

Autotransplantation of retained canines unable to undergo orthodontic traction

A clinical report

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Abstract

Aim: The canine is the tooth that, together with the third molar, presents the highest risk of inclusion: 85% of these teeth are located in the palate and 15% in the buccal area. In most treatment plans, retained canines are driven to extrusion through orthodontic treatment. However, in some cases, for technical reasons or patient choice, it is not possible to perform this consolidated approach. The present clinical report evaluates 10 ectopic canines transplanted in both adults and younger patients with up to 60 months of follow-up.

Case description: Two clinical cases are described in detail with accompanying photographs and radiographs. In both of these cases, the retained canine was extracted, the receiving site prepared, a proper socket adapted through the use of implant osteotomy burs, and the canine transplanted into its ideal position.

The tooth was fixed to the adjacent teeth for a variable period and healing was uneventful. After 60 months (Case 1) and 24 months (Case 2) of follow-up, the teeth did not show any color variation, the vitality tests were positive, and no signs of periapical reactions were detected.

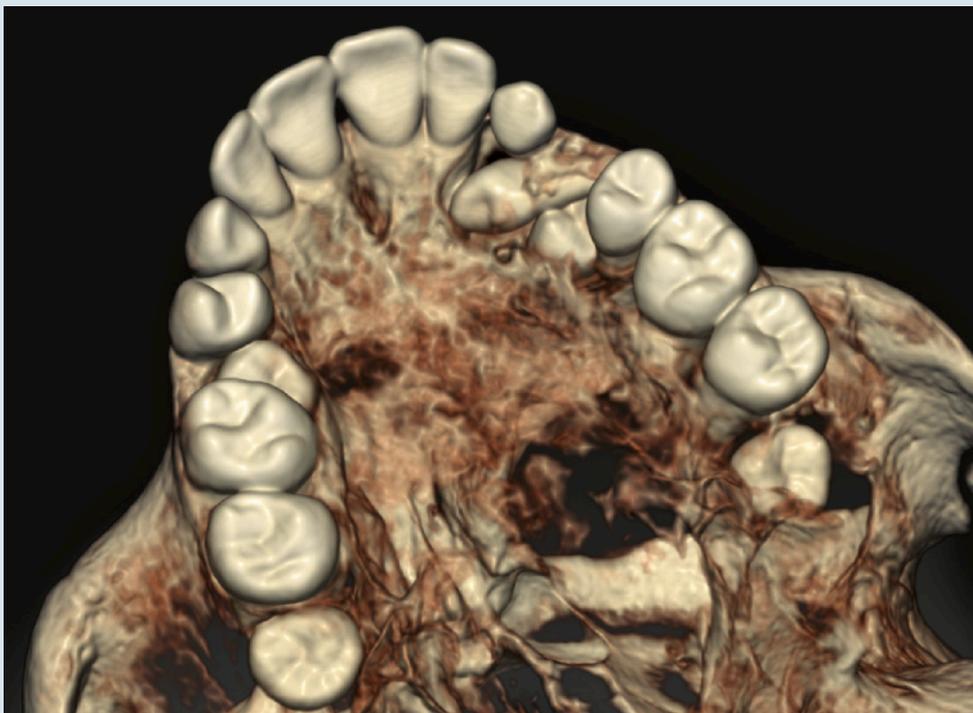
Practical implications: The transplantation of included canines, even with a formed apex, seems to be a successful procedure, although it should be reserved for those cases where an orthodontic approach is not viable. This procedure is able to provide a natural tooth with proprioceptive function, capable of accompanying the natural growth of the patient's jaws, with consequent eruption together with the adjacent teeth.

Keywords

case report, clinical cases, long-term follow-up, retained canine, tooth autotransplantation

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Introduction

Maxillary canines, together with central and lateral incisors, represent the focal point of smile esthetics. From a functional point of view, the presence of canines plays a fundamental role in creating the anterior guide, thus avoiding interference in the posterior sectors during the eccentric movements of the mandible.¹

Despite this, together with the third molar, canines are the teeth that present the highest risk of inclusion, with 85% of them located in the palatal and 15% in the buccal area.² Occasionally, an ectopic canine can lead to root resorption of the adjacent teeth such as the central and lateral incisors.³

Several treatment options are available nowadays, and certainly the orthodontic approach is the most common because it enables the tooth to be replaced in its correct position after surgical uncoverage and traction.⁴ However, in some cases, specific canine positions and the degree of tooth impaction do not allow an orthodontic approach and a predictable result. The procedure described in the present case report is indicated in those clinical cases in which it is not possible to perform orthodontic traction due to the degree of tooth impaction. In these cases, the proposed technique avoids the need for tooth extraction and subsequent tooth replacement. Moreover, especially in adult patients, an orthodontic option is not considered due to the long treatment duration and the use of brackets and orthodontic arches for long periods of time.

