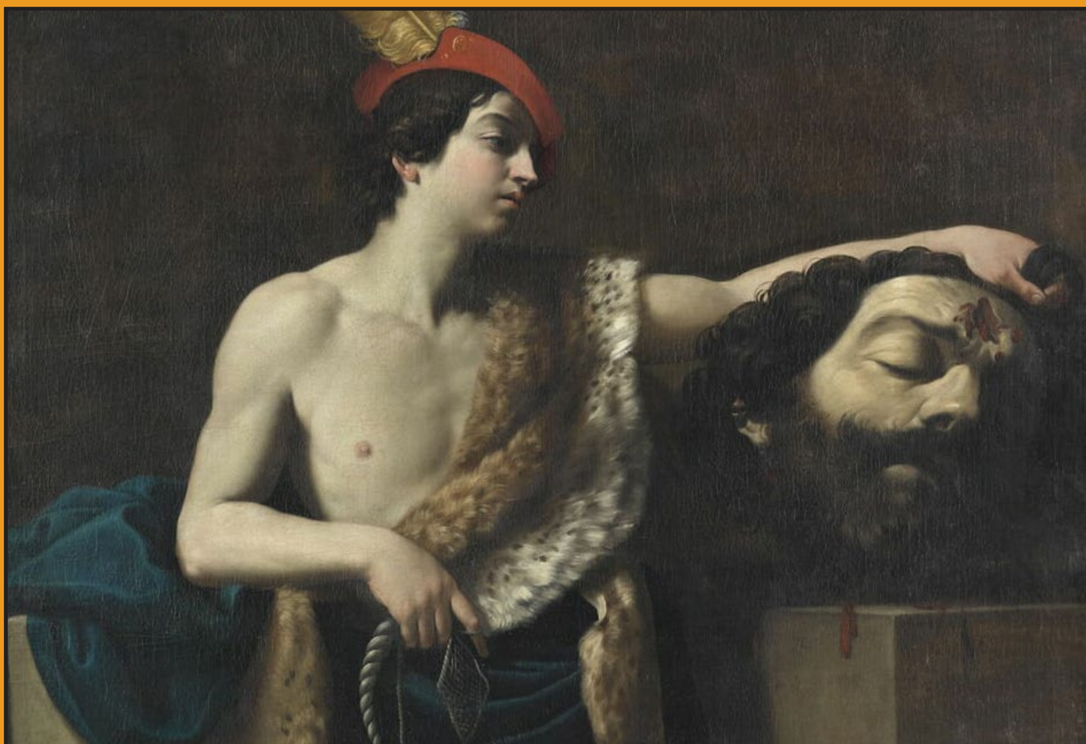
Volume 6, no. 1, January-June 2017

ISSN 2038-4106/2017 (print)

European Journal of Musculoskeletal Diseases



Guido Reni, *Davide con la testa di Golia* (1605), Uffizi di Firenze (*detail*).

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European Journal of Musculoskeletal Diseases
ISSN 2038-4106/2017

BPI

Eur J Musculoskel Dis 2017 Jan-Jun issue 1

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European Journal of Musculoskeletal Diseases
ISSN 2038-4106/2017

BPI

Article

RESOLUTION OF A CASE OF C5-C6 CERVICAL DISC HERNIA WITH DEEP PARAVERTEBRAL CT-GUIDED INFILTRATION OF OXYGEN-OZONE. A FIVE-MONTH MRI CHECK

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ABSTRACT

The authors describe the case of a patient with C5-C6 cervical disc herniation completely resolved with infiltrative treatment with oxygen-ozone according to the "CT guided deep paravertebral technique", with MRI control at five months.

In this study, we found that oxygen-ozone therapy can be a possible first therapeutic approach for patients with C5-C6 cervical disc hernia, as it can act both symptoms, neck, pain and branchialgia.

KEYWORDS: *oxygen, ozone, cervical disc herniation, cervicalgia*

INTRODUCTION

Oxygen-ozone therapy for herniated discs was introduced in 1985 (1-4). Over the years, numerous series have been presented in the literature which reports positive results ranging from 75% to 90% (5-12).

Neck pain and cervicobrachialgia are highly disabling pathologies, more widespread in every social category and at an increasingly precocious age. They can arise acutely, for example, following strain, trauma, or unusual movements, or slowly, often with progressive worsening (13-17). Moreover, they can have numerous etiologies related to vertebral pathology: disc diseases, facet joint diseases, spondylolysis or lyses, spinal canal stenosis, root cysts, meningiomas, and primary or metastatic tumor pathology. A precise diagnosis made after a careful, objective examination and supported by suitable instrumental examinations is therefore essential. In particular, in addition to the standard radiograms of the

Received: 10 February 2017
Accepted: 03 April 2017

ISSN: 2038-4106
 Disclosure: All authors report no conflicts of interest relevant to this article.

spine, Computerized Axial Tomography (CT) and/or Nuclear Magnetic Resonance (MR) are indispensable for a correct diagnosis (1-20).

A case of C5-C6 cervical disc herniation completely resolved after treatment with oxygen-ozone performed with CT-guided deep paravertebral technique is reported. In addition, the MRI control examination supported clinical data carried out five months after treatment.

Clinical Case

IM 53-year-old male came to our clinic referring to left cervicobrachialgic symptoms with loss of strength in the upper limb and tingling paresthesias in the left C6 distribution area; clinically, a deficit in the left C6 distribution territory was detected. The patient came to our attention in July 2016, bringing an MRI performed in April 2016, in which a large left paramedian C5-C6 hernia was visible.

The neurosurgeon assessed the severity of the subjective symptoms and, viewed the MRI, advised the patient to undergo surgery promptly. The patient, however, refused the proposed intervention and contacted us in order to get different therapeutic options. He freely opted to attempt oxygen-ozone therapy (by previously signing the informed consent). Therefore, intraforaminal CT treatment with oxygen-ozone was carried out using a 22 G needle, infiltrating at a concentration of 25 mg/ml by administering 3 cc of the gaseous mixture (Fig. 1, Fig. 2A-B-C-D).

After the session, the patient was clinically re-evaluated and reported a clear improvement in pain symptoms with a net increase in strength. Clinical control ten days after, allowed appreciating a complete resolution of the pain and paresthetic symptoms. The patient did not take pain-relieving and anti-inflammatory drugs.

In September 2016, a control MRI was performed (Figure 3 A-B-C-D), which shows the complete disappearance of the C5-C6 disc herniation. Clinically, the patient did not complain of any disturbance.

The patient, for diagnostic purposes, underwent an MRI of the cervical spine at the Clinical Institute City of Brescia with Siemens Magnetom AERA 1.5 T system in April 2016; the study was performed using standard sequences followed by Fat / Sat sequences without contrast administration (Table I).

The infiltrative treatment was performed using Hitachi model Supria 16/32 Computed Tomography (CT) equipment.

The patient underwent CT-guided targeted injection of an oxygen-ozone gas mixture using the deep paravertebral infiltration technique. For the production of the oxygen-ozone mixture, a "Maxi Ozon Active generator device Medica SRL, Bologna, Italy" was used, equipped with a digital photometer for the regulation of ozone concentrations, with check valves for the collection of the gaseous mixture in absolute sterility.

Fig. 1. *Positioning of the needle with a right lateral approach.*

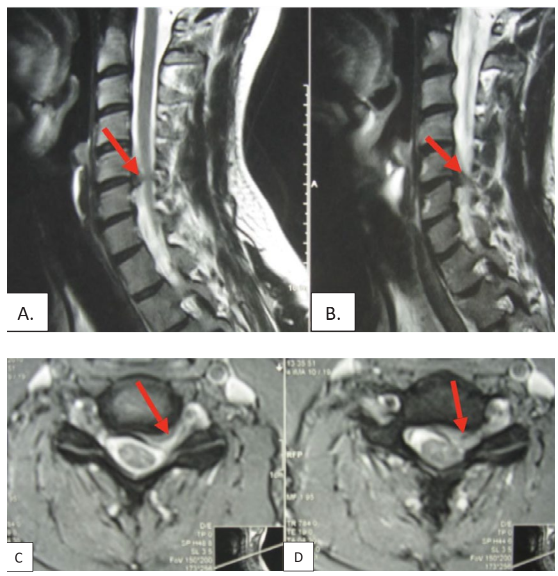

Fig. 2. ***A-B)*** *Sagittal MRI (14/04/2016): C5-C6 sub-ligamentous disc herniation (arrows), survey carried before treatment, on the date of the treatment.* ***C-D)*** *Axial MRI (14/04/2016): C5-C6 sub-ligamentous disc herniation (arrows), a survey carried out before treatment and on the date of the treatment.*

Infiltration technique

After receiving written informed consent from the patients, the injection level was established based on neuroradiological findings and clinical symptoms. Preliminary CT scans confirmed the level with the patient in a prone position to determine the point of needle entry. The skin was disinfected using a polyvinylpyrrolidone iodine solution after local anesthetic with ethyl chloride spray. CT-guided puncture was then performed using needles with a caliber of 22 G. CT guidance also served to check the correct position of the needle.

An aseptic technique was used to fill a 10 ml polyethylene syringe with a gas mixture of oxygen-ozone 3 ml at a concentration of 25 µg/ml gas was injected using a microporous filter to minimize the risk of contamination.

The injection site was disinfected and local anaesthesia was applied using an ethyl chloride spray. Infiltrations were done by specialist neuroradiologist at the Neuroradiology Service of Istituto Clinico Città di Brescia. The puncture site was identified by CT scan and marked on the patient's skin. The distance from this point to the foramen was subsequently measured. A 22 G Terumo needle (a 9 cm needle) was positioned 2-3 mm from the foraminal region, close to the ganglion of the affected nerve root. A CT scan was then repeated to check correct needle placement.

Once the treatment was completed, the patient remained for about two hours. At the end of the observation period, the patient was asked to re-evaluate the painful and paresthetic symptoms. A similar clinical check was performed after a further 10 days.

The control MRI was performed at the same Clinical Institute of the City of Brescia that had performed the first investigation, using the same equipment and settings of the study.

