Research, Society and Development, v. 10, n. 3, e21210313376, 2021
(CC BY 4.0) | ISSN 2525-3409 | DOI: http://dx.doi.org/10.33448/rsd-v10i3.13376

Transmigrated mandibular canines: clinical considerations and orthodontic biomechanics for the approach of orthodontic traction. A scoping review

Caninos mandibulares transmigrados: considerações clínicas e Biomecânica ortodôntica para abordagem da tração ortodôntica. Uma revisão de escopo

Caninos mandibulares transmigrados: consideraciones clínicas y biomecánica ortodóntica para el abordaje de la tracción ortodóntica. Una revisión del alcance

Received: 02/26/2021 | Reviewed: 02/28/2021 | Accept: 03/04/2021 | Published: 03/14/2021

Luan Ribeiro Braga
ORCID: https://orcid.org/0000-0003-0606-2117
Federal University of Piauí, Brazil
E-mail: luanbraga222@gmail.com
Leonard Euler Andrade Gomes do Nascimento
ORCID: https://orcid.org/0000-0001-8097-8233
Universidade do Estado do Piauí, Brazil
Federal University of Piauí, Brazil
E-mail: leonardeuler@hotmail.com
Matheus Melo Pithon
ORCID: https://orcid.org/0000-0002-8418-4139
Southwest Bahia State University, Brazil
Federal University of Rio de Janeiro, Brazil
E-mail: matheuspithon@hotmail.com

Abstract
This scoping review aims to identify the clinical considerations and orthodontics biomechanics of applying the orthodontic traction approach to transmigrated mandibular canines. The search strategy followed the PRISMA for scoping reviews and was based on six databases, Cochrane C.R.C. Trials, BVS, PubMed (NLM), Google Scholar, Web of Science, and SCOPUS, and included articles published as recently as February 2021. The records had to identify lower canines traction protocols and outcomes. The publications obtained had to meet criteria for the structure of the research and bibliography. The search included combinations of the keywords *lower canine*, *cuspid*, and *transmigration*, along with the terms *biomechanics* and *scoping review* in the databases. Only after a consensus of the three reviewers had been reached were the articles retrieved. When a transmigrated lower canine has already erupted, orthodontics biomechanics traction begins by bonding tooth buttons and/or bracket prescriptions: MBT 0.022" x 0.028", Roth 0.018" x 0.022", and/or Beggs rectangular arches, ligatures, and elastics. Surgical interventions may be added. The treatment time varied from 22 months to 3.6 years. The final occlusal relationships were satisfactory and did not cause damage to the surrounding tissues. Among the selected articles, the orthodontic biomechanics showed the complexity of the movements. An appropriate occlusion and stability were achieved. Failures in the approach were also found. The clinical considerations show this approach to be viable but to have inherent risks, which include the proximity of the canines to the lower incisor roots.
Keywords: Transmigration; Lower canines; Cuspids; Biomechanics; Scoping review.

Resumo
Esta revisão objetiva identificar as considerações clínicas e a biomecânica ortodôntica da aplicação da abordagem de tração ortodôntica em caninos inferiores transmigrados. A estratégia de busca seguiu o PRISMA para análises de escopo e foi baseada em seis bancos de dados, Cochrane C.R.C. Trials, BVS, PubMed (NLM), Google Scholar, Web of Science e SCOPUS, e artigos incluídos publicados até janeiro de 2021. Os registros tiveram que identificar protocolos e resultados de tração de caninos inferiores. As publicações obtidas obedeceram a critérios de estruturação da pesquisa e bibliografia. A pesquisa incluiu combinações das palavras-chave canino inferior, cúspide e transmigração, juntamente com os termos biomecânica e revisão de escopo nos bancos de dados. Somente depois que um consenso dos três revisores foi alcançado, os artigos foram recuperados. Quando um canino inferior transmigrado já irrompeu, a tração biomecânica ortodôntica começa com a colagem de botões dentais e / ou prescrições de braquetes: MBT 0,022" x 0,028", Roth 0,018" x 0,022" e / ou arcos retangulares de Beggs, ligaduras e elásticos. Intervenções cirúrgicas podem ser adicionadas. O tempo de tratamento variou de 22 meses a 3,6 anos. As relações oclusais finais foram satisfatórias e não causaram danos aos tecidos circundantes. Dentre os artigos selecionados, a biomecânica ortodôntica mostrou a complexidade dos movimentos. Uma oclusão e estabilidade adequadas foram

alcançadas. Falhas na abordagem também foram encontradas. As considerações clínicas mostram que essa abordagem é viável, mas tem riscos inerentes, que incluem a proximidade dos caninos às raízes dos incisivos inferiores.
Palavras-chave: Transmigração; Caninos inferiores; Caninos; Biomecânica; Revisão de escopo.

Resumen

Esta revisión de alcance tiene como objetivo identificar las consideraciones clínicas y la biomecánica de la ortodoncia de la aplicación del enfoque de tracción ortodóncica a los caninos mandibulares transmigrados. La estrategia de búsqueda siguió el PRISMA para las revisiones de alcance y se basó en seis bases de datos, Cochrane C.R.C. Ensayos, BVS, PubMed (NLM), Google Scholar, Web of Science y SCOPUS, e incluían artículos publicados tan recientemente como enero de 2021. Los registros tenían que identificar los protocolos y resultados de tracción de los caninos inferiores. Las publicaciones obtenidas debían cumplir criterios de estructura de la investigación y bibliografía. La búsqueda incluyó combinaciones de las palabras clave canino inferior, canino y transmigración, junto con los términos biomecánica y revisión de alcance en las bases de datos. Solo después de que se alcanzó un consenso de los tres revisores se recuperaron los artículos. Cuando un canino inferior transmigrado ya ha estallado, la tracción biomecánica de ortodoncia comienza uniendo botones dentales y / o prescripciones de brackets: MBT 0.022" x 0.028", Roth 0.018"x 0.022" y / o arcos rectangulares, ligaduras y elásticos Beggs. Se pueden agregar intervenciones quirúrgicas. El tiempo de tratamiento varió de 22 meses a 3,6 años. Las relaciones oclusales finales fueron satisfactorias y no causaron daño a los tejidos circundantes. Entre los artículos seleccionados, la biomecánica ortodóntica mostró la complejidad de los movimientos. Se logró una adecuada oclusión y estabilidad. También se encontraron fallas en el enfoque. Las consideraciones clínicas muestran que este enfoque es viable pero tiene riesgos inherentes, que incluyen la proximidad de los caninos a las raíces de los incisivos inferiores.
Palabras clave: Transmigración; Caninos inferiores; Caninos; Biomecánica; Revisión de alcance.