In adult patients, issues related to retained canine treatment occur when the primary canine starts to lose stability, or if the patient requests an esthetic improvement of the smile. In such cases, treatment options include an orthodontic approach, extraction with subsequent implant placement, placement of adhesive restorations, or tooth autotransplantation.⁴

Tooth autotransplantation is a well-documented treatment option that allows the repositioning of the patient's extracted tooth in a different location.⁵ Even if the technique shows a success range between 68.2%⁶ and 74%,⁷ autotransplantation must result in the nontraumatic extraction of the tooth from its ectopic area without ensuing damage to its integrity and vitality, and then in the reimplantation of the tooth into its correct position through the surgical formation of an ideal socket.⁸

The current literature states that the success of autotransplantation depends on several factors, including the age of the patient, the development of the tooth to be transplanted, the surgical approach, and the amount of time that the tooth remains outside the socket before being transplanted.⁹ In fact, it is essential to maintain a vital and healthy periodontal ligament in order to ensure the longevity of the transplanted tooth.¹⁰ Recently, a high survival rate and presence in situ of transplanted teeth with fully formed apexes has been reported.¹¹

The present clinical report highlights the surgical steps involved in autotransplantation of retained maxillary canines. The reported procedure, as a valid alternative to implants or adhesive dental bridges, is able to provide a natural tooth with proprioceptive function, capable of accompanying the natural growth of the patient's jaws, with consequent eruption together with the adjacent teeth.

Case presentations

The present clinical report evaluates 10 ectopic canines transplanted in adults and younger patients with up to 60 months of follow-up (Table 1). The surgical and maintenance procedures were similar in all cases. Only two cases are reported in detail. All patients signed informed consent forms



Table 1 Clinical cases data

Patient	Age [years]	Follow-up [months]	Trans-planted tooth number	Time outside of mouth in saline [min]	Pulp sensibility test	Color change	Need of endo-dontic therapy	Tooth mobility
FR (Case 1)	41	60	23	8	Negative	No	No	Physiologic
LL (Case 2)	12	24	23	6	Positive	No	No	Physiologic+
FS	18	48	13	9	Negative	No	No	Physiologic
BG	24	48	43	10	Negative	Slight	No	Physiologic
AA	17	36	13	10	Negative	No	No	Physiologic
AS	34	60	13	8	Negative	No	No	Physiologic
PB	22	12	23	11	Negative	No	No	Physiologic
SK	29	60	13	10	Negative	No	No	Physiologic
AB	19	60	33	12	Negative	No	No	Physiologic
FM	20	48	23	9	Negative	No	No	Physiologic