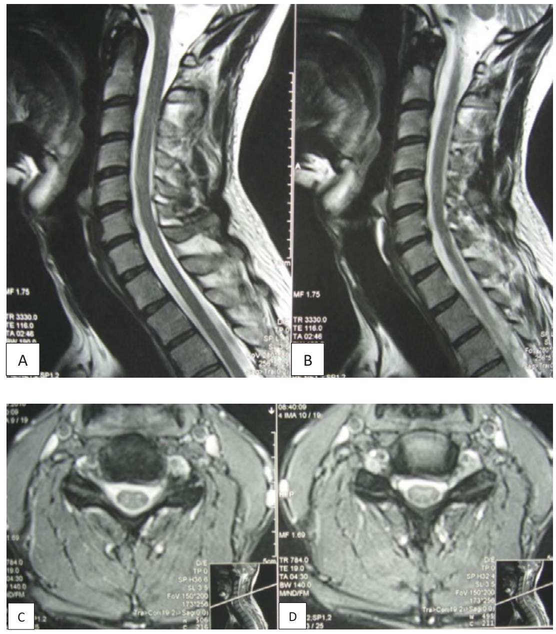

Fig. 3. ***A-B)*** *Sagittal MRI after ozone therapy (10/09/2016) - The MRI investigation documents the complete disappearance of the herniated disc.* ***C-D)*** *Axial MRI after treatment with oxygen-ozone therapy (10.09.2016) – Complete The disappearance of the hernia.*

DISCUSSION

The clinical case presented is of undoubted gravity from a clinical point of view, so that a surgical herniaectomy – although refused by the patient – was considered as the first therapeutic option.

By watching the imaging, it was initially doubtful that the success of the infiltrative treatment, and only the patient's insistence on attempting with oxygen-ozone led us to try. However, the clinical evolution was rapidly favorable, in complete disagreement with what we expected and with what was also suggested by the neurosurgeon colleague. The surgical option was therefore discarded.

After treatment, the patient expressed complete resolution of the painful symptoms. The clinical improvement was then confirmed by MRI scan, which showed complete disappearance of the treated disc herniation (five-month control).

Table I. *MRI Scan Protocol.*

T2 SAG	(Thickness 3 mm, Gap 20%, TR 3500, TE 100, Fov 300 mm, Matrix 384 Pd HF)
T1 SAG	(Thickness 3 mm, Gap 20%, TR 550, TE 9.7, Fov 300 mm, Matrix 384 Pd HF)
T2 AX	(Thickness 3 mm, Gap 10%, TR 4280, TE 100, Fov 220 mm, Matrix 384 Pd AP)
T2 SAG pair	(Thickness 3 mm, Gap 20%, TR 3900, TE 100, Fov 300 mm, Matrix 384 Pd HF)
T1 COR	(Thickness 3 mm, Gap 15%, TR 420, TE 9.1, Fov 300 mm, Matrix 384 Pd RL)
T1 FS SAG	(Thickness 3 mm, Gap 20%, TR 2500, TE 39, Fov 300 mm, Matrix 384 Pd HF, Fat/Sat)
T1 FS AX	(Thickness 3 mm, Gap 20%, TR 3500, TE 39, Fov 220 mm, Matrix 384 Pd AP, Fat/Sat)

The excellent therapeutic result is therefore attributable to the mechanisms of action of the oxygen-ozone mixture at the site of the disease.

The pharmacological action of ozone therapy is carried out, in fact, in a multifactorial way: decontracting (action with better oxygenation of the muscles), eutrophic (with stimulation of tissue reparative processes), antiphlogistic (resolution of inflammation with reduction of prostaglandin synthesis), analgesic (diffusion of a gaseous mixture of oxygen-ozone through the anatomical structures responsible for pain), neoangiogenetics (increased oxygenation with improved transport and release of oxygen at the tissue level), "chemical acupuncture" reflexotherapy effect (capable of interrupting the chain of chronic pain through antalgic mechanisms of the antinociceptive and neuropathic type, activating blood circulation, immunomodulating, adaptation to oxidative stress).

In the herniated disc, oxidation is the mechanism by which ozone destroys the connective "cells" that contain water in the pulpy nucleus. The water is thus released, and the hernia is reduced. Thanks to the oxygen-ozone anti-inflammatory and dehydrating action, the hernia's size is thus reduced.

CONCLUSION

In recent years several studies have demonstrated the utility of oxygen-ozone therapy in the treatment of herniated discs (1-20).

Oxygen-ozone can be curative thanks to several factors linked to its mechanisms and administration techniques: improvement of local circulation (with effect in eutrophication in the proximity of the compressed nerve root and muscle spasm); normalization of the level of cytokines and prostaglandin (with anti-inflammatory and pain reliever); increase in the production of superoxide dismutase (with minimization of oxidizing reagents); proximity to the herniated material (which causes accelerated dehydration or destruction of a non-vascularized tissue that justify the good end-result).

The rapid resolution of pain with no complications and the safety due to the control of infiltration by TC, allow to propose oxygen-ozone therapy technique as a viable alternative to surgical treatment of disc herniation and therefore a method of choice between conservative therapies.

Oxygen-ozone therapy can be considered as a possible first line approach to these patients since it can act both on the symptom "neck pain and brachialgia" and on the cause of "herniated disc", (i.e. inflammation).

Conflict of interest

The authors declare that they have no conflict of interest.

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European Journal of Musculoskeletal Diseases
ISSN 2038-4106/2017

Review

BRUXISM: REPORTS ON CENTRAL DOPAMINERGIC PATHOGENESIS

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ABSTRACT

Bruxism is a parafunctional activity which causes the clenching and grinding of teeth. It is divided into two types: bruxism during sleep and bruxism during wakefulness. Bruxism has a multifactorial aetiology. The purpose of this study is to review the literature and summarize the current evidence regarding the association between these central neuronal pathways, especially dopaminergic pathways, and the onset of bruxism episodes.

KEYWORDS: *bruxism, abrasion, erosion, dopamine, central nervous system*

INTRODUCTION

Bruxism is an oral condition of great interest to researchers and clinicians in the dental, neurological and sleep medicine domains (1). Bruxism can be defined as "a repetitive jaw-muscle activity characterized by clenching or grinding of teeth and/or by bracing or thrusting of mandible". Bruxism has two distinct circadian manifestations: it can occur during sleep (i.e., sleep bruxism - SB) or during wakefulness (i.e., awake bruxism - AB) (1). Although bruxism represents a common clinical phenomenon (2), the prevalence of "generic bruxism" (i.e., without any distinction between AB and SB) is between 8% to 31,4% in the examined population. A prevalence of 22-31% for the AB and 13-23% for the SB in the adult population.

Beyond the different circadian manifestations of bruxism, there is consensus that it has a multifactorial aetiology and expresses a centrally mediated rather than peripherally mediated phenomenon (3).

Several studies focused on factors associated with its pathogenesis which included: alcohol smoking, drugs (4, 5),

Received: 19 January 2017
Accepted: 04 March 2017

ISSN: 2038-4106

psychotropic substances (6), anxiety (7), stress (8-11), psychiatric diseases (5), malocclusions (12, 13), obstructive sleep apnea syndrome (OSAS) (14).

It is believed that these biological, environmental, and psychosocial factors may represent a motor stimulus at the central nervous system (CNS) level, triggering an altered response to transmission channels of the dopaminergic system, which will correspond to the clenching or grinding of the teeth (15-17). However, the exact molecular mechanism that regulates these neuronal circuits and allows them to play a primary role in the pathogenesis of bruxism is still unclear.

The aim of this review is to analyze the association between central neuronal pathways (dopaminergic pathways) and the onset of bruxism, including both AB and SB.

MATERIALS AND METHODS

The research was performed with MEDLINE / PubMed database, using the term "bruxism" associated with appropriate word combinations, such as dopamine; dopamine antagonists; neurochemicals; dopamine receptor; amphetamines; antipsychotic agents; psychostimulants; attention deficit disorder with hyperactivity; ecstasy.

The original works published in English were thus selected. Additional sources were selected through the previously published articles by searching their references. Since the works concerning the association between dopaminergic transmission and the pathogenesis of bruxism are entirely incongruent and confusing, tables have been created to summarize the data of selected papers.

Inclusion criteria include:

1) clinical studies showing an association between a single molecule and bruxism;
2) experimental studies that demonstrate a cause-effect relationship between a specific molecule (drugs, psychotropic substances) and bruxism;
3) studies based on diagnostic methods such as anamnestic questionnaires, clinical examination, recording by polysomnography (PSG) and/or electromyography of masticatory muscles (EMG);
4) studies whose samples represent an adult and/or adolescent-pediatric population.

Exclusion criteria include:

1) studies in which participants are affected by genetic or neuromuscular diseases;
2) studies in which patients present with temporomandibular disorders (TMJ) and/or obstructive sleep apnea syndrome;
3) studies in which the diagnosis of bruxism does not meet the diagnostic criteria approved by the scientific community;
4) animal studies;
5) studies whose subjects are under pharmacological treatment for psychiatric pathologies.

The study selection process was performed in three phases. In the first phase, titles and abstracts were analyzed to identify papers focusing on the research topic. In the second phase, the complete text was read. Finally, in the third phase, studies that met the inclusion criteria were selected and included in this review.

RESULTS

A total of 140 articles were identified from the MEDLINE / PubMed database. Ninety-two studies were selected from the analysis of the titles, of which 10 were then excluded as animal studies; after evaluation of the abstract of each work, 31 works were selected for full-text reading and analysis of the inclusion criteria.

Finally, 15 articles met the inclusion criteria and were therefore included in this review (Table I). Each study evaluated the relationship between dopaminergic neuronal pathways and the genesis of bruxism in different modalities.

Table I. *Inclusion criteria.*

Bruxism and Dopaminergic Agonists	10 studies
Bruxism and Dopaminergic Antagonists	2 studies
Bruxism and D2 Receptors	2 studies
Bruxism and ADHD	1 study

Most studies reveal a prominent role of dopaminergic transmission in tooth clenching and grinding pathophysiology, as it represents the major neurotransmitter involved in motor control. However, it was demonstrated that dopamine does not always act similarly.

The final effect dopamine can exert in triggering the hyperactivity of the chewing muscles is strongly dependent on its quantity (excess/defect) and pharmacokinetics. The studies showed a great complexity of dopaminergic transmission due to many circuits and receptors. The heterogeneity of bruxism patterns presents among the population (sleep bruxism, awake bruxism or both) and the relationship existing with hyper- and hypo-dopaminergic states derive from the involvement of different brain regions and from the complex pharmacology of different receptor subtypes to which dopamine binds. The interactions between dopamine and bruxism are summarized below in Table II and III, showing each study's specificity.

