate. No diagnosis was made, and the symptoms were not clearly related to a TMD diagnosis.

Dental material testing

The only study focusing on dental material testing by the use of AK, in order to detect intolerances and allergies, was published by Staehle et al. [33]. Test–retest reliability was assessed. Two dentists with a medical diploma of the International Medical Society for Applied Kinesiology (IMAK) examined 40 volunteers, who were tested before (baseline) and after being exposed to two different composite resins in an open test and then in a double-blind test. The first dentist achieved a correspondence between the two trials in 27% of the cases; the second dentist achieved correspondence in 40% of the cases, demonstrating an accuracy not superior to random probability.

Discussion

From the trials examined, there is no evidence to support the use of AK for the diagnosis and treatment of TMD and for the detection of allergies or intolerances to dental materials. In fact, only one study was retrieved on TMD, and only one study was published on dental material testing. The former was a very low-quality article with uncertain diagnosis and uncontrolled results [14]. The latter was a double-blind trial to evaluate the test-retest variability of the procedure, and the outcome revealed scarce repeatability. However, the results were not compared to laboratory or skin testing to evaluate the accuracy of the methodology [33]. This outcome does not seem to be limited to the field of dentistry. In fact, it is very similar to what was reported by Schwartz et al. [51] in a double-blind study, where subjects holding glass vials containing different substances were tested by 3 different kinesiologists and by a dynamometer. The results revealed no agreement between the tests performed by the kinesiologists and the dynamometer. In addition, the toxic vial was identified correctly almost exactly at chance both by the kinesiologists and by the dynamometer. This was confirmed in a study by Kenney et al. [7], where evaluations of different substances and placebos by MMT of two kinesiologists were compared to each other, to standard laboratory testing, and to computerized isometric muscle testing. The results revealed no correlation between the two testers and standard biochemical tests for nutrients and between MMT and computerized muscle testing. In addition, no significant differences were revealed in the response to placebo, nutrients identified to be deficient, and nutrients identified to be adequate.

Similarly, in a study by Schmitt et al. [52], after identifying 17 subjects as positive for food allergies with AK MMT, blood samples of the same subjects were analyzed. IgE radioallergosorbent test (RAST) confirmed only 24% of the allergies, IgG RAST confirmed 67% of the allergies, IgE food immune complex assay confirmed none of the allergies, and IgG food immune complex assay confirmed 48% of the allergies. Disagreement between the different tests is probably due to the fact that they have scarce accuracy in determining food allergies, as stated by the guidelines of the National Institute of Allergy and Infectious Diseases (NIAID) [53]. Furthermore, no serum tests were carried out for the subjects testing negative with AK MMT. Surprisingly, the authors claim encouraging results selecting only the positive results of the serum tests and ignoring the negative ones. In this case, over 90% of the food allergies hypothesized based on AK screening technique were confirmed [52].

Some interesting information was found while examining articles describing the relationship between dental occlusion and isometric muscle strength. These results were taken into account because MMT used in AK is a procedure where the examiner estimates the strength of a particular muscle by pushing against resistance without changing the muscle's length. Therefore, it is an isometric muscle test. Even though the results are not consistent in the literature examined, most of them report a correlation between the two variables. These results can be partly attributed to a placebo response due to the patient's and clinician's expectations and to the subjective nature of the procedure [54]. However, some trials included a placebo control group [24,25] and blinding procedures [24–28,33]; therefore, it is unlikely that the results might be only ascribed to a placebo response. In addition, most of the studies used objective measurements to avoid bias due to aware or unaware

subjective misinterpretation of the test results [23–32]. Nonetheless, it is also difficult to compare the different studies because of the great variability of the methods used. The appliances used were diverse, although most of them were MORA. Some of them had the occlusion set with MMT of the deltoid muscle [25,26,28], one was obtained by using the myocentric neuromuscular position [24], and others used a bite-elevating appliance (BEA) with defined thickness [27,29,30,32]. Also, the muscles tested and measuring devices were different across the studies, although some measuring devices with different names seem to be very similar (kinesiometer, dynamometer, strain gauge) [23,24,26–28,31].

When specifically looking at the VDO, it seems that there is an individual value of VDO at which subjects exhibit a peak of isometric muscle strength; lower values (loss of VDO) and higher values cause a decrease of muscle strength [25–32]. The clinical meaning of such a phenomenon is uncertain.

It seems that dental occlusion or the maxillo-mandibular relationship can affect the excitatory and inhibitory inputs reaching the motoneurons of the anterior horn of the spinal cord determining a stronger or weaker muscle response to the test.

The probable neurologic explanation for these interferences is the numerous connections between the trigeminal system and the central nervous system. Specifically, the mesencephalic nucleus of the trigeminal nerve is connected to the vestibular nuclei, the cerebellum, and the reticular formation, all neural structures involved in somatic motor control [55,56]. It is possible that alterations of dental occlusion or the maxillo-mandibular relationship, through trigeminal afferences to the mesencephalic nucleus and its connections to the mentioned structures, send inhibitory stimuli to the motoneurons of the anterior horn of the spinal cord causing a reduction of isometric muscle strength tested by MMT of AK. However, MMT of AK is not intended to test the specific muscle being examined, rather to evaluate "dysfunctional" occlusion as a possible etiologic factor for pathology and to plan proper treatment. This purpose of AK was not supported by any of the studies examined. There is no evidence that a "weak" muscle, as tested by MMT, is correlated to any pathology, and there is no evidence that making that muscle test "strong" by manipulating dental occlusion or maxillo-mandibular relationship has any positive prognostic value.

As also suggested by many authors [2,57,58], well-designed, double-blind, randomized controlled trials are needed to establish repeatability and accuracy of MMT and correlations between MMT and dental diseases. To enhance the opportunity for replication, trials using MMT should state the exact proceeding and instrumentation, duration of test, peak force, and timing of application of the force.

Conclusion

Based on the studies retrieved in this review, the use of AK for the diagnosis and treatment of pathologies in the field of dentistry is not supported by scientific evidence. Well-designed, double-blind, randomized controlled trials are needed to establish repeatability and accuracy of MMT and correlations between MMT and dental diseases. However, a relationship between dental occlusion or maxillo-mandibular relationship and isometric muscle strength has been noted.

Disclosure statement

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