1. Introduction

The term ectopia is used to describe the placement of two contiguous teeth when their position has changed; the teeth are also said to be transposed (Chattopadhyay & Srinivas, 1996; Peck, 1993; Peck, 1998). Whenever the ectopia is extended beyond a single tooth displacement in the mandible and involves the lower canine, which almost always moves in the mesial direction (Röhrer, 1929; Shapira & kuftinec, 2005). A form of intraosseous migration can result in a canine crossing the midline, characterizing transmigration (Kara et al., 2011; Röhrer, 1929; Shapira & kuftinec, 2005). The incidence of transmigrated mandibular canine (TMC) varies from 0.075%* to 0.34% (Aydin et al., 2004; Mazinis et al., 2012). The correct etiology of TMC is still unknown, but cysts, odontomas, and anomalies of the lateral incisors contribute to the incidence of this condition (Dalessandri et al., 2017). The earliest treatment protocol used a pin and eyelet inserted into the crown in an impacted canine to facilitate the guidance of the tooth that had failed to erupt. (Wertz, 1994)

Canine teeth play an important role in the relationship between facial aesthetics and occlusal function. (Dalessandri et al., 2017). Various treatments seek to re-establish this relationship with the following alternatives (Mazinis et al., 2012): 1) simply aligning all teeth in both arches; 2) canine extraction; 3) TMC retrieved via guided eruption and put into its appropriate location; 4) re-implant; 5) no intervention.

The decision to adopt the TMC traction protocol is a challenge, due to each types of transmigration (Mazinis et al., 2012). The main limitations of treatment with TMC are late diagnosis and intraosseous location (Dalessandri et al., 2017). This scoping review aims to identify the clinical considerations and the characteristics of orthodontic biomechanics when the TMC traction protocol is adopted.

2. Methodology

Search strategy

A scoping review of the published literature was carried out following the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis for Scope Reviews (PRISMA-ScR) (Tricco et al., 2018). Five databases were used

for this review: Cochrane C.R.C. Trials; BVS; PubMed (NLM); Google Scholar; Web of Science; and SCOPUS. These databases were searched for relevant articles published as recently as February 2021. The types of studies chosen could be systematic reviews, meta-analyses, RCTs, (non/CCTs), case reports, gray literature, and primary research studies. The records had to identify lower canine traction treatment, the intervention involved, and the outcomes. The search used the keywords *transmigration, lower canines cuspids,* biomechanics; and *scoping review,* which were also crossed with combinations of the term *biomechanics* and *protocols* in all the included electronic databases. (Table 1) Regarding the study selection, two reviewers (LB and LE) searched for publications by initially reading their titles and abstracts, followed by analyzing the words contained in the title and abstract of the retrieved papers and analyzing the index terms used to describe the articles. After that, the reference lists were searched for additional articles. There were no language restrictions and hand searching was also performed. Full-text reports of the studies that met the inclusion criteria were obtained. The authors of primary studies or reviews were contacted for further information when necessary. A third reviewer (MP) helped to resolve any uncertainty regarding the final inclusion until a consensus was reached. In the case of disagreement, a consensus was reached.

Table 1. The search strategies for each of the five databases.

Database	Search Strategy
Cochrane C.R.C. Trials	"'Lower canine; OR Lower canine AND Transmigration; AND Treatment; AND Traction;
BVS	(tw:("mandibular canine")) AND (tw:(transmigration)) AND (tw:(treatment))
PubMed	("mandibular canine"[MeSH Terms] OR "lower canine"[All Fields]) AND transmigration [All Fields])) AND treatment [All Fields]
Google Scholar	“Mandibular canine”; OR “lower canine”; OR “Cuspid”; AND “transmigration”; AND “treatment”, AND “traction”, AND “Scoping Review”
Web of Science	(mandibular canines) AND Tópico: (transmigration) AND Tópico: (treatment)

Source: Authors.

Eligibility criteria

The following inclusion criteria (participants, concept, context (PCC)) were used in this scoping review.

I. Participants: humans over 8 years of age with lower transmigrated canines;
II. Concept:
    a. The intervention/phenomenon of interest were orthodontic traction protocols for lower TMC
    b. The outcomes had to include the characteristics of lower TMC orthodontic traction approaches with clinical and surrounding tissue considerations.
III. Context: any comparison of lower TMC orthodontic traction approaches was included with no restriction on control groups.

The exclusion criteria used to avoid confounding population factors were patients that had their permanent canine extracted and/or had undergone canine autotransplantation.

Clinical considerations and orthodontic biomechanics

The mapping between the clinical considerations and the orthodontic biomechanics was done independently to obtain and confirm data from the researchers. For the publications that met the inclusion criteria, the charting data were

author/year/journal of publication, study design, malocclusion type, age, clinical suspicion, complexity level, tooth extraction, orthodontic appliance, traction type, temporary anchorage devices (TADs); outcome; and duration of the treatment. Criteria adapted from Mupparapu (2002) were used to classify the TMC complexity level, as shown in Table 2.

Table 2 – The following criteria were used to classify the transmigrated canines' complexity level.

Type	Criteria	%
1	Canine positioned mesio-angularly across the midline within the jawbone, labial or lingual to anterior teeth, and the crown portion of the tooth crossing the midline.	45.6
2	Canine horizontally impacted near the inferior border of the mandible below the apices of the incisors	20
3	Canine erupting either mesial or distal to the opposite canine	14
4	Canine horizontally impacted near the inferior border of the mandible below the apices of either premolars or molars on the opposite side	17
5	Canine positioned vertically in the midline (the long axis of the tooth crossing the midline) irrespective of eruption status	1.5

Source: Authors.

Critical appraisal of individual sources of eligible studies

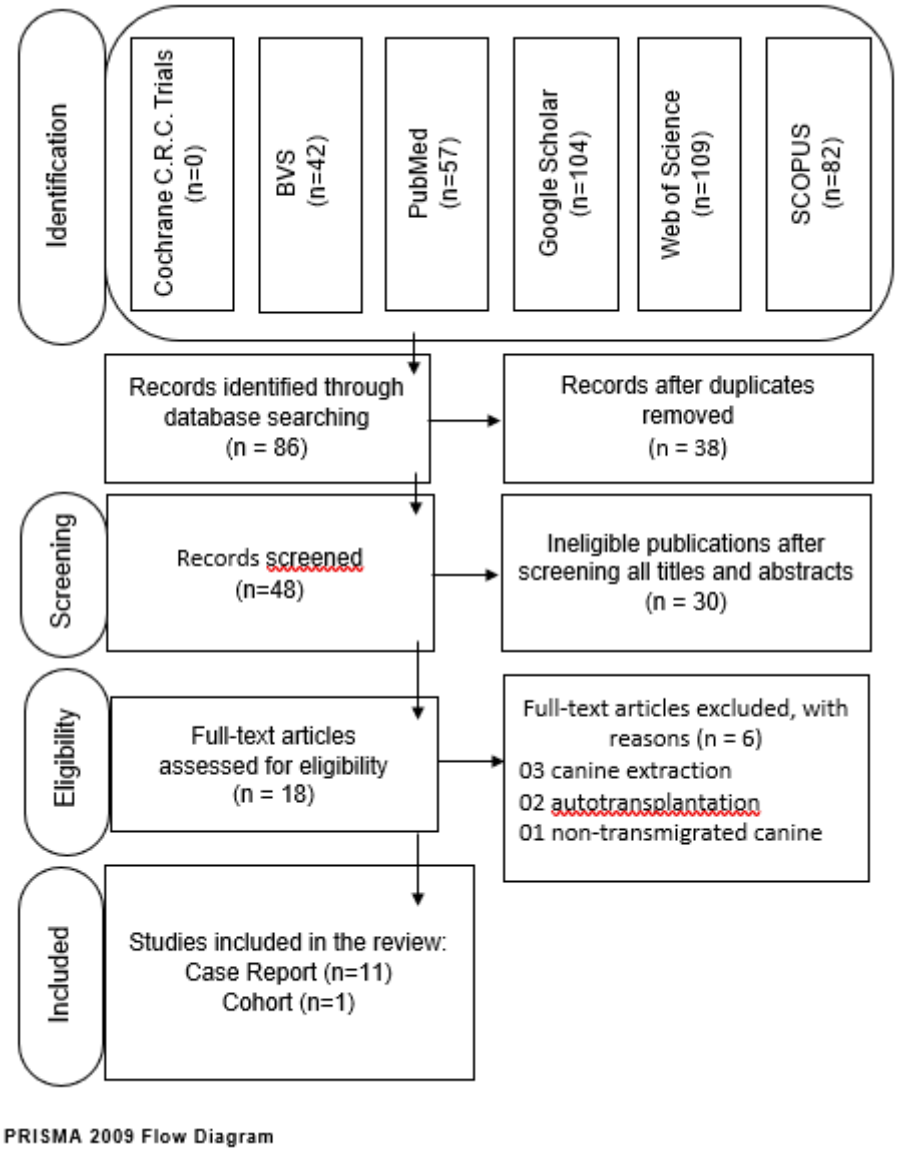
The TMC traction approaches in the retrieved papers involved clinical considerations. Topics in the models of JBI Systematic Reviews (Gagnier et al., 2013) and those described by the Downs and Black criteria were adopted (Downs, & Black, 1998).