DISCUSSION

Selected studies confirm the hypothesis that an altered dopaminergic transmission at the nigrostriatal and mesocortical pathways level is involved in the onset of bruxism. Conversely, depletion of dopaminergic transmission at the level of the meso-cortical pathway and the nigro-striatal pathway can result in an imbalance of the basal ganglia circuit, which determines muscle hyperactivity (3, 18, 19).

These neuronal pathways, therefore, represent the two main dopaminergic pathways involved in the pathophysiology

Table II. *The interactions between dopamine and bruxism.*

	Study design	*Population (n° of partecipants)*	*Group A*	*Group B*	*Effect on Bruxism*
Magee, 1970	Case Study	1	L-Dopa (short term)		↑
Lobbezoo F et al. 1996	Controlled clinical trial	20	SB	Control Group	↓
Lobbezoo F et al, 1997	Controlled clinical trial	10(5M and 5W)	L-Dopa 100mg + bensarazide 25mg	Placebo	↓30%
Lobbezoo F, 1997	Clinical Trial	2	Bromocriptin 7,5mg	Placebo	↓
J.Van Der Zaag et al, 2007	Open trial	1(SB)	Pergolide (o.o5-0.5mg)+domperidone		↓
Lavigne et al, 2001	Double blind trial	7	Bromocriptine 7.5mg + domperidone	Plcebo + Domperidone	No Effects
Cahlin B et al, 2017	Randomized open trial	13(SB)	Pramipexole (o.9-0.54mg)	Placebo	No effects
Chen et al, 2005	Case Study	3 (AB + SB)	Metaclopramide 15mg o.s		↓
Ho Sung Yi et al. 2013	Case Study	2(AB)	Metaclopramide 15 mg o.s	Metaclopramide 9mg o.s	↓

Table III: ***AB****= awake bruxism;* ***SB****= sleep bruxism;* ***t****= bruxism enhancement.*

	Study design	*Population (n° of participants)*	*Drugs*	*Mean Age*	*Effect on bruxism*
See S-J e Tan E-K 2003	Case Report	1 (AB + SB)	Amphetamine (chronic use)	37	t
Ricardo Jorge Dinis-Oliveira 2010	Case Reports	3 (AB + SB)	3,4-Methylenedioxymethamphetamine (ecstasy)	35.33	t
Mendhekar. et al. 2008	Case Report	1	Methylphenidate 10 mg per die	9	t
Mendhekar D. &., 2009	Case Report	1	Atomoxetine 10 mg/ dia	12	t
Micheli et al. 2003	Case Reports	8 (5 men e 3 women)	Haloperidol 8mg	68.5	t
Mendhekar D. &., 2009	Case Report	1 (AB + SB	Trifluoperazine 15 mg Triesiphenidyl 4 mg	56	t

of bruxism. Suppression of the nigro-striatal pathway, following the administration of typical antipsychotic drugs, determines the establishment of "iatrogenic" bruxism due to loss of motor control.

"Idiopathic" bruxism, on the other hand, could be alleviated with short-term administration of L-DOPA and dopaminergic agonists. They stimulate dopaminergic receptors in basal ganglia, thus increasing dopamine control over motor functions by the nigrostriatal pathways.

An imbalance of the dopaminergic pathway in the meso-cortical tract may represent a key to the genesis and pathophysiology of wakefulness and/or sleep bruxism (20-22). This feature is even more evident in patients with frontal lobe cerebral hypo-perfusion. In fact, in these patients, there is a hypersensitivity of the presynaptic receptors.

One study suggests that bruxism can also be induced by the action of other neurotransmitters, such as serotonin (5-HT) and noradrenaline (23). Thus, we assume the existence of an "alternative" pathway between bruxism and the neuronal circuits of the central nervous system, demonstrating the complexity of these interactions in our brain. Indeed, it is known that nicotine addiction is closely associated with bruxism (24, 25). Nicotine represents a powerful stimulus for the transmission and release of dopamine in the brain, which could explain the evidence that the prevalence of SB in smokers is two times higher than in non-smokers (26, 27).

CONCLUSIONS

Bruxism can be considered a parafunction of the central nervous system, a fact that implies a multifactorial aetiology. The reported data suggest that bruxism is an expression of disorders of the dopaminergic central system, and these alterations can be of two types: direct or indirect.

Direct alterations are mainly related to the effect of substances (such as dopaminergic agonists or antagonists) which act directly on the dopaminergic pathways by exerting an up or down-regulation of the nigro-striatal pathway. Indirect alterations are mainly due to molecules (re-uptake inhibitors or 5-HT antagonists) that interfere with these central neuronal circuits, inhibiting or enhancing the meso-cortical pathway.

Finally, it should be remembered that the dentist is usually the first specialist to diagnose bruxism. Deep knowledge of bruxism origin is essential to counterbalance or eliminate the factors responsible for the phenomenon where possible.

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European Journal of Musculoskeletal Diseases
ISSN 2038-4106/2017

BPI

Case report

ATROPHIC POSTERIOR MANDIBLES TREATED WITH SANDWICH OSTEOTOMY WITHOUT MINISCREWS AND MINIPLATES: A CASE REPORT

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ABSTRACT

The posterior mandible may be challenging due to insufficient height and width of the edentulous alveolar crestal bone. The aim of this case report was to use an inlay technique without the use of miniscrews and miniplates for the stabilization of grafted bone fragments. A 54-year-old patient was treated with a horizontal osteotomy performed 2-3 mm above the mandibular canal, and two oblique cuts were made using an ultrasonic. The final phase of the osteotomy was performed with a lever for dental extraction. One miniblock of equine bone was inserted between the coronal osteotomized segment and the mandibular basal bone. Particles of cortical-cancellous equine bone filled the residual space. A resorbable collagen membrane was used for covered the biomaterials and miniblock. Four months after surgery, a panoramic X-ray was taken before implant insertion. No dehiscence of the mucosa was observed at the marginal ridge of the mobilized fragment. Rx showed a mineralized zone between the osteotomized segment's basal bone and coronal portion. This case

Received: 19 January 2017
Accepted: 04 March 2017

ISSN: 2038-4106
 Disclosure: All authors report no conflicts of interest relevant to this article.

report showed that equine collagenated blocks present higher stability, allowing to eliminate the use of miniscrews and miniplates, thus simplifying the sandwich technique.

KEYWORDS: *inlay, bone, graft, screw, fixation*

INTRODUCTION

The extensive loss in the posterior mandible is challenging for implant placement (1). Vertical augmentation of the alveolar ridge is necessary for patients with extensive resorption. Different regenerative techniques are currently utilized to increase bone volume for the predictable placement of endosseous implants. Many surgical approaches are proposed, such as autogenous bone grafts, alloplastic materials, alveolar distraction osteogenesis and inlay technique (2-7). Vertical bone regeneration in posterior mandibles with onlay bone grafts has been used, but the results have not been promising. Guided bone regeneration was proposed in a 1991 report by Dahlin and colleagues (8). Expanded polytetrafluoroethylene membranes were proposed for posterior mandibular reconstruction (9, 10). However, vertical augmentation is a highly sensitive technique, predictable only when the surgical protocol is followed strictly (11).

Titanium mesh and autogenous bone grafts have been used successfully for vertical ridge augmentation of the atrophic maxilla and mandible and have gained popularity (12, 13). However, the titanium mesh must be fixed with screws. In addition, infection is a common complication that may cause loss of grafted bone, resulting in failure. The visor technique was first described in 1975 by Harle (14) to increase the absolute height of the atrophic edentulous mandible. In this technique, the alveolar ridge of the mandible is osteotomized and moved on the visor principle.

Horizontal osteotomy with the interposition of bone as a ‘sandwich’ to augment the alveolar ridge has been described. The inlay, which uses a bone block graft positioned between osteotomized bony segments, was developed by Schettler (15) in 1974 Stoelinga and colleagues (16) combined the visor osteotomy and sandwich techniques to augment the severely atrophic edentulous mandible with success. However, this technique involves donor site morbidity (17), as autogenous bone is used as the interpositional material.

The following report describes the treatment outcome after alveolar ridge augmentation by a sandwich osteotomy combined with an interpositional xenograft.

The aim of this report is to show an inlay technique without the use of miniscrews and miniplates for the stabilization of bone fragments.

CASE REPORT

A 54-year-old male presented with a unilateral atrophic mandible and requested implant therapy. The patient was referred to the Oral Surgery Department of the University of Chieti-Pescara for a fixed prosthetic rehabilitation of the posterior mandible. Radiographic examination with cone-beam tomography revealed the insufficient height of mandibular ridges unsuitable for implant placement (Fig. 1).

The patients refused to harvest autogenous bone; therefore, an inlay procedure was proposed using a collagenated cancellous equine bone block to allow subsequent implant placement for prosthetic rehabilitation (18, 19). The surgical procedure was performed under local anaesthesia (articaine 4% and adrenaline 1:100,000) with intravenous sedation (diazepam 0.2 mg/kg). After a paracrestal incision in the buccal vestibule avoiding the emergence of the mental nerve, a subperiosteal tissue dissection limited to the buccal side, a horizontal osteotomy was performed 2-3 mm above the mandibular canal, and two oblique cuts were made using an ultrasonic device (Surgysonic, Esacrom, Imola Italy). The final phase of the osteotomy was performed with a lever for dental extraction.

The osteotomized segment was then raised, sparing the lingual periosteum. Two miniblocks of equine bone (5 x 5 x 3 mm, OsteoBiol Sp-Block, Tecnoss, Coazze, Italy) were inserted between the coronal osteotomized segment and the mandibular basal bone (Fig. 2).