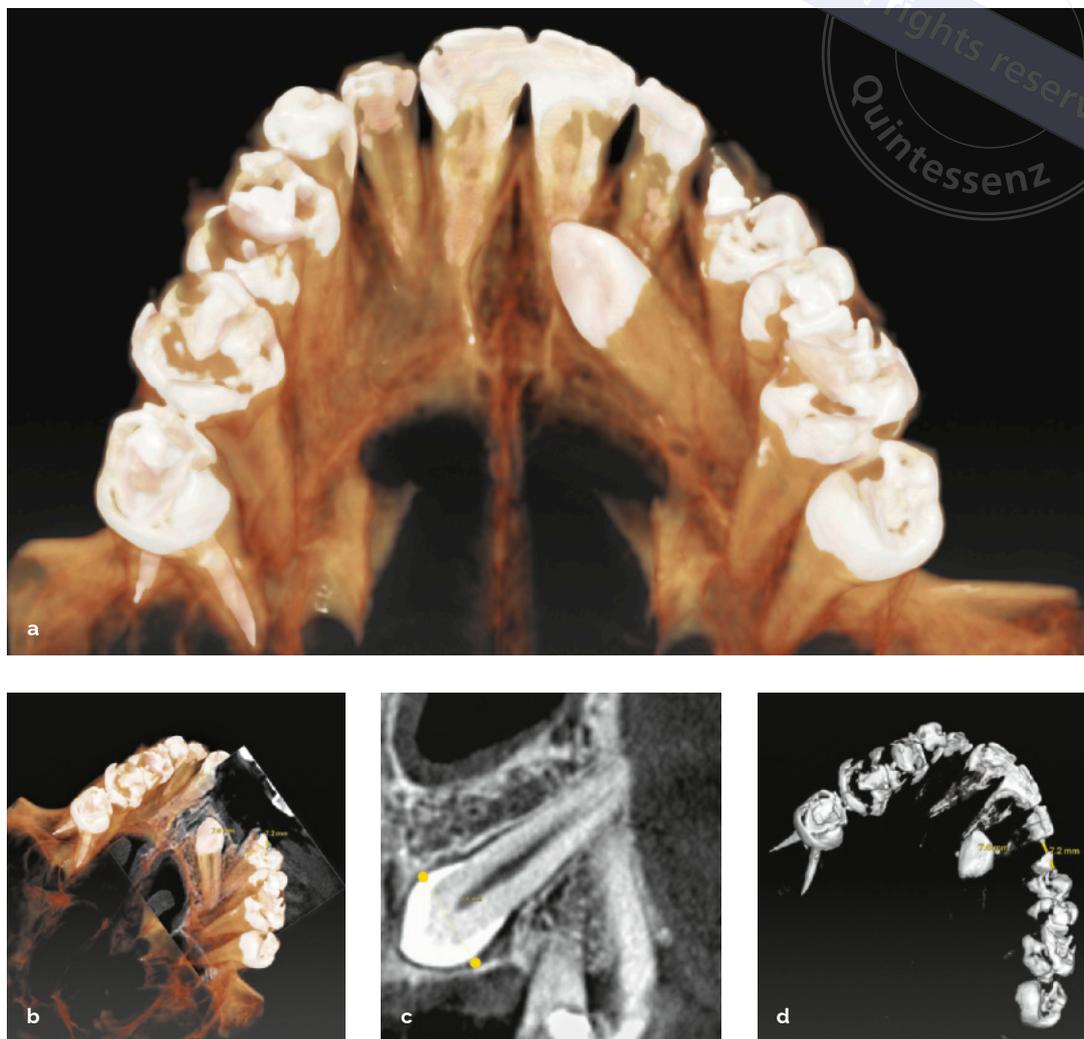
Fig 1 Initial clinical view of the maxillary left primary canine (tooth 63) showing hypermobility and gingival recession.

that detailed the clinical procedures and were treated according to the principles outlined in the Declaration of Helsinki ethical statement on clinical research involving human subjects. The CARE guidelines (for Case Reports) were followed in the preparation of this article.

Case 1

A 41-year-old patient suffered hypermobility and gingival recession of the maxillary left primary canine and requested an esthetic improvement of the affected area (Fig 1). Following physical, clinical, and

Fig 2a to d Initial radiographic views: 3D reconstruction of the maxillary arch highlighting the deep palatal position of the canine.



radiographic examinations, the presence of an impacted canine was detected on the palatal side (Fig 2).

The patient was informed of the possible treatment options such as extraction of the tooth and subsequent implant placement or extraction and transplantation of the tooth. After a comprehensive analysis of all the available solutions, the patient decided on tooth transplantation as the most suitable option.

The space available around the maxillary left primary canine was 7.2 mm, while the mesiodistal dimension of the impacted ca-

nine was 7.6 mm. It was therefore necessary to use aligners to ensure the correct mesiodistal space to accommodate the tooth, which obviously turned out to be larger than the counterpart primary tooth (Fig 3). After a 3-month treatment period with aligners, the optimal space required to accommodate the maxillary left canine in the arch was achieved. Before proceeding with the extraction and transplantation of the retained canine, a careful periodontal assessment and full periapical radiographs were carried out to evaluate possible periodontal issues or periapical reactions throughout the oral cavity.





Fig 3 The use of aligners to ensure the correct mesio-distal space to accommodate the tooth.