3. Results

Search strategy and eligibility criteria

The search strategy yielded 394 articles; 86 of these were selected. After the duplicates were removed, 48 articles remained. The independent reviewers excluded 30 articles after reading their titles and abstracts. After the overall appraisal, 6 articles of the 18 full-text articles retrieved (Agarwal et al., 2013; Cavuoti et al., 2016; Jaisinghani et al., 2019; Janakiraman et al., 2016; Koszowskiet al., 2015; Kuftinec et al., 1995; Kulkarni, & Lee, 2016; Northway, 2019; Peerlings, 2010; Plaza, 2016; Shukla et al., 2019; Sinko et al., 2016; Üçüncüet al., 2011; Umashree et al., 2013; Vaidaet al., 2014; Vera-Guerraet al., 2019; Verma et al., 2012; Wertz, 1994) were excluded because of the following: in three articles, the treatment included the extraction of the canine (Janakiraman et al., 2016; Kuftinec et al., 1995; Umashree et al., 2013), two articles were related to the autotransplantation approach (Kulkarni, & Lee, 2016; Verma et al., 2012), and one study focused on a non-transmigrated canine(Agarwal et al., 2013). Apart from case reports and cohort studies, no other design was found during the search. After the exclusion criteria had been met, 12 full-text articles (Cavuoti et al., 2016; Jaisinghani et al., 2019; Koszowski et al., 2015; Northway, 2019; Peerlings, 2010; Plaza, 2016; Shukla et al., 2019; Sinko et al., 2016; Üçüncü et al., 2011; Vaida et al., 2014; Vera-Guerra et al., 2019; Wertz, 1994) remained to be retrieved and examined for further evaluation. The characteristics of the included studies are summarized in Figure 1, and the key findings about the orthodontic biomechanics and clinical considerations were collected and are summarized in Tables 3 and 4.

Figure 1 - Flowchart of the search.



Source: Authors.

Clinical considerations

The resources found for diagnosis and etiology were clinical examination and additional images, such as panoramic cephalometric radiographs (Cavuoti et al., 2016; Jaisinghani et al., 2019; Northway, 2019; Peerlings, 2010; Shukla et al., 2019; Üçüncü et al., 2011; Vera-Guerra et al., 2019; Wertz, 1994) and computed tomography (CT) images (Koszowski et al., 2015; Plaza, 2016; Sinko et al., 2016; Vaida et al., 2014). The etiological factors presented by the population involved were retrognathism (Koszowski et al., 20150), deciduous canine retention, mesial inclination of the permanent canine germ, dental cyst, mental trauma, and tooth loss (Sinko et al., 2016). Some authors (Cavuoti et al., 2016; Wertz, 1994) reported that TMC traction is the protocol with the best long-term prognosis. Traction was described in cases where the TMC was angled, suggesting that the majority of traction cases were due to the angulation (Type 1 Mupparapu), (Cavuoti et al., 2016; Jaisinghani et al., 2019; Shukla et al., 2019; Sinko et al., 2016; Vera-Guerra et al., 2019; Wertz, 1994) as is summarized in Tables 3 and 4.

Table 3 - The summarized TMC traction protocols of the included studies.

Article Year Paper	Cavuoti 2016 Angle Orthod	Shukla 2019 JDMS	Koszowski 2018 Op. Medicine	Peerlings 2010 AJODO	Sinko 2016 JOMS	Vaida 2014 RJME
Study design	CR				Cohort	CR
Malloclusion type	Cl. II Div 1	Cl I	Skeletal Asymmetries	Cl. II Div 1	Cl. II Div 2	Lower Crowding
Age	12yo	16yo	11yo	11yo	10 >14yo	10yo
Clinical suspect	Right PC absence	Ectopically PCs	Left PC absence		Left and Right PCs absence	Right DC in the arch
Complexity level[33]	Type 1		Type 5	Type 2	Types 1 and 2	Type 2
Orthodontic Traction features						
Tooth extraction	Right	Right & Left	none		Left	Right
	DC				DC	
Orthodontic appliance	Alexander 0.018"x 0.025"	MBT 0.022" x 0.028"	Full orthodontic appliance	0.018" slot Roth - Omni-arch	0.018" slot Brackets - 0.017"x0.025"	--------
Traction Type	TMA 0.017x0.025 Aelastic 5/16	T bend	Just A/N	ML + Aelastic	GL + Aelastic thread renewed each month - 200g	ML + Aelastic
TAD's	----------	Both sides	-------		Yes	
Outcome	Orthodontic + surgical is a viable option to TMC traction	Early diagnosis + treatment of TMC traction ends with aesthetics and function	Approach determines time for commencing TMC traction and choose the optimal procedure for teeth at risk	TMC traction is a viable treatment. The time will be long, but the result can be rewarding	TMC traction is a challenge, but if preservation is a choice, there are secondary methods before extraction	TMC traction with early diagnosis and proper planning approach success
Treatment time	3.6y	22m	----	3y	1 – 36m 2 – unsuccess 3 – 22m 4 – 27m	----

Legend: CR: case report; yo: years old; y: years; m: month; PC: permanent lower canine tooth; DC: deciduous lower canine tooth; A/N; alignment and leveling; ML: metallic ligature; GL: gold ligature; TAD's: temporary anchorage devices. Source: Authors.

Table 4 - The summarized TMC traction protocols of the included studies.