The residual space was filled by particles of cortical-cancellous porcine bone (OsteoBiol Gen-Os, Tecnoss, Coazze, Italy). After periosteal releasing incisions, the flap was sutured carefully with Vicryl 4.0 (Ethicon FS-2; St. Stevens-Woluwe,

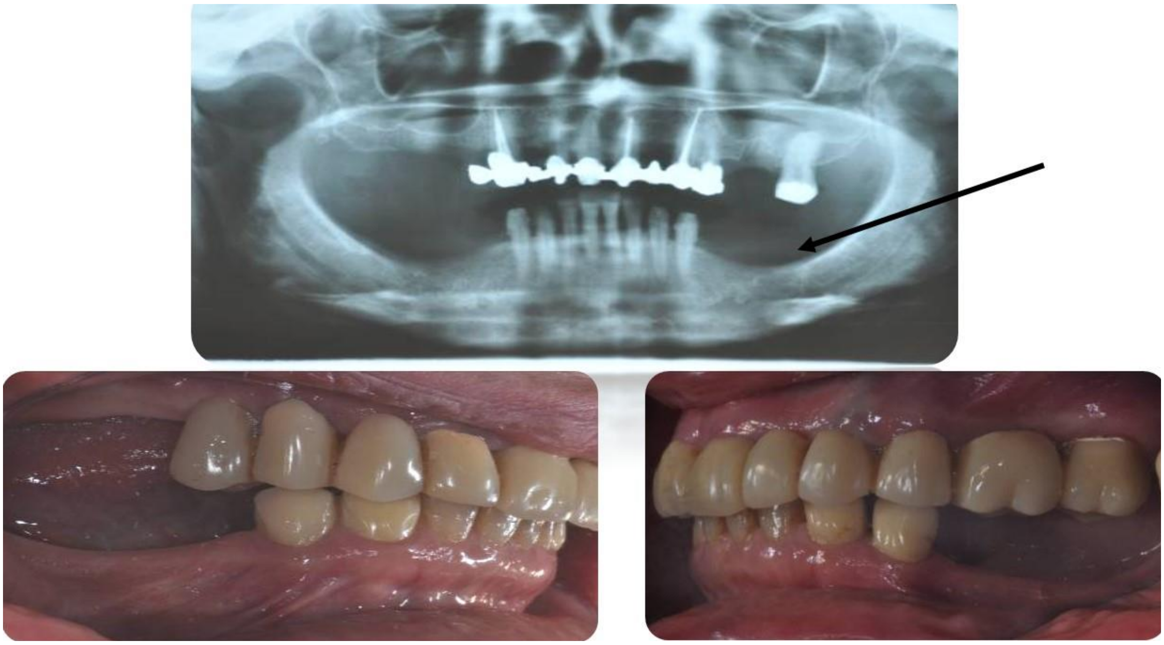

Fig. 1. *Radiograph and photos showing mandible before verticle ridge augmentations.*

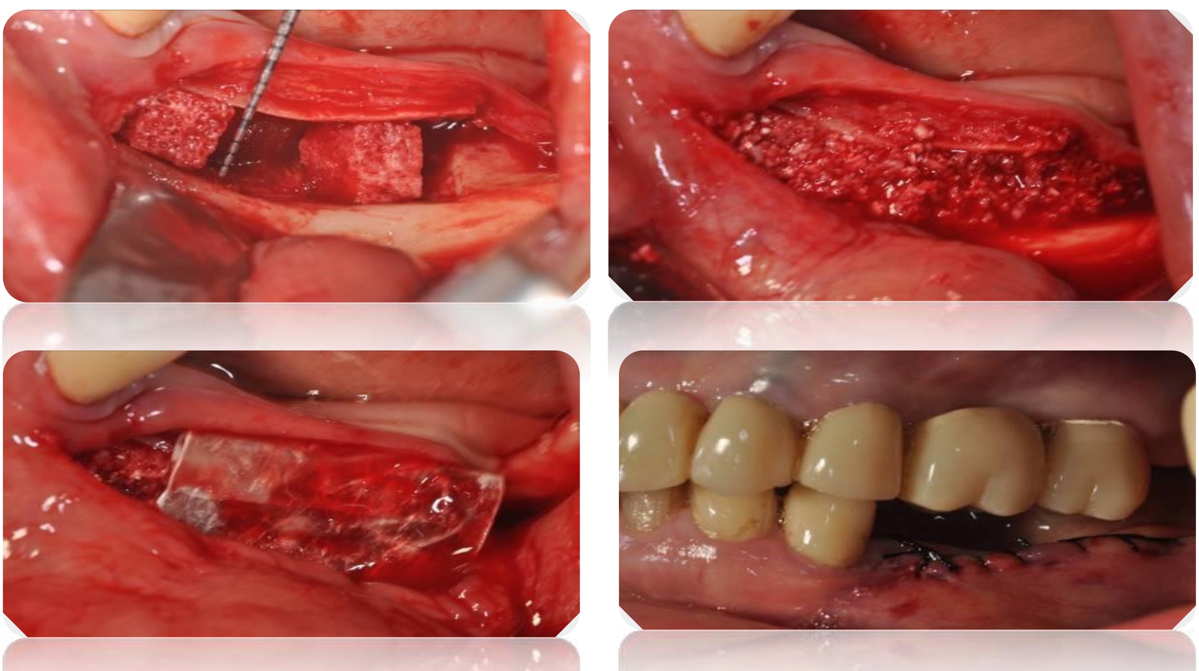

Fig. 2. *The bone segment was moved superiorly after all bone cuts were completed with piezosurgery device. Two blocks of collagenated equine bone interposed between the basal bone and the mobilized fragment.*

Belgium). The patients were followed with a clinical examination every week in the first month after surgery and twice in the subsequent months before implant insertion. The healing process was uneventful. No neurosensory disturbances were recorded. Cone-beam tomography assessments were performed immediately after the surgical procedure.

Four months after surgery, a cone-beam tomography was taken before implant insertion, showing a vertical increase of 7 mm. Two submerged Close BL implants 4mm x 10mm with a screw-retained conical abutment connection (Isomed, DUE CARRARE (PD), Italy) were placed in positions #35 and #37.

DISCUSSION

The reported case of posterior mandibular atrophy was successfully treated with interpositional sandwich osteotomy bone grafts without miniscrews and miniplates.

The inlay technique, recently revisited (18), facilitates implant placement by raising the bone above the nerve, and improves the interocclusal distance, thus reducing the crown-implant ratio. However, many clinical complications are reported after and during bone graftings, such as fracture of the cortical bone, membrane exposure, bone resorption, and neurological impairment (20). The absence of micromovement and the blood supply are key factors for successfully integrating the grafted biomaterials and substituting new bone (8). A high success rate of the inlay graft technique for the treatment of posterior mandible atrophy was reported by Barone et al. and Felice et al. (21, 22). In this case report, the effectiveness was shown by a post-operative course without any adverse event, accompanied by a high level of graft integration reported in the radiographical follow-up. In addition, the piezosurgery device simplified the technique and reduced the incidence of complications (23-25).

The interpositional inlay bone grafting using a fixation device is already used by many researchers. On the contrary, the technique without using a fixation device was used by a few authors and has the advantage of decreased risk of failure and complication for fracture or bone resorption related to the insertion of miniscrews and miniplates.

CONCLUSIONS

In conclusion, the present case report showed that equine collagenated blocks present a higher stability, allow avoiding the use of miniscrews and miniplates and simplify the sandwich technique.

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European Journal of Musculoskeletal Diseases
ISSN 2038-4106/2017

BPI

Comparative Study

EPIDEMIOLOGICAL ANALYSIS OF ORTHODONTIC TREATMENT NEEDS IN ITALY: A COMPARISON BETWEEN TWO STUDIES

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ABSTRACT

This study aims to verify the prevalence and distribution of various types of malocclusion in a cross-section of patients in the province of Bergamo. A comparison is also presented with one study conducted 16 years earlier in the same location. The patient evaluation was made utilising cephalometric analysis. The study was conducted on a sample of 441 patients in Italy and area treated in the Alzano Lombardo Hospital. Gender, age, SNA, SNB, ANB, intermaxillary angle, SNP-A, Go-Me, Wits index, OVJ, OVB and gonial angles (total, upper and lower) are investigated. There are 49.21% skeletal class I, 44.9% class II and 5.9% class III. More than 50% of children are normodivergence, 8.54% hypodivergent and 39.76% hyper-divergent. Only 39.23% of subjects have a correctly positioned maxilla. Only 30.61% of patients presented correct mandibular positioning. A normomandible is present in about one-third of children. The presence of maxillary deficit is found in 48% of patients. An analysis of skeletal bite data demonstrates that only 17% of subjects have a normo bite. 40.82% of patients present a negative Wits appraisal. 71% of children have a normo-overbite, whereas 12% have a diminished overbite and 16% present an increased overbite. A previously performed study showed a higher prevalence of class II and hyperdivergence. In this study, it was possible to present an overview of the different malocclusion indices in a sample of children in the province of Bergamo. Most of them have malocclusion and require orthodontic treatment.

KEYWORDS: *epidemiological analysis, orthodontic treatment, malocclusion*

INTRODUCTION

Orthodontic treatment has received much attention from specialists and patients due to the impact of such treatment on social life (1-3). In clinical practice, many patients are interested in orthodontic treatment to increase their quality of

Received: 15 March 2017
Accepted: 20 Aprile 2017

ISSN: 2038-4106
 Disclosure: All authors report no conflicts of interest relevant to this article.

life, and statistics confirm that 20% of children are already affected by malocclusion by age 6, and 6% of these patients require urgent treatment (4).

A recent study conducted in Northern Europe confirmed that there has been an increase in the incidence of malocclusions in the last 400-700 years (5). Furthermore, malocclusions mainly affected women in the past, whereas today, there is no significant difference between the two genders.

Today malocclusions do not self-correct with age but tend to worsen (6). A study by Heikiheimo et al. highlights the necessity for urgent treatment and how the presence of a relatively severe malocclusion increases from 23% at 7 years of age to 46% at 12 years of age (7). Profitt et al. conducted a study on the American population by applying the "indicators of the need for orthodontic treatment" (8). The study's results suggested that 57% to 59% of people require orthodontic treatment. The same study suggested that the Mexican-American population has a higher prevalence of incisor malposition, class II malocclusion and class III malocclusion compared to the rest of the American population but also a lower prevalence of deep bite and open bite. The most severe cases of malocclusion tend to be seen in the African-American population.