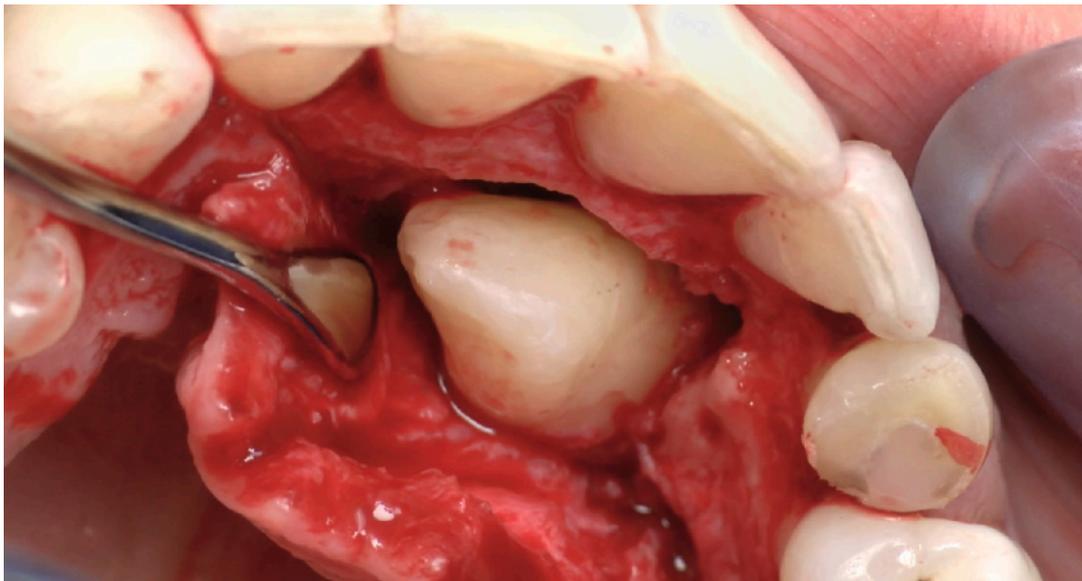


Fig 4 Painstaking care was taken to avoid altering the integrity of the tooth crown.

The week before surgery, the patient underwent a professional oral hygiene session and was given precise instructions regarding the correct everyday oral hygiene in view of the forthcoming surgery.

The day before and 2 h prior to surgery, 1 g of amoxicillin was administered to the patient. After the administration of a local anesthetic (articaine 1:100,000), a sulcular incision was made in the palatine region, from the distal area of the maxillary left second premolar to the distal part of the maxillary right lateral incisor. After raising a full-thickness flap, an osteotomy was per-

formed with a round bur to highlight the crown of the retained tooth. Painstaking care was taken to avoid altering the integrity of the tooth crown (Fig 4).

Subsequently, through the use of levers, the retained canine was mobilized and extracted. The tooth was then immersed in physiologic solution before being replanted.

Following the extraction of the retained canine, the primary tooth was also extracted using appropriately shaped forceps (Fig 5, see video). In order to create a surgical socket of adequate size to accommo-

Fig 5 The primary canine was extracted using appropriately shaped forceps.