Article Year Paper	Plaza 2016 JO	Vera-Guerra 2019 CRD	Üçüncü 2011 PC Orthod	Jaisinghani 2019 Orthod Waves	Northway 2019 Angle Orthod	Wertz 1994 AJODO
Study design	CR					
Malloclusion type	Cl. I		Cl. III	Cl. II Div 1	Cl. I	P1/P3 Cl. II P2 Cl. I
Age	11yo	14yo	10yo	19yo	11yo	8yo
Clinical suspect	Left DC in the arch	Right & Left PC absence	Right PC impacted	Right & Left DC in the arch	Right PC impacted	Absence: P1/2 Left PC P3 Right PC
Orthodontic Traction features						
Complexity level[33]	Type 2	Type 1	Type 2	Type 1	Type 2	Type 1
Tooth exctraction	Left DC	None		Right DC	Right DC	Left DC
Orthodontic appliance	Smartclip MBT 0.022”	Roth 0.018” Accessories bonded	Roth 0.018" x 0.022"	MBT 0.022” slot	0.022” x 0.028” Brackets.	Upper/Lower 0.018 edgewise appliances
Traction Type	Coil spring 1,7mm heavy	LG	ML 0,030mm + Elastic 50g / 90g	ML 0,010mm Box loop + Elastic - 75g	LG + power thread vertical loop 0,018	Pin and eyelet bonded on the TMC
TAD’s	Yes	No	----	Yes	No	-----
Outcome	The treatment is long. Adequate TMC traction can be achieved	Adequate TMC traction is essential using light forces and controlling force vectors	Light and constant forces + surgical approach, satisfactory results are achieved	Adequate diagnosis and biomechanics can be achieved without minimal damage to adjacent teeth	Appropriate treatment method, avoided prostheses, preserving the facial profile and ensuring periodontal stability	The repositioning of the TCM has its difficulties. Attention should be paid to cases with rash disorders
Duration of treatment	38m	3y	2y	27m	40m	P2/P1 34/36 m P3 22 m

Legend: CR: case report; yo: years old; y: years; m: month; PC: permanent lower canine tooth; DC: deciduous lower canine tooth; A/N; alignment and leveling; ML: metallic ligature; GL: gold ligature; TAD’s: temporary anchorage devices. Source: Authors.

Orthodontic biomechanics (Tables 3 and 4)

Different forms of interventions and procedures related to the management of TMC traction protocols were reported in the selected papers (Cavuoti et al., 2016; Jaisinghani et al., 2019; Koszowski et al., 2015; Northway, 2019; Peerlings, 2010; Plaza, 2016; Shukla et al., 2019; Sinko et al., 2016; Üçüncü et al., 2011; Vaida et al., 2014; Vera-Guerra et al., 2019; Wertz,

1994). In addition, these protocols described tractions (Cavuoti et al., 2016; Jaisinghani et al., 2019; Koszowski et al., 2015; Northway, 2019; Peerlings, 2010; Plaza, 2016; Sinko et al., 2016; Üçüncü et al., 2011; Vaida et al., 2014; Vera-Guerra et al., 2019; Wertz, 1994), by means of orthodontic forces, some requiring surgical intervention and, when the TMC was already erupted, no surgical approach was applied other than orthodontics (Shukla et al., 2019).

Whether or not surgical approaches were needed to access the TMC, they were performed under general (Peerlings, 2010) or local anesthesia(Cavuoti et al., 2016; Plaza, 2016; Sinko et al., 2016; Üçüncü et al., 2011). The surgical access to the TMC was obtained with: (a) dental exposure, accessory bonding, and flap closure (Cavuoti et al., 2016; Jaisinghani, et al., 2019; Koszowski et al., 2015; Northway, 2019; Peerlings, 2010; Plaza, 2016; Sinko et al., 2016; Vaida et al., 2014; Vera-Guerra et al., 2019; Wertz, 1994); (b) the open technique (Üçüncü et al., 2011); (c) with cauterization and subsequent traction from the open field (Jaisinghani, et al., 2019). When applied, surgical synthesis was performed in a single plane and with silk thread (Peerlings, 2010).

The lower TMC traction protocols in the retrieved articles (Cavuoti et al., 2016; Jaisinghani et al., 2019; Koszowski et al., 2015; Northway, 2019; Peerlings, 2010; Plaza, 2016; Shukla et al., 2019; Sinko et al., 2016; Üçüncü et al., 2011; Vaida et al., 2014; Vera-Guerra et al., 2019; Wertz, 1994) also considered levels of complexity (Mupparapu, 2002) as follows: 6 had TMC classified as Type 1 (Cavuoti et al., 2016; Jaisinghani et al., 2019; Shukla et al., 2019; Sinko et al., 2016; Vera-Guerra et al., 2019; Wertz, 1994), 5 were classified as Type 2 (Northway, 2019; Peerlings, 2010; Plaza, 2016; Sinko et al., 2016; Üçüncü et al., 2011; Vaida et al., 2014), and only 1 was classified as Type 5 (Koszowski et al., 2015). Angle Class III (Üçüncü et al., 2011), II (Cavuoti et al., 2016; Jaisinghani et al., 2019; Peerlings, 2010; Sinko et al., 2016; Wertz, 1994), and I (Northway, 2019; Plaza, 2016; Shukla et al., 2019; Vaida et al., 2014; Vera-Guerra et al., 2019; Wertz, 1994) of cases were found in the retrieved papers. No association was identified between the type of Angle malocclusion and the Mupparapu classification (Mupparapu, 2002). Some authors (Sinko et al., 2016; Üçüncü et al., 2011) verified whether ankylosis was presented. The treatment was followed by bonded tooth buttons (Jaisinghani et al., 2019; Peerlings, 2010; Plaza, 2016; Shukla et al., 2019; Sinko et al., 2016; Üçüncü et al., 2011; Vaida et al., 2014; Vera-Guerra et al., 2019) or bracket prescriptions: MBT 0.022” x 0.028” (Shukla et al., 2019), Roth 0.018” x 0.022” (Plaza, 2016), and Beggs (Jaisinghani et al., 2019), 0.022” x 0.028” (Northway, 2019). Instead of bonded accessories being used, perforations could be made (Cavuoti et al., 2016; Wertz, 1994) in the canine crown. The most widely used ligatures were metallic ones (Peerlings, 2010) (0.011” (Cavuoti et al., 2016), 0.030” (Üçüncü et al., 2011), 0.010” (Jaisinghani et al., 2019)) followed by gold ones (Northway, 2019; Sinko et al., 2016); both were associated with elastics (3/16 Intraoral Elastic Latex, Morelli). To obtain the initial TMC traction, Neeteesh (Shukla et al., 2019) used mechanics with a vertical curve ("T"), and Jaisinghani (Jaisinghani et al., 2019) used the "R," also with elastics. Plaza (2016) used the closed spring (3M-Unitek) for the entire retraction process of the TMC, while Northway (2019) used a vertical folded handle for occlusion to finish the traction. When the TMC was positioned at the midline, the alignment and leveling wire sequence positioned the TMC in the arch (Koszowski et al., 2015). During the traction phase, some authors (Plaza, 2016; Sinko et al., 2016; Üçüncü et al., 2011; Vaida et al., 2014) installed mini-implants as TADs (6 x 13 mm). Light force was used (Cavuoti et al., 2016; Jaisinghani et al., 2019; Koszowski et al., 2015; Peerlings, 2010; Plaza, 2016; Sinko et al., 2016; Vaida et al., 2014; Vera-Guerra et al., 2019; Wertz, 1994); ranging from 50 gf to 200 gf (Jaisinghani et al., 2019; Üçüncü et al., 2011; Sinko et al., 2016), and it was maintained until the transmigrated canine was present in the arch. The duration of the phenomena of interest in this scope review ranged from 22 (Shukla et al., 2019) months to 3.6 years (Cavuoti et al., 2016), and ultimately showed satisfactory occlusion and stability. Failures (Sinko et al., 2016) were observed, even within the definition of an entire traction protocol.