An epidemiological study conducted in Nigeria on a sample of 493 patients aged 7 to 10 years revealed that 1/3 required interceptive orthodontic treatment - the type of malocclusion most commonly found is a crossbite, followed by the inclusion of permanent teeth and premature loss of deciduous teeth, all accompanied by poor dental hygiene habits. However, this study did not reveal significant differences between boys and girls (9). Ten years later, a new study was conducted in Nigeria on 320 patients aged 13 to 20 years, which found that 11.8% of patients had normal occlusion, 80.3% had class I malocclusion, 6.3% presented class II malocclusion and 1.6% were affected by class III malocclusion (10).

Similar results have been found in Italy in a study conducted on 3017 patients aged between 8 and 13; 75.8% of patients have malocclusions accompanied by widespread premature loss of deciduous teeth and increased overjet and overbite (11).

In accordance with past results, Siriwat and Jarabak (12) have come to the conclusion that the most frequent cases of malocclusion are class I (47%), followed by class II (46.2%) and finally, class III (6.6%). Furthermore, Aldrees conducted a study in South Arabia, confirming that the most common malocclusions are class I (13).

The same results have been found in a study performed in China: once again, the most common cases of malocclusion are class I (48%), but what differentiates the results obtained in this study from those obtained in European and American studies is the predominance of class III malocclusion (21%) (14). In addition, various studies reported that the most common problem is the crowding of incisors, present in 38.9 % of patients examined (15-16).

Dental agenesis is also very common. In decreasing order, the most common elements affected by agenesis are the third molars, second premolars, and lateral maxillary incisors. The latter has an incidence of 5%, and after third molars, they are the dental elements most affected by agenesis though different populations (15-16).

Moreover, among permanent teeth, maxillary canines are most often included teeth (5.24%), followed by second lower premolars (2.23%), second superior premolars (1.11%) and inferior canines (0.92%) without statistical differences between men and women and with arch length as a risk factor. None of the patients with dental inclusions had a squared arch shape (17-18).

Regarding canine inclusion, a literature review shows that palatally displaced canines correlate with genetic anomalies, while labially impacted canines result from lack of space (17-18).

The main purpose of this study is to analyse the predominance of malocclusions Italy and compare the results with those obtained from international literature and those of studies performed in the Bergamo area 16 years ago (19).

MATERIALS AND METHODS

The study was conducted on 441 patients (219 men and 222 women) from the Bergamo area in the Alzano Lombardo Hospital. It was performed with respect to the Declaration of Helsinki of 2013. All patients had a first evaluation, and the following documents were collected and investigated:

- lateral radiography: cephalometric analysis was then performed in accordance with the parameters of Giannì school;
- orthopantomography;
- cast model of upper and lower jaws.

All data were included in a database, and particular attention was focused on the following:

- skeletal class: identified through the analysis of ANB angle;
- divergence: given by the intermaxillary angle;
- presence of agenesis ;
- presence of impacted canines;
- maxillary position: obtained from the value of SNA angle;
- lower jaw position: given by the value of SNB angle;
- maxillary dimension: Sna-A;
- mandibular dimension: Go-Me/S-N;
- transversal dimension;
- Wits index;
- overjet;
- overbite;
- ethnic group;
- gender

RESULTS

In the analysed sample of 441 patients living in Italy treated in the Department of Dentistry in Alzano Lombardo Hospital, a correspondence can be seen between the number of female (50.34%) and male patients (49.66%) (Table I).

Considering the total sample, without any distinction between gender, only 49.21% have a class I malocclusion, while 44.9% have a class II malocclusion and only 5.9% are affected by a class III malocclusion. However, if a distinction between men and women is made when analysing the types of occlusions, the following conclusions can be drawn: class I is equally distributed between men and women, class II malocclusion is more frequent in women by a factor of 1.54%, while class III malocclusion is more frequent in men (6.39%) than in women (5.39%).

Regarding divergence, there are significant differences in the distribution of normodivergent, hypodivergent and hyperdivergent facial patterns: there is a prevalence of normodivergence in more than 50% of cases examined, whereas in the remaining cases, 8.54% are hypodivergent and 39.76% are hyperdivergent (Table II).

There are differences between males and females: it can be seen that normodivergence is more frequent in women than in men, with a difference of about 4% percentage points. The difference is even greater in the distribution of hypodiveregence, which is more common in men (12.08%) than women (5.08%). However, hyperdivergence is more common in women (3%).

Regarding agenesis, these occur in a significant part of the sample (5.44%) and are distributed very differently between men and women. There is a higher presence of agenesis in women (7.41%) compared to men (3.65%) (Table II).

Table I. *Percentage analysis of distribution of different skeletal classes by gender.*

PATIENTS	M	F	SKELETAL CLASS I	SKELETAL CLASS II	SKELETAL CLASS III
TOTAL	219	222	217	198	26
	441		441		
	49.66%	50.34%	49.21%	44.90%	5.90%
MEN	219	0	108	97	14
	219		219		
			49.32%	44.29%	6.39%
WOMEN	0	216	106	99	11
		216	216		
			49.07%	45.83%	5.09%
DIFFERENCE			0.24%	-1.54%	1.30%

Also, the presence of impacted canines is distributed differently in the population, with a difference of 2.87% between men and women (with a higher prevalence in women).

Regarding maxillary positioning, only 39.23% of patients present a correctly positioned maxilla, and there is a difference in maxillary normoposition with 43.84% of men against 34.26% of women (Table III).

The maxillary protrusion is present in 14.74% of patients, distributed differently in men and women (11.87% *vs* 18.06%); a maxillary retrusion can be seen in 46.03% of cases, non-uniformly distributed between men and women: a higher frequency of alterations in maxillary position is found in women.

The data regarding mandibular positioning suggests that only 30.61% of patients present correct mandibular positioning, with significant differences between men and women (a normopositioned mandible is 1.88% more frequent in women than men). In addition, more than two-thirds of patients (with equal distribution between men and women) present mandibular retrusion. Instead, only 2.49% have a mandibular protrusion (Table IV).

Table II. *Percentage analysis of divergence, presence and number of agenesis, and impacted canines (the results on divergence are referred to a sample of 410 patients).*

PATIENTS	Normo div.	Hypo Div.	Hyper Div.	Agenesis	N° agenesis	Presence of impacted canines
TOTAL	212	35	163	24	49	38
	410					441
	51.71%	8.54%	39.76%	5.44%		8.62%
	100.00%					100.00%
MEN	103	25	79	8	20	15
	207					219
	49.76%	12.08%	38.16%	3.65%		6.85%
	100.00%					100.00%
WOMEN	106	10	81	16	29	21
	197					216
	53.81%	5.08%	41.12%	7.41%		9.72%
DIFFERENCE	-4.05%	7.00%	-2.95%	-3.75%		-2.87%

Table III. *Maxillary position in the examined sample and differences between genders.*

PATIENT	M	F	Maxillary normoposition	Maxillary protrusion	Maxillary retrusion
TOTAL	219	222	173	65	203
	441		441		
	49.66%	50.34%	39.23%	14.74%	46.03%
	100.00%		100.00%		
MEN	219	0	96	26	97
	100.00%	0.00%	43.84%	11.87%	44.29%
WOMEN	0	216	74	39	103
	0.00%	100.00%	34.26%	18.06%	47.69%
DIFFERENCE			9.58%	-6.18%	-3.39%

Table IV. *Mandibular position divided by genders.*

PATIENT	(Mandible) Mandibular normoposition	(Mandible) Mandibular protrusion	(Mandible) Mandibular retrusion
TOTAL	35	11	295
	441		
	30.61%	2.49%	66.89%
MEN	68	4	147
	31.05%	1.83%	67.12%
WOMEN	63	7	146
	29.17%	3.24%	67.59%
DIFFERENCE	1.88%	-1.41%	-0.47%

Considering jaw dimension, we can see a normomandible in about one-third of patients, without any significant difference between males and females. On the contrary dimensional differences are distributed in a heterogeneous way. Hypomandible is found primarily in men (41.12%), with a difference of 8% compared to women. Hypermandible, instead, is found in 29.49% of patients, with a higher frequency in women. Maxillary dimension is reported in Table V; maxillary deficit is found in 48% of patients .

An analysis of bite data demonstrates that only 17% of patients, without any significant difference between males and females, have a normo bite. On the other hand, 53.53% have a deep bite, and 28.7% have a skeletal openbite, with a difference of about 2 % between the two genders (Table VI).

Maxillary constriction is very common: only 53.51% of patients examined have no transverse contraction, 35.83% have a maxillary constriction, and 10.66% have a severe transversal deficit with a higher frequency in men (13.76%) than in women (6.91%).

Regarding Wits index, overjet and overbite, 40.82% of patients present a negative Wits appraisal: in 4 patients (2M and 2F), a value lower than -7 was obtained, representing 0.91% of the sample. Moreover, one-third of patients have normal Wits with values between -1 and +1 (36% in women and 29% in men) (Table VII).