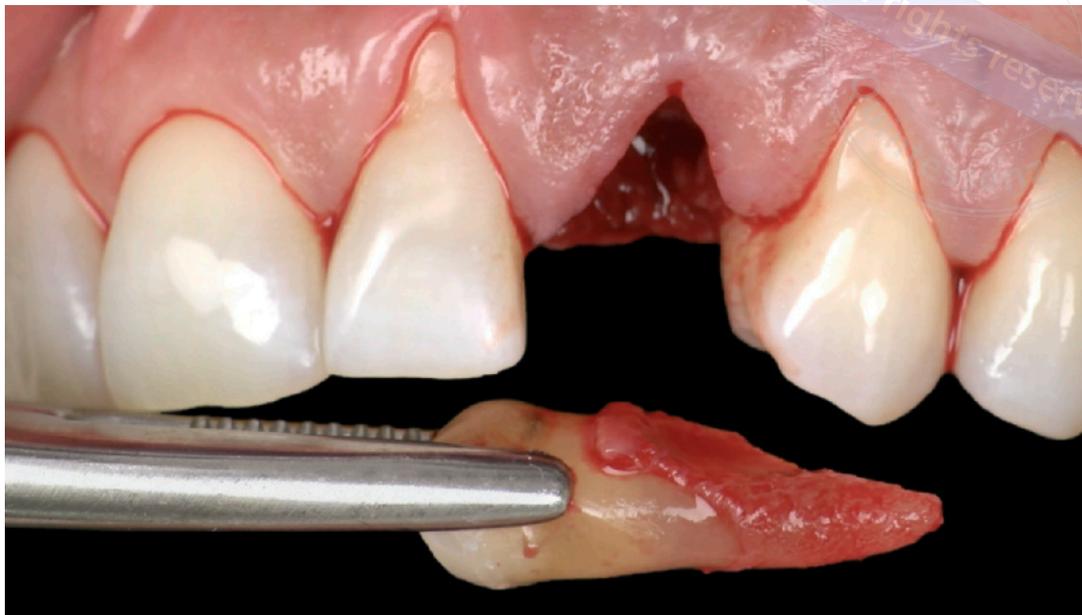
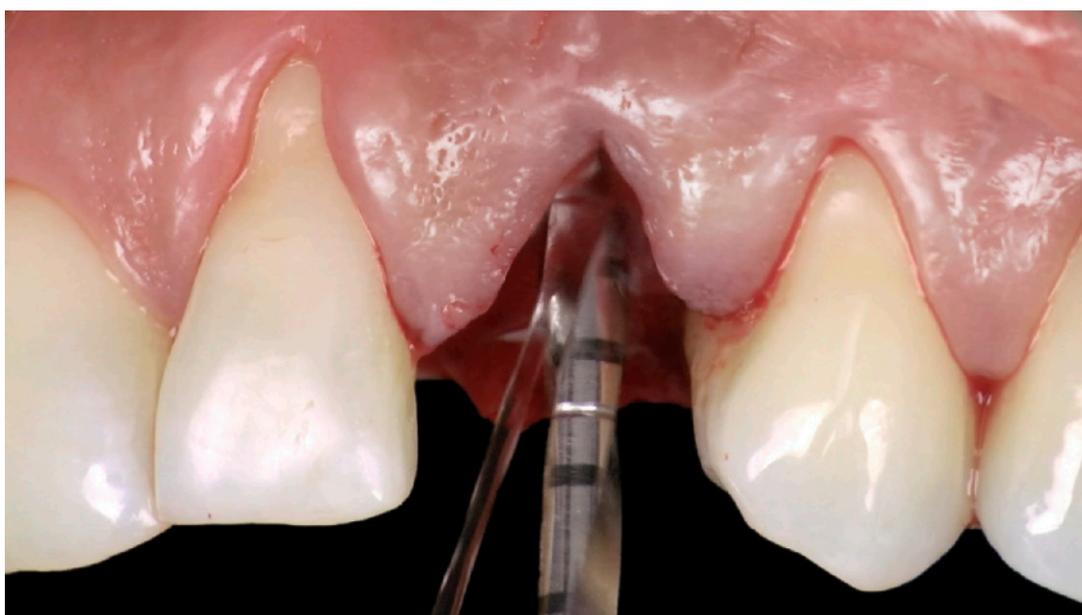


Fig 6 Preparation of the receiving socket through the use of burs for implant osteotomy.



Video



date the root of the canine, the surgical site was created through the use of implant site preparation burs, taking the length of the root as the working length (Fig 6).

The surgical site on the palatal side was in communication with the osteotomy created for the extraction of the canine itself. Once a surgical socket of adequate size was achieved, the canine was placed, tak-

ing care to evaluate its optimal position in relation to the adjacent teeth and its antagonist tooth.

After careful tooth repositioning, amelogenins (Emdogain; Straumann, Basel, Switzerland) and a bone substitute (Bio-Oss; Geistlich, Wolhusen, Switzerland) were placed along the tooth root through the access via the palatal flap in order to



Fig 7 Single nonresorbable sutures were used to obtain primary flap closure.



Fig 8 The canine was stabilized utilizing a squared-section orthodontic arch segment via the adjacent teeth in order to ensure good stability during the engraftment period.

fill the cavity left by the extracted canine, and were subsequently covered with a resorbable collagen membrane (Bio-Gide; Geistlich). Single nonresorbable sutures (Gore-Tex CV5; Gore Medical, Newark, DE, USA) were used to obtain primary flap closure (Fig 7).

The canine was stabilized using a squared-section orthodontic arch segment via the adjacent teeth in order to ensure good stability during the engraftment period (Fig 8).

Fourteen days after surgery, the sutures were removed, revealing excellent soft tissue recovery.

Three months after surgery, the arch segment was removed. The tooth showed a degree of physiologic mobility identical to

that of the adjacent teeth (Fig 9). In addition, the pocket probing depth (PPD) around the tooth also showed excellent tissue engraftment on the transplanted tooth.