Critical appraisal of individual sources of eligible studies

The topics considered (Downs, & Black, 1998; Gagnier et al., 2013) are shown in Table 5. In 11 of the 12 included studies, the patient's demographic characteristics were clearly described 9 (Cavuoti et al., 2016; Koszowski et al., 2015; Northway, 2019; Peerlings, 2010; Plaza, 2016; Sinko et al., 2016; Üçüncü et al., 2011; Vaida et al., 2014; Vera-Guerra et al., 2019; Wertz, 1994). Among the selected studies (Cavuoti et al., 2016; Jaisinghani et al., 2019; Koszowski et al., 2015; Northway, 2019; Peerlings, 2010; Plaza, 2016; Shukla et al., 2019; Sinko et al., 2016; Üçüncü et al., 2011; Vaida et al., 2014; Vera-Guerra et al., 2019; Wertz, 1994), some provided takeaway lessons (Jaisinghani et al., 2019; Northway, 2019; Peerlings, 2010; Plaza, 2016; Shukla et al., 2019; Sinko et al., 2016; Üçüncü et al., 2011; Vaida et al., 2014; Vera-Guerra et al., 2019), whereas others were not clear about the patient's history (Jaisinghani et al., 2019; Vaida et al., 2014; Vera-Guerra et al., 2019), others described the current clinical condition and diagnostic tests (Üçüncü et al., 2011). The cohort article (Sinko et al., 2016) did not present important topics, such as statistical tests and any attempt to blind the patient. Some did not describe the patient's history (Wertz, 1994), the patient's clinical condition, informations about the interventions (Koszowski et al., 2015; Wertz, 1994), and the non-presentation of adverse events (Koszowski et al., 2015).

Table 5 - Consideration of topics[13,14] to the 12 retrieved articles, used in JBI Systematic Reviews,[13] and that one described by Downs and Black.[14]

Critical checklist	Yes	No	Unclear	NA
	Author/Year/Paper by references			
a) Were patient's demographic characteristics clearly described?	15-25	10	none	none
b) Was the patient's history clearly described and presented as a timeline?	15-18 20,22,25		19,21,23	
c) Was the current clinical condition of the patient on presentation clearly described?	16-20, 23,24,25	10,15	21,22	
d) Were diagnostic tests or assessment methods and the results clearly described?	15-17,19 20,23,24,25	10	18,21,22	
e) Were the confounding factors identified?	none	18	none	10, 15-17 19-25
f) Was an attempt made to blind study subjects to the intervention they have received?				
g) Was the intervention(s) or treatment procedure(s) clearly described?	17,18,20 22,23,24	10,15	16,19, 21,25	none
h) Was the post-intervention clinical condition clearly described?	16-25		none	
i) Were adverse events or unanticipated ones identified and described?	10,17,19 20,23,24	15,16,18, 22,25	21	
j) Were the statistical tests used to assess the main outcomes appropriate?	none	18	none	10,15-17 19-25
k) Was the follow up time reported and enough long for outcomes to occur?	10,16,18, 22,25	15,17,19 20,21,23,24		none
l) Does the case report provide takeaway lessons?	16-25	10,15		

Legend: NA: not applicable; 10: Wertz RA; 13: Gagnier JJ et al.; 14: Downs SH & Black N; 15: Koszowski R et al.; 16: Cavuoti S et al.; 17: Peerlings RHJ; 18: Sinko K et al.; 19: Vaida L et al.; 20: Plaza SP; 21: Vera-Guerra JA et al.; 22: Üçüncü N et al.; 23: Jaisinghani AP et al.; 24: Shukla NK et al.; 25: Northway, W. Source: Authors.

4. Discussion

TMC is a rare event that has not been comprehensively reviewed. It seems to be complex and diverse. Its management challenge is limited to orthodontists and oral and maxillofacial surgeons (Cavuoti et al., 2016; Vera-Guerra et al., 2019). By considering reports and studies in orthodontic mechanics that used methodological TMC traction protocols, the authors constructed a scoping review to identify clinical considerations and orthodontics biomechanics in the approach to orthodontic traction for TMC (Tables 3, 4, and 5).

Clinical considerations

CT offers good visualization, allowing an accurate analysis of the position of the root of the canine in relation to the root of the incisors (Koç et al., 2020; Koszowski et al., 2015), a finding consistent for many authors (Koszowski et al., 2015; Sinko et al., 2016; Vaida et al., 2014). Some clinical signs may suggest the presence of TMC, such as: prolonged retention of a deciduous canine, proclination of the lower anterior teeth, enlarged symphyseal area, and chronic infection with fistulas (Camilleri, 2007).

The long axis of the canine should be evaluated with respect to the medium sagittal plane during the mixed dentition phase to prevent damage associated with a transmigrated canine (Koç et al., 2020). Later approaches may be unsuccessful in repositioning the TMC due to a greater degree of complexity (Mupparapu, 2002), which makes mechanical repositioning impossible (Wertz, 1994).

The limitations of the lower TMC treatment protocols were considered, and the following difficulties were found to establish adequate traction of the TMC, which included proximity of the canine to the roots of the lower incisors (Jaisinghani et al., 2019; Peerlings, 2010; Shukla et al., 2019; Vaida et al., 2014), lack of space (Koszowski et al., 2015), sensitivity in the soft tissue containing the TMC (Wertz, 1994), failures in DAT,s (Plaza, 2016) or even the complexity of movements (Cavuoti et al., 2016), whose factors can limit the traction. The TMC treatment protocols (Agarwal et al., 2013; Camilleri, 2007; Cavuoti et al., 2016; Díaz-Sánchez et al., 2016; Jaisinghani et al., 2019; Janakiraman et al., 2016; Koç et al., 2020; Koszowski et al., 2015; Kuftinec et al., 1995; Kulkarni, & Lee, 2016; Mesquita, & Salgado, 2015; Northway, 2019; Peerlings, 2010; Plaza, 2016; Rebellato, & Schabel, 2003; Shukla et al., 2019; Singh et al., 2019; Sinko et al., 2016; Üçüncü et al., 2011; Umashree et al., 2013; Vaida et al., 2014; Vera-Guerra et al., 2019; Verma et al., 2012; Wertz, 1994) also presented inherent risks and offered an appropriate occlusion, as evidenced by their orthodontic biomechanical characteristics and clinical considerations of the surrounding tissues. Damage to adjacent teeth (Wertz, 1994) can be avoided when a diagnosis of TMC is obtained in the early stages of mixed dentition. The greatest amount of intraosseous migration occurs before the complete formation of the tooth root (Rebellato, & Schabel, 2003), however, the diagnosis of TMC occurs late in routine radiological exams, with more advanced dentition and root formation (Dalessandri et al., 2017), in agreement with Vera-Guerra et al. (2019), Jaisinghani et al. (2019), and Shukla et al.(2019). The conditions for the alignment of a transmigrated canine is the acceptance and collaboration of the patient and/or guardians. It is imperative to explain that the treatment is long and expensive and that it demands good oral hygiene during the entire TMC traction process, and to explain the intrinsic risks (Sinko et al., 2016) of each procedure, such as gingival recession. In the studies collected, there were cases (Cavuoti et al., 2016; Jaisinghani et al., 2019; Peerlings, 2010; Üçüncü et al., 2011) of mild recession in comparison with the homologous tooth, however, in situations with Miller class III recession, adjuvant treatment may be needed with periodontal surgery for the repositioning of the gingival margin (Vera-Guerra et al., 2019). For periodontal problems, resorption, and infections (Shukla et al., 2019) in the absence of