Table V. *Dimension of maxilla and lower jaw in relation to the total number of patients and gender.*

PATIENT	Normo mandible	Hypo mandible	Hyper mandible	Normo maxillia	Hypo maxillia	Hyper maxillia
TOTAL	147	159	128	128	210	99
	434			437		
	33.87%	36.64%	29.49%	29.29%	48.05%	22.65%
	100.00%			100.00%		
MEN	74	88	52	67	101	49
	34.58%	41.12%	24.30%	30.88%	46.54%	22.58%
WOMEN	69	70	75	58	106	50
	32.24%	32.71%	35.05%	27.10%	49.53%	23.36%
DIFFERENCE	2.34%	8.41%	-10.75%	3.77%	-2.99%	-0.78%

Table VI. *Skeletal bite and maxillary constriction (parameters were obtained from cast models).*

PATIENT	Normo-bite	Deep-bite	Open-bite	Maxillary constriction	No Maxillary constriction	Severe maxillary constriction
TOTAL	78	235	126	158	236	47
	439			441		
	17,77%	53,53%	28,70%	35,83%	53,51%	10,66%
	100,00%			100,00%		
MEN	39	118	60	79	109	30
	17,97%	54,38%	27,65%	36,24%	50,00%	13,76%
WOMEN	38	114	64	78	124	15
	17,59%	52,78%	29,63%	35,94%	57,14%	6,91%
DIFFERENCE	0,38%	1,60%	-1,98%	0,29%	-7,14%	6,85%

Table VII. *Distribution of Wits values, overjet and overbite.*

PATIENT	wits <-7	wits>-7; <-1	wits >-1; <+1	wits >+1; <+6	wits >+6	overjet <0.5	overjet >0.5; <4.5	overjet > +4.5	overbite <0.5	overbite >0.5; <4.5	overbite >+4.5
TOTAL	4	180	144	111	2	11	282	130	52	302	71
	441					423			425		
	0.91%	40.82%	32.7%	25.17%	0.45%	2.6%	66.67%	30.73%	12.24%	71.06%	16.71%
	100.0%					100%			100%		
MEN	2	90	65	62	1	6	134	69	22	142	45
	0.91%	40.91%	29.5%	28.18%	0.45%	2.9%	64.11%	33.01%	10.53%	67.94%	21.53%
WOMEN	2	86	78	48	1	5	145	59	29	157	25
	0.93%	40%	36.3%	22.33%	0.47%	2.4%	69.38%	28.23%	13.74%	74.41%	11.85%
DIFFERENCE	-0.02%	0.91%	-6.73%	5.86%	- 0.01%	0.48%	-5.26%	4.78%	-3.2%	-6.46%	9.68%

In analysing the distribution of anomalies of skeletal classes, it can be concluded that first and second-class malocclusions are uniformly distributed between men and women. On the contrary, the third class is found more often in men (53.85%) (Table VIII). Table IX describes children originating from different ethnic groups living in the province of Bergamo and treated at the Department of Dentistry in Alzano Lombardo Hospital. Noteworthy, only 23% of children who underwent a first examination in this hospital are foreigners, and only a very small portion of these patients underwent orthodontic treatment; this indicates a low motivation in diagnosis and treatment of malocclusions.

DISCUSSION

In the present study, a comparative analysis is presented with a similar epidemiological study conducted in 2000 (19).
As can be seen from Table X, the most recent study has a greater number of patients enrolled and a greater ethnic heterogeneity of the sample.
Skeletal class, hyperdivergence and agenesis are common parameters investigated in both studies. However, regarding the skeletal class, some significant differences can be noted. In fact, in the 2000 study, class II is more represented than in the 2016 study (56.2% *vs* 44.9%) and class I less (41.2% *vs* 49.21%) (Table XI).
Regarding the divergence, some significant differences can be noted. In fact, in the 2000 study, the hyperdivergence is

Table VIII. *Distribution of different skeletal classes in both genders.*

N.	Male	Female
1^ CLASS	108	109
	49.77%	50.23%
2^ CLASS	97	101
	48.99%	51.01%
3^ CLASS	14	12
	53.85%	46.15%

Table IX. *Number and percentage distribution of patients from different ethnic groups.*

PATIENT	Caucasic	Asiatic	North african	African	South american
TOTAL	403	7	21	2	8
	441				
	91.38%	1.59%	4.76%	0.45%	1.81%

Table X. *Comparison of the number and ethnic groups of patients enrolled in the epidemiological studies of 2000 and 2016.*

	N° patients	Ethnic groups
2000 Study	342	Caucasic (100%)
2013 Study	441	Caucasic (91.38%). North African (4.76%). South American (1.81%). Asiatic (1.59%). African (0.45%)

Table XI. *Comparison of the distribution of skeletal classes in patients enrolled in the epidemiological studies of 2000 and 2016.*

	Class I	Class II	Class III
2000 study	41.2%	56.2%	2.6%
2013 study	49.21%	44.9%	5.9%

Table XII. *Distribution of different skeletal classes in both genders.*

	Normo Div.	Hypo Div.	Hyper Div
2000 study	27.8%	0.6%	71.7%
2016 study	51.71%	8.54%	39.76%

more represented than in the 2016 study (71.7% *vs* 39.76%) and the hypodivergence (0.6% *vs* 8.54%) and normodivergence less (27.8% *vs* 51.71%) (Table XII).

In 2000, agenesis was noted only in 4.38% of a total of 342 patients, corresponding to a total of 40 missing elements, which is similar to the 5.44% of the 2016 study (49 missing teeth on 441 patients).

The major limitation of the present study is the ethnic homogeneity of the sample (91.38% of patients are Italian); This is probably due to the lower socio-economic level of patients of different ethnic groups coming to the hospital for diagnosis and treatment. In addition, since orthodontic treatment is not entirely free (like other medical treatments in Italy), it could be an additional barrier to treating young patients. Therefore, the future should conduct new epidemiological investigations on more heterogeneous pediatric population samples to differentiate the various cephalometric parameters based on ethnicity.

There are substantial differences in the distributions of skeletal classes and divergence between the studies performed in 2000 and the present analysis: in the previous study, there is a higher prevalence of Class II and hyperdivergent patients. A plausible explanation for detecting mild and minor malocclusion in the recent data presented here is that greater attention is paid by families to the malocclusions of their children in recent years compared to 2000, thanks to the numerous interventions to raise awareness of the mitigated orthodontic problems. In addition, this fact can explain because patients with "less severe" malocclusion come to the hospital now compared to patients 16 years ago.

CONCLUSIONS

In this study, it was possible to present an overview of the different malocclusion indices in a sample of children in Italy. Most of them have malocclusion and are needed for orthodontic treatment.

Author Contributions

P.C. and G.C. designed the research study. G.C. performed the research. P.C. and G.C. wrote the manuscript. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

Funding

This research received no external funding.

Conflict of Interest

The authors declare no conflict of interest.

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European Journal of Musculoskeletal Diseases
ISSN 2038-4106/2017

BPI

Case Report

ORTHODONTIC AND SURGICAL DISINCLUSION OF AN IMPACTED ANKYLOSED CUSPID: A CASE REPORT

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ABSTRACT

Dental ankylosis is defined as the alveolar bone's fusion with dentin or cement. Maxillary cuspids are important teeth both in terms of aesthetics and function. A cuspid's eruptive failure probability is estimated to be 1-3%. In most cases, the crown surgical exposure of the impacted cuspid is carried out after the orthodontic treatment start, when the dental alignment is obtained, as the canine space is obtained. Usually, immediately after surgery, the orthodontist begins to direct the element towards its natural location. However, these mechanics are not always successful. In this case, another option is possible. Here we report a case of canine autotransplant performed to bring an ankylosed impacted upper cuspid into the dental arch.

KEYWORDS: *cuspid, impacted, tooth, movement, ankylosis*

INTRODUCTION

Dental ankylosis is defined as the alveolar bone's fusion with dentin or cement (1). An ankylosed tooth does not respond to orthodontic forces; therefore, surgical procedures may be indicated to facilitate its movement. In order to bring an ankylosed impacted tooth into the arch, a surgical exposure with luxation and orthodontic movement or an autotransplant can be performed.

The type of surgery to expose the impacted tooth, the necessary orthodontic mechanics, the timing of orthodontic treatment, potential treatment problems and prognosis depend on the type of tooth, its position, upper or lower arch location and the patient's age.

Received: 23 February 2017
Accepted: 28 March 2017

ISSN: 2038-4106

Diagnosis and location of dental inclusion are based on clinical and radiographic examination. Radiographic examinations (OPT, teleradiography of the skull, occlusal and intraoral radiographs according to the Clark technique, CT) confirm the diagnosis of dental inclusion and provide information regarding the position of the ectopic element, its relationship with adjacent teeth and any resorption, allowing to select the most appropriate treatment method (2, 3). Therefore, cone beam CT is the diagnostic method of choice. Although the image definition is similar to traditional CT, exposure to ionizing radiation is significantly reduced; moreover, it allows perfect three-dimensional reconstruction of the maxilla and detailed position of dental elements.

Maxillary cuspids are important teeth both in terms of aesthetics and function. A cuspid's eruptive failure probability is estimated to be 1-3% (4, 5). Impacted maxillary cuspid ankylosis can make obtaining optimal orthodontic treatment aesthetic and function more difficult. About one-third of impacted maxillary cuspids are positioned vestibularly, while the remaining two-thirds are located palatally (6). Canine inclusion causes are multifactorial (local and genetic) and may be correlated with other dental anomalies. Local causative factors are dento-basal discrepancies, which reduce eruptive space, prolonged tooth retention or early deciduous canine loss, abnormal dental bud position, cleft, root dilaceration, or idiopathic conditions (7, 8). As for other impacted teeth, the treatment's prognosis depends on the dental position in the alveolar process and its relationship with adjacent teeth.

The impacted cuspid's disinclusion approach is multidisciplinary and often involves an orthodontist, oral surgeon, pedodontist, and periodontist (9). In most cases, the crown exposure surgery of the impacted cuspid is carried out after the orthodontic treatment start, when the dental alignment is obtained, as the canine space. Usually, immediately after surgery, the orthodontist begins to direct the element towards its natural location. However, these mechanics are not always successful: the tooth may not respond to the applied orthodontic forces, a clear sign of dental ankylosis.

MATERIALS AND METHODS

A 15-year-old male patient presented for our observation complaining about no upper canine eruption. The intraoral clinical examination revealed an Angle class I malocclusion due to modest dentobasal discrepancy (DBD) (diastemas in the upper arch and crowding in the lower arch) and permanence of upper deciduous canines. The recent and remote medical history was negative for systemic pathologies or pathologies of dental interest. The orthopantomography confirmed what was evident on intraoral examination: the permanence of deciduous cuspids and disodontiasis with the inclusion of substitutes (Fig. 1).