The 60-month follow-up highlighted the excellent health of the adjacent tissue, good primary stability, and the absence of tooth sensitivity. In addition, no periapical lesions or changes in the color of the transplanted tooth were detected (Fig 10).

Case 2

A 12-year-old patient requested evaluation of the feasibility of autotransplantation or extraction of an included canine that was completely unsuitable for an orthodontic approach.

Fig 9a and b

Clinical (a) and radiographic (b) views at the 3-month follow-up showing excellent tissue health.



Fig 10a and b

Clinical (a) and radiographic (b) views at the 60-month follow-up showing excellent health of the adjacent soft tissue and the absence of periapical lesions and color changes of the transplanted tooth.



As was clearly detectable from the 3D reconstruction of the maxillary arch, the retained maxillary left canine was in a horizontal position, with the apex in a buccal position and the crown in contact with the root of the maxillary left lateral incisor. Instead, the maxillary left first premolar, even if retained, was well oriented toward the surface (Fig 11).

The retained canine as well as its lateral counterpart appeared to be small in size and was therefore not causing problems relating to the overall dimensions of the final tooth in the arch.

Three weeks before surgery, the patient spontaneously lost the primary tooth, and 1 week before surgery underwent an oral hygiene session, receiving precise instructions as to the correct everyday oral hygiene in view of the forthcoming surgery (Fig 12).

On the day of surgery, 2 h prior to surgery, 1 g of amoxicillin was administered to the patient as an antibiotic cover. After the administration of a local anesthetic (articaine 1:100,000), a sulcular incision was made in the palatine region from the mesial area of the maxillary left central incisor to the distal part of the maxillary left second premolar (Fig 13).

After raising a flap, the crown of the canine and a very thin layer of bone covering the root were revealed. Using a piezosurgery insert, a light osteotomy was performed to create fracture lines in the delicate superficial bone layer in an effort to keep it connected to the tooth root during extraction.

Once the extraction was performed (Fig 14), the tooth was placed in saline solution.

In order to create a surgical socket of adequate size to accommodate the root of the



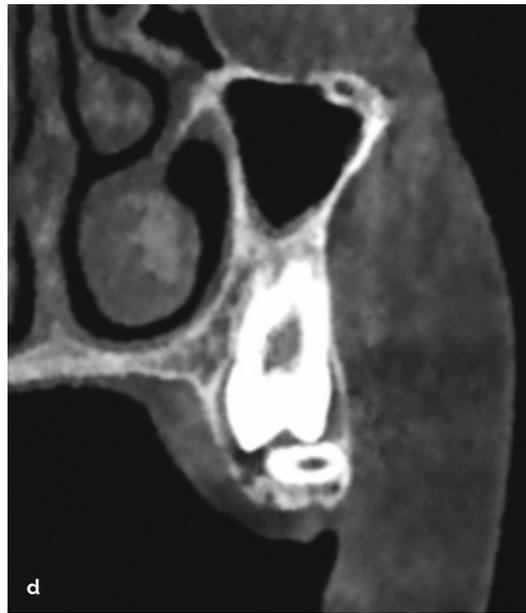
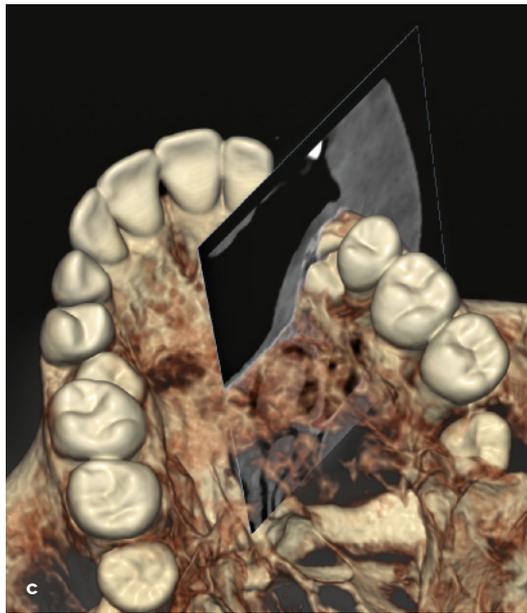
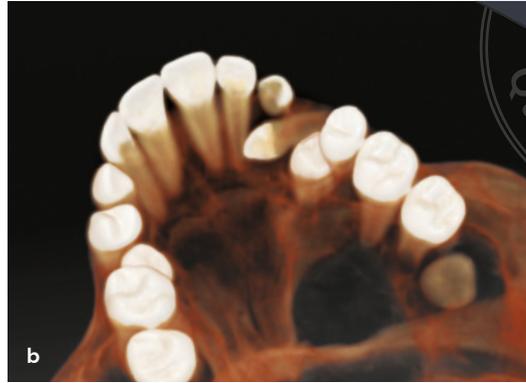
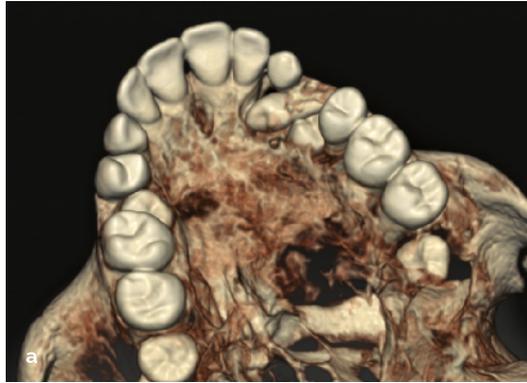