symptoms (Mesquita, & Salgado, 2015), a follow-up observation by examination was adopted (Shukla et al., 2019). The application of TMC autotransplantation was rarely reported in the literature (Janakiraman et al., 2016; Kulkarni, & Lee 2016; Rebellato, & Schabel 2003; Sinko et al., 2016), probably due to the late diagnosis of TMC (Dalessandri et al., 2017). Despite the existence of various traction protocols, the different forms of treatment, and different conductions of TMC protocols (Cavuoti et al., 2016; Gruszka et al., 2014; Jaisinghani et al., 2019; Koszowski et al., 2015; Kulkarni, & Lee 2016; Mesquita, & Salgado, 2015; Northway, 2019; Peerlings, 2010; Plaza, 2016; Rebellato, & Schabel 2003; Sharma, & Nagpal, 2011; Shukla et al., 2019; Sinko et al., 2016; Üçüncü et al., 2011; Vaida et al., 2014; Vera-Guerra et al., 2019; Wertz, 1994), a final outcome is still difficult to achieve because of the inherent clinical and biomechanical features of each treatment, and the orthodontist's approach *vs.* the patient's decision, as was seen in the retrieved articles of this scoping review (Cavuoti et al., 2016; Jaisinghani et al., 2019; Koszowski et al., 2015; Northway, 2019; Peerlings, 2010; Plaza, 2016; Shukla et al., 2019; Sinko et al., 2016; Üçüncü et al., 2011; Vaida et al., 2014; Vera-Guerra et al., 2019; Wertz, 1994).

The complex management of treatment protocols for TMC can involve a) resources for diagnosis and etiology; b) treatment alternatives; and c) TMC traction protocols. Eligibility, considering traction as the first option, and other forms of interventions can be addressed sequentially as: 1) monitoring, 2) extraction, or 3) autotransplant (Sinko et al., 2016).

Orthodontic biomechanics

After the vestibular TMC is positioned at the roots of the incisors, the initial line of traction must be toward the buccal and then toward the distal, which provides greater predictability for the traction until the appropriate position is reached (Sinko et al., 2016). It is possible to avoid effects such as unwanted resorptions (Verma et al., 2012). DATs may assist the traction process (Jaisinghani et al., 2019; Plaza, 2016; Shukla et al., 2019; Sinko et al., 2016), inserted bicortically (Peerlings, 2010) to reduce the risk of injury to the roots of neighboring teeth, to allow simultaneous alignment of and to avoid intrusive forces on the anchor teeth (Jaisinghani et al., 2019).

Traction cases of TMC with Type 2 complexity (Mupparapu, 2002) claim a greater indication for extraction (Rebellato, & Schabel, 2003; Rodrigues et al., 2020). This information differs from the findings of our review, where traction protocols for Type 2 were applied and described in detail by the authors (Northway, 2019; Peerlings, 2010; Plaza, 2016; Sinko et al., 2016; Üçüncü et al., 2011; Vaida et al., 2014). For the Type 5 complexity level (Mupparapu, 2002), found in only one article (Koszowski et al., 2015), insertion of the TMC into the arch with alignment, leveling, and anatomization of the crown at the end of the treatment was described. The Types 3 and 4 complexity levels (Mupparapu, 2002) did not appear in articles that met the inclusion criteria for this review. According to Mupparapu (2002), Types 3 and 4 have a prevalence of 14% and 17%, respectively, coinciding with our results, which assumed that these types have a low prevalence.

The outcomes of the selected studies reported a viable option for TMC traction, as the orthodontic + surgical (Cavuoti et al., 2016; Koszowski et al., 2015), The aesthetics and functional success (Northway, 2019; Shukla et al., 2019; Sinko et al., 2016), are rewarding results (Cavuoti et al., 2016). A TMC traction keeps risks for the teeth (Koszowski et al., 2015). Jaisinghani (2019) stated that adequate biomechanical traction and alignment can be achieved with minimal damage to adjacent teeth. One author (Wertz, 1994) considered that the repositioning of a TCM was difficult, and that great care should be used in the procedure.

The topics considered (Downs, & Black, 1998; Gagnier et al., 2013) are shown in Table 5. In 11 of the 12 included studies, the patient's demographic characteristics were clearly described 9 (Cavuoti et al., 2016; Koszowski et al., 2015; Northway, 2019; Peerlings, 2010; Plaza, 2016; Sinko et al., 2016; Üçüncü et al., 2011; Vaida et al., 2014; Vera-Guerra et al., 2019; Wertz, 1994). Among the selected studies (Cavuoti et al., 2016; Jaisinghani et al., 2019; Koszowski et al., 2015; Northway, 2019; Peerlings, 2010; Plaza, 2016; Shukla et al., 2019; Sinko et al., 2016; Üçüncü et al., 2011; Vaida et al., 2014;

Vera-Guerra et al., 2019; Wertz, 1994), some provided takeaway lessons (Jaisinghani et al., 2019; Northway, 2019; Peerlings, 2010; Plaza, 2016; Shukla et al., 2019; Sinko et al., 2016; Üçüncü et al., 2011; Vaida et al., 2014; Vera-Guerra et al., 2019), whereas others were not clear about the patient's history (Jaisinghani et al., 2019; Vaida et al., 2014; Vera-Guerra et al., 2019), others described the current clinical condition and diagnostic tests (Üçüncü et al., 2011). The cohort article (Sinko et al., 2016) did not present important topics, such as statistical tests and any attempt to blind the patient. Some did not describe the patient's history (Wertz, 1994), the patient's clinical condition, informations about the interventions (Koszowski et al., 2015; Wertz, 1994), and the non-presentation of adverse events (Koszowski et al., 2015).