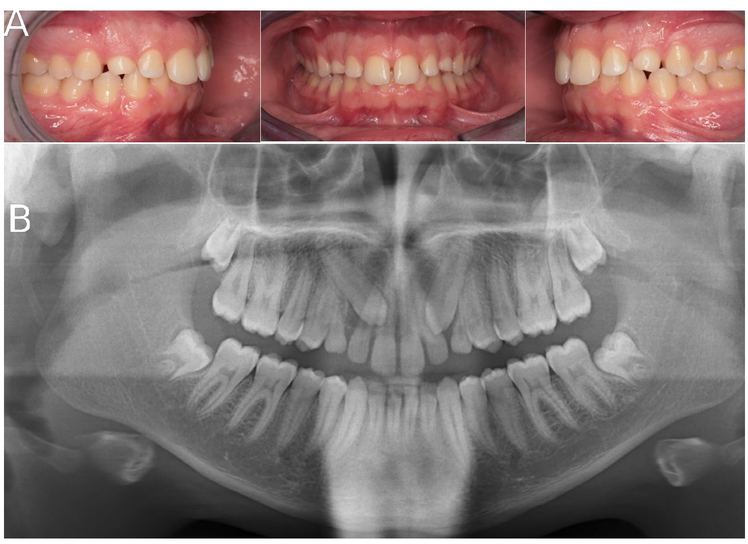

Fig. 1. ***A)*** *Angle I class with mixed dentition in the upper arch, with upper deciduous cuspids' permanence. Modest DBD with diastemas in the upper arch and crowding in the lower arch;* ***B)*** *The OPT shows the permanence of deciduous canines and disodontiasis with the inclusion of substitutes.*

The cone beam CT showed the presence of both upper canines in palatal inclusion: 1.3 in bone inclusion and 2.3 in osteo-mucosal inclusion. The relationships with the contiguous teeth roots were favourable: the roots of both impacted elements had no relationship with the roots of the premolars, and the crowns were palatally localized to those of the incisors. In addition, 1.3 had a more pronounced mesial inclination than 2.3. There was no evidence of any root resorption of proximal teeth (Fig. 2). The case required orthodontic recovery of both maxillary cuspids.

In the first instance, the surgical act of exposing definitive cuspids was carried out: after loco-regional anaesthesia (mepivacaine with adrenaline 1: 200,000), a full-thickness palatine flap was designed that did not affect papillae and nasopalatine nerve; subsequently the 1.3 crowns was exposed, removing the thin bone case that covered it; both canines were delicately dislocated and thin osteotomies, 3 mm deep, were performed by piezoelectric surgery in order to facilitate orthodontic traction (Fig. 3); subsequently two orthodontic buttons with a woven metal ligature were applied, in order to allow orthodontic traction forces' application to the tooth, and the flap was sutured. However, deciduous canines have not yet been extracted to maintain space.

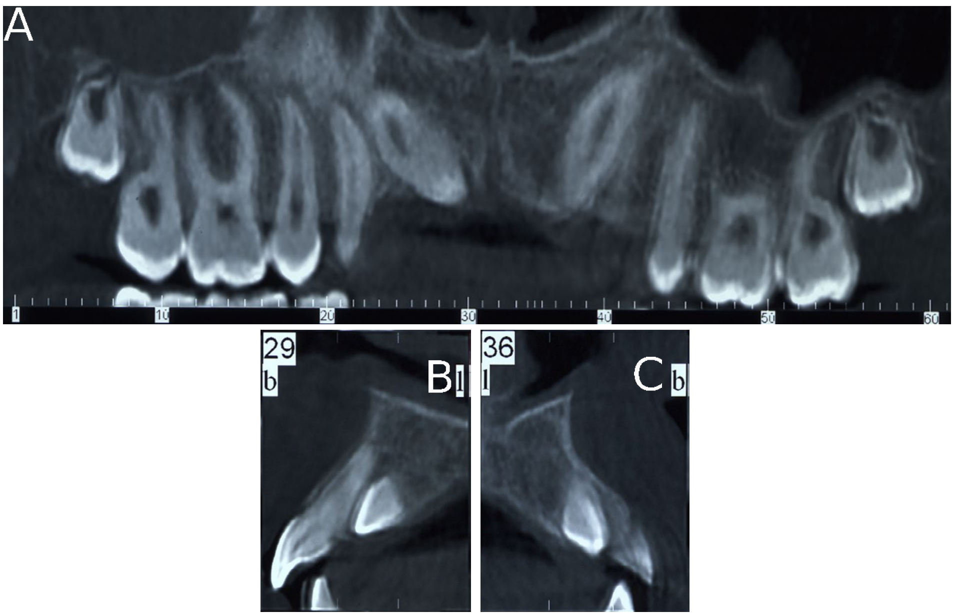

Fig. 2. ***A)*** *CBCT section showing the position of the upper cuspids;* ***B)*** *CBCT section showing the presence of a thin bone case on 1.3;* ***C)*** *CBCT section showing the osteo-mucosal inclusion of 2.3.*

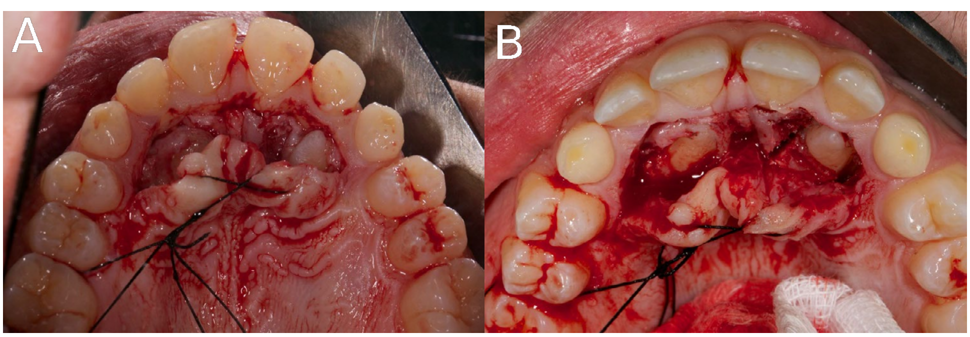

Fig. 3. ***A)*** *1.3 bone inclusion and 2.3 osteo-mucosal inclusion;* ***B)*** *3 mm deep osteotomies using piezoelectric surgery to promote orthodontic disinclusion.*

At 3 days after the surgery, a sixth to sixth upper arch bonding was performed, except for the two deciduous cuspids, and a passivated steel orthodontic wire with a round section (diameter 0.020 inches) was placed; it was used as anchorage for the canines' traction. Immediately after bonding, the deciduous cuspids were extracted to proceed with gentle traction of the permanent canines in the vestibule-distal direction using elastomeric threads tied to the archwire.

About 10 months after the start of therapy, 2.3 erupted palatally, while 1.3 did not show to respond to orthodontic forces on intraoral x-rays. Therefore, suspecting that a scar consisting purely of fibrous tissue was opposing to non-inclusive forces, the fibro-mucosa was removed by an electrosurgical device, exposing the crown of the tooth, which was again delicately dislocated. A few weeks after this second surgery, the healing was complete, with a restitutio ad integrum of the soft palatine tissues; in the meantime, 1.3 has always been pulled with elastic threads. After a few months, noticeable results were still visible, but a modest intrusion of the anchorage teeth was highlighted. It was therefore decided to perform a new cone beam CT of the upper arch (Fig. 4).

Upon examination of this further radiographic investigation, the situation remained substantially unchanged as regards the position of 1.3 compared to the previous CT investigation. Therefore it was decided to subject the patient to a surgical repositioning of 1.3 in order to restore the occlusion without the need to perform extraction and implant-prosthetic rehabilitation. After loco-regional anesthesia (mepivacaine with adrenaline 1: 200,000) a full thickness palatine and buccal envelope flap was drawn with papillae involvement; lifting the flap and comparing the surgical site with the first uncovering operation, it was evident that the element had not moved from its original position, confirming the hypothesis of ankylosis. Bone incisions were made using piezoelectric equipment on the impacted canine's alveolus in order to displace the tooth in its final position. The receiving site was created by removing a small amount of bone, surgically intervening only on the crestal and palatal surface, leaving the vestibular one unaltered, not to give rise to subsequent bone dehiscences with consequent damage to the periodontium. Then the tooth was dislocated and placed in the receiving site. The obtained position was not the desired one, since the tooth was extruded more than necessary and with a strong vestibular inclination. Two further vertical osteotomies were then performed in the vestibular alveolar process to facilitate an orthodontic movement of the tooth by exploiting the consequent Rapid Acceleratory Phenomenon (RAP) (10, 11); the flaps were sutured and the tooth was stabilized to the archwire using a fluid composite (Fig. 5).

Two weeks after the repositioning surgery, the tooth was cleaned from composite and bonded with an orthodontic bracket; subsequently it was engaged in a 0.016-inch steel archwire and distally pulled by an elastomeric chain with heavy orthodontic force to exploit the RAP.

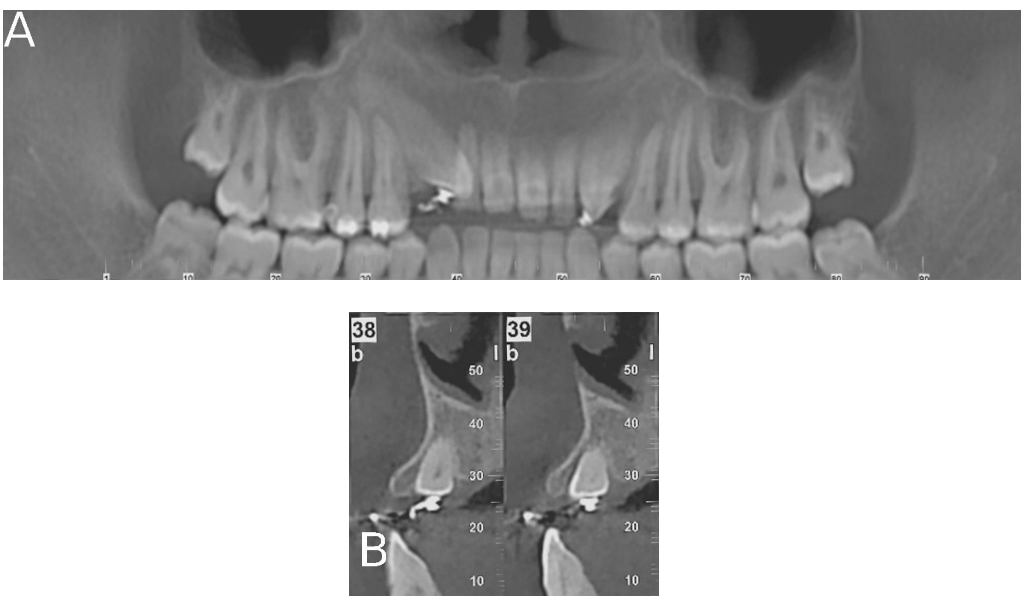

Fig. 4. ***A)*** *CBCT section showing the position of the upper cuspids;* ***B)*** *CBCT section showing the substantially unchanged position of 1.3.*

Six weeks after the last surgery, the tooth was completely in contact with the premolar, a sign that the orthodontic movement had taken place correctly (Fig. 6). It was thus possible to switch to a .019x.025 inches steel archwire to provide a correct radiculo-buccal torque at the root of 1.3.