Fig 11a to d
Initial radiographic views: 3D reconstruction of the maxillary arch highlighting the retained left canine in a horizontal position.



Fig 12
Three weeks before surgery, the patient spontaneously lost the primary tooth, and 1 week before surgery underwent an oral hygiene session.

Fig 13a and b

A sulcular incision was made in the palatine region from the mesial area of the maxillary left central incisor to the distal part of the maxillary left second premolar.

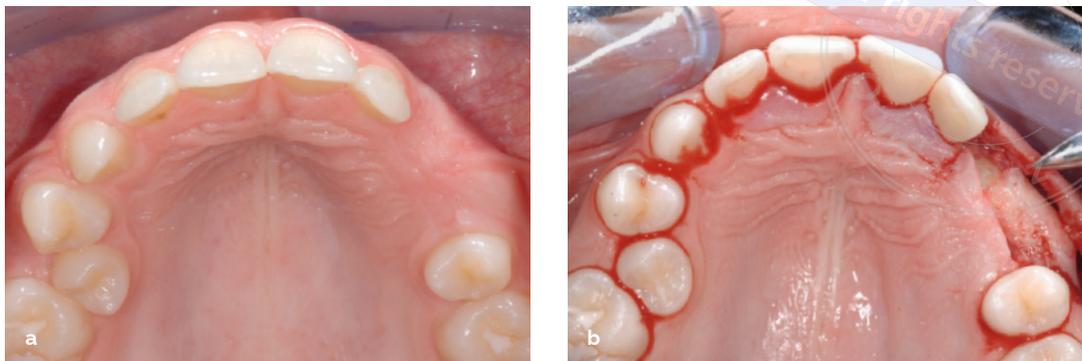


Fig 14 Tooth extraction.

canine, a surgical site was created through the use of implant site preparation burs, taking the length of the root as the working length. The tooth immersed in the saline solution was replanted and anchored by a metal arch fixed with a flow composite. The canine was stabilized using a squared-section orthodontic arch segment via the adjacent teeth in order to ensure good stability during the engraftment period.

Single nonresorbable sutures (Gore-Tex CV5) were used to obtain primary closure of the flap to ensure healing (Fig 15).

Fifteen days after surgery, the sutures were removed, revealing excellent tissue recovery. A CBCT scan was performed 30 days after surgery that showed the correct position of the transplanted tooth. Removal of the arch at 12 weeks highlighted

good primary stability of the tissue, with PPDs comparable with the adjacent teeth.

At the 3-month follow-up, the tooth did not show any variation in color compared with the contralateral tooth, the vitality test was positive, and no signs of periapical reactions were detected (Fig 16).

Discussion

The present clinical report assessed the survival rate of ectopic canines transplanted to their optimal site in patients aged 12 to 41 years. Tooth stability, PPDs, color variation with respect to the contralateral tooth, and vitality testing through ethyl chloride were assessed.