Critical appraisal of individual sources of eligible studies

The eligible articles (Cavuoti et al., 2016; Jaisinghani et al., 2019; Koszowski et al., 2015; Northway, 2019; Peerlings, 2010; Plaza, 2016; Shukla et al., 2019; Sinko et al., 2016; Üçüncü et al., 2011; Vaida et al., 2014; Vera-Guerra et al., 2019; Wertz, 1994). involved protocols for different complexity levels, and differences in the method of treatments, sampling, details of traction protocol, and confounding factors. Overall, most of the retrieved studies (Cavuoti et al., 2016; Jaisinghani et al., 2019; Northway, 2019; Peerlings, 2010; Plaza, 2016; Shukla et al., 2019; Sinko et al., 2016; Üçüncü et al., 2011; Vaida et al., 2014) reported TMC traction approaches with a minimal absence of detail, even with longer treatments (Sinko et al., 2016). Data for features of the orthodontic archwires (Cavuoti et al., 2016; Jaisinghani et al., 2019; Koszowski et al., 2015; Peerlings, 2010; Plaza, 2016; Shukla et al., 2019; Üçüncü et al., 2011; Vaida et al., 2014; Vera-Guerra et al., 2019; Wertz, 1994) were not specified. Other works had incomplete information, such as for patient history (Jaisinghani et al., 2019; Vaida et al., 2014; Vera-Guerra et al., 2019), diagnostic tests (Sinko et al., 2016; Üçüncü et al., 2011; Vera-Guerra et al., 2019), performed interventions (Cavuoti et al., 2016; Vaida et al., 2014), and the non-notification or incomplete notification of adverse effects that might have occurred (Koszowski et al., 2015; Northway, 2019; Sinko et al., 2016; Üçüncü et al., 2011; Vera-Guerra et al., 2019; Wertz, 1994).

The article by Wertz (1994) was one of the first to describe the traction technique for TMC, with reports of adverse effects during the case and after treatment, suggesting that traction for the TMC is viable and stable. Koszowski (2015) article reported that by monitoring the development of dentition, it is possible to determine the ideal time for the treatment of transmigrated canines.

This scoping review has shown comparisons across studies. Furthermore, there were no attempts to perform quality appraisal, because it is not considered to be mandatory in scoping reviews (Arksey, & O'Malley, 2005; Izu et al., 2020). In view of the lack of data charting, this scoping review can be specified and documented under protocols, with the aim to construct a future systematic review or meta-analysis (Azuelo et al., 2020; Neta et al.,2020).

5. Conclusions

Among the selected articles that involved orthodontics traction of the transmigrated lower canines, the findings showed that:

a) The clinical considerations indicated that this traction approach is viable but has inherent risks, which include the proximity of the canine to the lower incisor roots.

b) The orthodontic biomechanics showed the complexity of the movements in the heterogenous traction protocols adopted. An appropriate occlusion and stability were reached. Failures in the approach were also found.

References

Agarwal, S., Yadav, S., Shah, N. V., Valiathan, A., Uribe, F., & Nanda, R. (2013). Correction of bilateral impacted mandibular canines with a lip bumper for anchorage reinforcement. *American Journal of Orthodontics and Dentofacial Orthopedics*, *143*(3), 393-403. https://doi.org/10.1016/j.ajodo.2011.12.030

Arksey, H., & O'Malley, L. (2005). Scoping studies: towards a methodological framework. *International Journal of Social Research Methodology*, *8*(1), 19-32. https://doi.org/10.1080/1364557032000119616

Aydin, U., Yilmaz, H. H., & Yildirim, D. (2004). Incidence of canine impaction and transmigration in a patient population. *Dentomaxillofacial Radiology*, *33*(3), 164-169. https://doi.org/10.1259/dmfr/15470658

Azuelo, N. C. S., de Souza Filho, Z. A., das Neves, A. L. M., de Oliveira Ferreira, B., de Lima Oliveira, D., & Tavares, N. K. C. (2020). Prevalência de depressão em pessoas que vivenciaram violência por parceiro íntimo: revisão sistemática com meta-análise. *Research, Society and Development*, *9*(8), e84985094-e84985094. https://doi.org/10.33448/rsd-v9i8.5094

Camilleri, S. (2007). Double transmigration and hyperdontia. *The Angle Orthodontist*, *77*(4), 742-744. https://doi.org/10.2319/071006-285

Cavuoti, S., Matarese, G., Isola, G., Abdolreza, J., Femiano, F., & Perillo, L. (2016). Combined orthodontic-surgical management of a transmigrated mandibular canine. *The Angle Orthodontist*, *86*(4), 681-691. https://doi.org/10.2319/050615-309.1

Chattopadhyay, A., & Srinivas, K. (1996). Transposition of teeth and genetic etiology. *The angle orthodontist*, *66*(2), 147-152. https://doi.org/10.1043/0003-3219(1996)066%3C0147:TOTAGE%3E2.3.CO;2

Dalessandri, D., Parrini, S., Rubiano, R., Gallone, D., & Migliorati, M. (2017). Impacted and transmigrant mandibular canines incidence, aetiology, and treatment: a systematic review. *European Journal of Orthodontics*, *39*(2), 161-169. https://doi.org/10.1093/ejo/cjw027

Díaz-Sánchez, R. M., Castillo-de-Oyagüe, R., Serrera-Figallo, M. Á., Hita-Iglesias, P., Gutiérrez-Pérez, J. L., & Torres-Lagares, D. (2016). Transmigration of mandibular cuspids: review of published reports and description of nine new cases. *British Journal of Oral and Maxillofacial Surgery*, *54*(3), 241-247. https://doi.org/10.1016/j.bjoms.2016.01.010

Downs, S. H., & Black, N. (1998). The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. *Journal of Epidemiology & Community Health*, *52*(6), 377-384. http://dx.doi.org/10.1136/jech.52.6.377

Gagnier, J. J., Kienle, G., Altman, D. G., Moher, D., Sox, H., Riley, D., & CARE group. (2013). The CARE guidelines: consensus-based clinical case reporting guideline development. https://doi.org/10.1111/head.12246

Gruszka, K., Różyło, T. K., Różyło-Kalinowska, I., Denkiewicz, K., & Masłowska, K. (2014). Transmigration of mandibular canine–case report. *Polish Journal of Radiology*, *79*, 20. https://dx.doi.org/10.12659%2FPJR.890090

Izu, M., Silvino, Z. R., dos Santos, L. M., & Balbino, C. M. (2020). Cuidados de enfermagem em pacientes submetidos a transplante de células-tronco hematopoiética: Protocolo de revisão de escopo. *Research, Society and Development*, *9*(7), e575974381-e575974381. https://doi.org/10.33448/rsd-v9i7.4381

Jaisinghani, A. P., Pradhan, T., Keluskar, K. M., & Takane, V. (2019). Treatment of a transmigrated and an impacted mandibular canine along with missing maxillary central incisor: A case report. *Orthodontic Waves*, *78*(2), 84-92. https://doi.org/10.1016/j.odw.2019.04.002

Janakiraman, N., Vaziri, H., Safavi, K., Nanda, R., & Uribe, F. (2016). Management of severely impacted mandibular canines and congenitally missing mandibular premolars with protraction of autotransplanted maxillary premolar. *American Journal of Orthodontics and Dentofacial Orthopedics*, *150*(2), 339-351. https://doi.org/10.1016/j.ajodo.2015.08.022

Kara, M. I., Ay, S., Aktan, A. M., Sener, I., Bereket, C., Ezirganli, S., & Demirkol, M. (2011). Analysis of different type of transmigrant mandibular teeth. *Med Oral Patol Oral Cir Bucal*, *16*(3), e335-40. http://dx.doi.org/doi:10.4317/medoral.16.e335

Koç, A., Kaya, S., & Abdulsalam, W. A. (2020). Three-Dimensional Analysis of Impacted Maxillary and Mandibular Canines and Evaluation of Factors Associated With Transmigration on Cone-Beam Computed Tomography Images. *Journal of Oral and Maxillofacial Surgery*. https://doi.org/10.1016/j.joms.2020.10.002

Koszowski, R., Pisulska-Otremba, A., Wójcik, S., & Śmieszek-Wilczewska, J. (2015). Canine transmigration accompanying mandibular retrognathism secondary to osteitis. *Open Medicine*, *10*(1), 566. https://doi.org/10.1515/med-2015-0096

Kuftinec, M. M., Shapira, Y., & Nahlieli, O. (1995). Bilateral transmigration of impacted mandibular canines. *The Journal of the American Dental Association*, *126*(7), 1022-1024. https://doi.org/10.14219/jada.archive.1995.0279

Kulkarni, G., & Lee, L. (2016). Vital Autotransplantation and Orthodontic Treatment of a Transmigrant Mandibular Canine. *Pediatric dentistry*, *38*(1), 1E-4E.