During all post-surgery visits, the mobility and vitality of the surgically repositioned tooth was constantly monitored, which showed compatible values with the orthodontic and surgical actions performed on it. Mesially, a gingival recession caused by the rapidity of displacement occured. However, periodontal probing revealed the presence of an epithelial attachment with a 1.5 mm probing. At 16 weeks after surgery, the cuspid responded positively to the vitality tests.

At the end of the orthodontic-surgical treatment, the endodontic treatment of the upper canines was necessary due to the appearance of internal resorptions (Fig 7).

However, the effectiveness of the treatment performed will have to be verified over time, since the literature reports evidence of endodontic and periodontal problems following arch recovery treatments of autotransplanted ankylosed teeth (12).

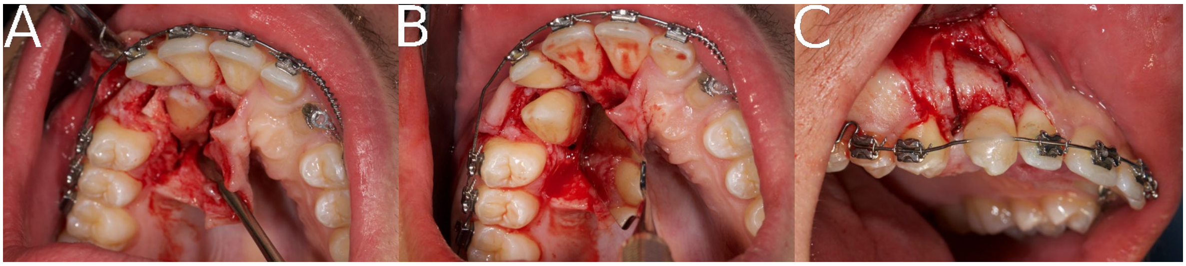

Fig. 5. ***A)*** *Exposure of ankylosed 1.3 and osteotomies;* ***B)*** *Dislocation of 1.3;* ***C)*** *1.3 placed in its site and peri-radicular corticotomies.*

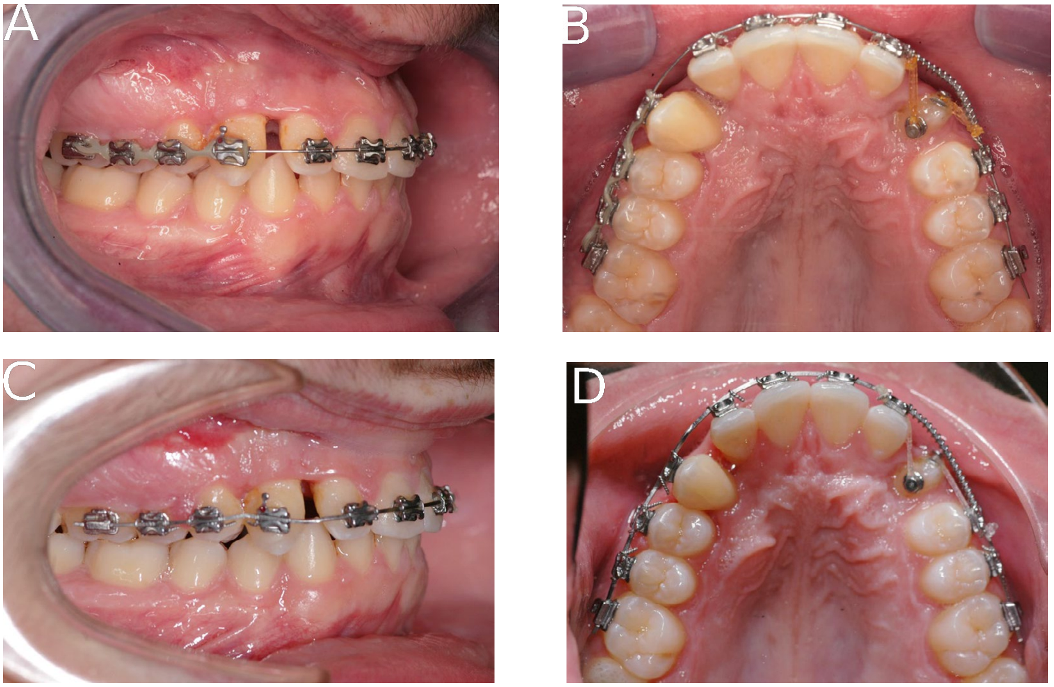

Fig. 6. ***A-B)*** *.016 inches round stainless-steel archwire and elastomeric chain;* ***C-D)*** *.019x.025 stainless-steel archwire with radiculo-buccal torque on the right cuspid.*

DISCUSSION

Maxillary cuspids are the teeth that are most frequently impacted (excluding third molars). According to Dewel (13), canines have the longest development period, as well as the longest and most tortuous path from the point of formation to their final destination in the arch. Given their importance for function and aesthetics, when impacted it is important that they are brought into their correct position. However, it is not a rare occurrence that during the traction phases they go into ankylosis, or that they are already ankylosed before treatment, so it is necessary to find a clinical solution for their restoration in the arch.

The traditional treatment for an ankylosed impacted cuspid in an adult, if this damages the proximal teeth or prevents implant rehabilitation, involves the surgical removal of the element and rehabilitation by means of an implant-prosthesis. However, this treatment can produce a large bone defect in the alveolus that often requires bone augmentation before implant placement.

In growing patients, one option is osteogenetic distraction, a procedure useful for producing new soft and hard tissues by moving a bone segment. In agreement with Koford et al. (14) the tooth-bone segment is displaced by the distractor following appropriate osteotomies. The main limitation of this method is that it allows bone-tooth segments to be moved only in one direction, therefore it is not applicable to palatally ankylosed cuspids or canines with inclinations such as to prevent correct aesthetic and functional repositioning.

Therefore, it is more desirable to attempt orthodontic-surgical recovery of the ankylosed cuspid by direct repositioning, creating a receiving site and dislocating the tooth by moving it to the desired position. It is also useful to avoid the complete extraction of the tooth by removing it from the oral cavity, because this could lead to damage to the periodontal ligament with the consequent risk of a subsequent new ankylosis of the canine.

Having analyzed the problems resulting from dental autotransplants, we came to the conclusion that the repositioning

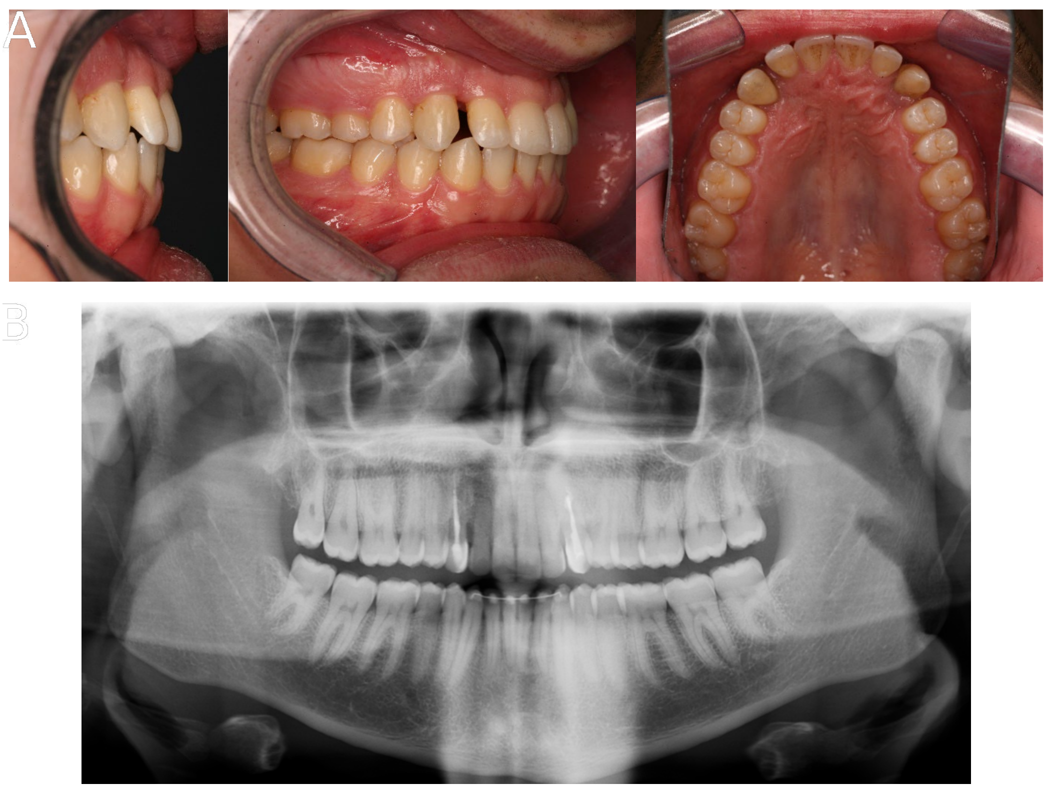

Fig. 7. ***A)*** *The case after debonding with the complete repositioning of the canines;* ***B)*** *The end-of-treatment orthopantomography.*

of our patient's cuspid in a location that is not entirely appropriate could result in aesthetic and functional damage since it would not have been possible to apply orthodontic forces at a later time, despite not had been fully extracted. However, considering the current innovations on piezolectric surgery applied to orthodontics, we have tried to overcome the problem of ankylosis by allowing a tooth movement favored by the RAP (10, 11). According to Frost's theory, after a surgical insult, the bone tissue reacts with a rapid, transient and localized osteopenia in which there is no loss of bone volume, but loss of bone density. This phenomenon is referred to as RAP which increases the speed of the orthodontic movement from 2 to 10 times; it begins 2-3 days after surgery and peaks at 1-2 months (15). For these reasons, two vertical osteotomies were performed on the vestibular side of the alveolar bone of the receiving site of the ankylosed cuspid.

CONCLUSION

The orthodontic treatment of tooth repositioning by means of autotransplantation with the aid of piezoelectric surgery is applicable to ankylosed impacted canines in growing patients, since it allows, in addition to a rapid restoration of functionality and aesthetics of the cuspid, also a subsequent orthodontic correction of its position.

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