All the teeth had a fully formed apex, and after transplantation they were checked at

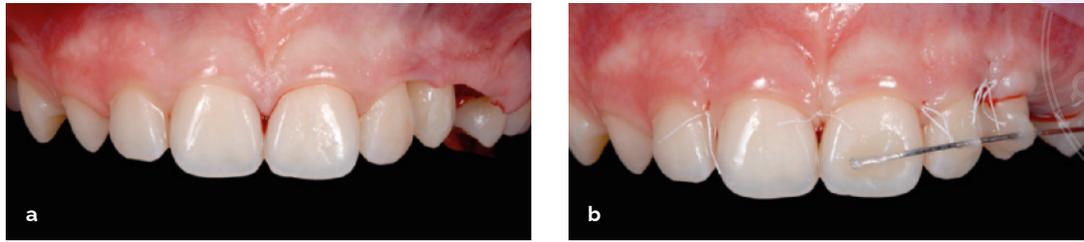


Fig 15a and b The canine was stabilized utilizing a squared-section orthodontic arch segment via the adjacent teeth to ensure good stability during the engraftment period. Single nonresorbable sutures were used to obtain primary closure of the flap to ensure healing.



Fig 16a and b Clinical (a) and radiographic (b) views at the 3-month follow-up. The tooth did not show any variation in color compared with the contralateral tooth, the vitality test was positive, and no signs of periapical reactions were detected.

15 days, 1 month, 3 months, and 6 months posttreatment, after which follow-up visits were performed every 6 months, together with standard hygiene sessions.

The current literature states that the level of root formation is one of the key factors for survival of tooth transplantation; namely, the apex in formation can be advantageous with regard to the success of this type of approach.^{12,13} None of the transplanted teeth had an apex in formation, but the evaluation of all the parameters under examination led to the prediction of a successful outcome for all 10 cases in the present clinical report.

Particular attention was paid to ensuring the least traumatic extraction possible, with an attempt to preserve the integrity of the root surface and its delicate periodontal

ligament. In fact, the average amount of time of transplanted teeth out of the oral cavity was less than 15 min, and during this period of time they were always kept immersed in saline solution.

In all cases, the repositioning of the tooth in the surgical socket was done manually, with care taken not to achieve primary stability through strong pressure but rather through trying to shape the surgical socket based on the size of the root itself.

It is interesting to note that, when the sutures were removed, all the transplanted teeth showed excellent stability, the soft tissue was free of inflammation, and the PPDs were similar to those of the adjacent teeth.

No root resorption, which is described as one of the possible problematic issues of

this approach, was detected in the transplanted teeth during the follow-up period (between 12 and 60 months).¹⁴ On the contrary, it must be highlighted that some patients showed a more coronal level of periodontal attachment than the bone level present in the surgical socket, and during the healing phases the tissue underwent stabilization following the level of periodontal attachment on the transplanted tooth.

Another important consideration is related to vitality testing, which was performed using ethyl chloride. Almost all of the transplanted teeth showed a reduction or a complete lack of response to this test, and the radiographic examinations showed no periapical reactions. Furthermore, no color variation of the transplanted teeth was detected, which is an indication of proper pulp vitality.

Even in cases of complete lack of response to vitality testing performed with ethyl chloride, root canal treatment was avoided due to the complete lack of symptoms, the absence of periapical reactions, and the maintenance of color when compared with the contralateral teeth.¹⁵

One of the advantages that could be associated with the technique reported here is the ability of a transplanted tooth to maintain a trophism of the tissue compared with extraction and implantation or the placement of an adhesive bridge.¹⁶ Another advantage is the possibility of movement with the adjacent teeth during the continual facial growth of the patient, avoiding situations of infraocclusion, as in the case of implants.¹⁷ Moreover, after the stabilization period, a transplanted tooth can be moved through orthodontic therapy.¹⁸

The final advantage of this procedure concerns the purely esthetic aspect; a natural tooth is more esthetically well-integrated with the surrounding structures.

Possible contraindications for the reported technique are represented by the

impossibility of maintaining the integrity of the tooth during extraction, and in periodontopathic patients during the splinting phase of the autotransplanted tooth.

Conclusions

Transplantation of retained canines, even in case of a formed apex, seems to be a predictable procedure, even if this treatment option should be reserved for those cases where uncoverage with an orthodontic connection is not a viable choice. It should be considered the therapeutic alternative when compared with extraction of the included tooth with subsequent prosthetic or implant-prosthetic rehabilitation.

This procedure seems to be very operator-dependent, not so much due to the difficulty of the several clinical steps, but more so as regards the achievement of a nontraumatic extraction.

In order to confirm the results of the presented cases, further studies should be undertaken that include more cases, a control group, and longer follow-up periods.

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