Mazinis, E., Zafeiriadis, A., Karathanasis, A., & Lambrianidis, T. (2012). Transmigration of impacted canines: prevalence, management and implications on tooth structure and pulp vitality of adjacent teeth. *Clinical Oral Investigations*, *16*(2), 625-632. https://doi.org/10.1007/s00784-011-0545-8

Mesquita, P., & Salgado, H. (2015). Transmigrant mandibular canine–Case report. *Revista Portuguesa de Estomatologia, Medicina Dentária e Cirurgia Maxilofacial*, *56*(1), 63-67. https://doi.org/10.1016/j.rpemd.2015.02.002

Mupparapu, M. (2002). Patterns of intra-osseous transmigration and ectopic eruption of mandibular canines: review of literature and report of nine additional cases. *Dentomaxillofacial Radiology*, *31*(6), 355-360. https://doi.org/10.1038/sj.dmfr.4600732

Neta, A. G. L., David, M. C. M. M., de Araújo, B. T. S., Gama, G. L., & Leite, J. C. (2020). Eficácia do treinamento cognitivo associado ao exercício físico em indivíduos com doença de Alzheimer: uma metanálise. *Research, Society and Development*, *9*(12), e15791211022-e15791211022. https://doi.org/10.33448/rsd-v9i12.11022

Northway, W. (2019). Orthodontic management of a dental anomaly pattern (DAP) including mandibular canine transmigration: A case report: A challenging treatment but worth it!. *The Angle Orthodontist*, *89*(1), 149-162. https://doi.org/10.2319/021018-115.1

Peck, L., Peck, S., & Attia, Y. (1993). Maxillary canine-first premolar transposition, associated dental anomalies and genetic basis. *The Angle Orthodontist*, *63*(2), 99-109. https://doi.org/10.1043/0003-3219(1993)063%3C0099:MCFPTA%3E2.0.CO;2

Peck, S. (1998). On the phenomenon of intraosseous migration of nonerupting teeth. *American Journal of Orthodontics and Dentofacial Orthopedics*, *113*(5), 515-517. https://doi.org/10.1016/S0889-5406(98)70262-8

Peerlings, R. H. J. (2010). Treatment of a horizontally impacted mandibular canine in a girl with a Class II Division 1 malocclusion. *American Journal of Orthodontics and Dentofacial Orthopedics*, *137*(4), S154-S162. https://doi.org/10.1016/j.ajodo.2008.08.025

Plaza, S. P. (2016). Orthodontic traction of a transmigrated mandibular canine using mini-implant: a case report and review. *Journal of Orthodontics*, *43*(4), 314-321. https://doi.org/10.1080%2F14653125.2016.1224539

Rebellato, J., & Schabel, B. (2003). Treatment of a patient with an impacted transmigrant mandibular canine and a palatally impacted maxillary canine. *The Angle Orthodontist*, *73*(3), 328-336. https://doi.org/10.1043/0003-3219(2003)073%3C0328:TOAPWA%3E2.0.CO;2

Rodrigues, J. P. P., de Araújo Carvalho, L. R. R., de Paulo Cravinhos, J. C., Carvalho, L. R. D. A., Moura, R. A., de Melo Neto, M. V., & Silva, F. A. D. J. C. (2020). Tratamento cirúrgico de canino incluso na base da mandíbula: relato de caso. *Research, Society and Development*, *9*(8), e323985176-e323985176. https://doi.org/10.33448/rsd-v9i8.5176

Röhrer, A. (1929). Displaced and impacted canines A radiographic research. *International Journal of Orthodontia, Oral Surgery and Radiography*, *15*(10), 1003-1020. https://doi.org/10.1016/S0099-6963(29)90386-0

Shapira, Y., & Kuftinec, M. M. (2005). Unusual intraosseous transmigration of a palatally impacted canine. *American Journal of Orthodontics and Dentofacial Orthopedics*, *127*(3), 360-363. https://doi.org/10.1016/j.ajodo.2004.04.018

Sharma, G., & Nagpal, A. (2011). Transmigration of mandibular canine: report of four cases and review of literature. *Case Reports in Dentistry*, *2011*. https://doi.org/10.1155/2011/381382

Shukla, N. K., Sharma, V. K., & Chaturvedi, T. P. (2019). Management of Transmigrated and Transposed Mandibular Canines-A Case Report. DOI: 10.9790/0853-1805108085

Singh, A. K., Sharma, N. K., Mishra, N., Singh, S., & Singh, S. (2019). Management of impacted transmigrated mandibular canine associated with dentigerous cyst: A surgical approach. *International Journal of Oral Health Sciences*, *9*(1), 45. DOI: 10.4103 / ijohs.ijohs_57_17

Sinko, K., Nemec, S., Seemann, R., & Eder-Czembirek, C. (2016). Clinical management of impacted and transmigrated lower canines. *Journal of Oral and Maxillofacial Surgery*, *74*(11), 2142-e1. https://doi.org/10.1016/j.joms.2016.07.001

Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., & Straus, S. E. (2018). PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Annals of internal medicine*, *169*(7), 467-473. https://doi.org/10.7326/M18-0850

Üçüncü, N., Aslan, B. I., & Türel, H. T. O. (2011). Treatment and long term follow-up of a patient with an impacted transmigrant canine. *Principles in Contemporary Orthodontics*, 337.

Umashree, N., Kumar, A., & Nagaraj, T. (2013). Transmigration of mandibular canines. *Case Reports in Dentistry*, *2013*.

Vaida, L., Todor, B. I., Corega, C., Baciut, M., & Baciut, G. (2014). A rare case of canine anomaly–a possible algorithm for treating it. *Rom J Morphol Embryol*, *55*(3 Suppl), 1197-1202.

Vera-Guerra, J. A., Herrera-Atoche, J. R., & Colomé-Ruiz, G. E. (2019). Orthodontic treatment of bilateral impacted mandibular canines and a Mupparapu type 2 transmigration. *Case Reports in Dentistry*.

Verma, S. L., Sharma, V. P., & Singh, G. P. (2012). Management of a transmigrated mandibular canine. *Journal of Orthodontic Science*, *1*(1), 23. https://dx.doi.org/10.4103%2F2278-0203.94778

Wertz, R. A. (1994). Treatment of transmigrated mandibular canines. *American Journal of Orthodontics and Dentofacial Orthopedics*, *106*(4), 419-427. https://doi.org/10.1016/S0889-5406(94)70064-8