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Annual incidence and pre-treatment prognostic factors of labial gingival recessions in young orthodontically treated patients

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Annual incidence and pre-treatment prognostic factors of labial gingival recessions in young orthodontically treated patients

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KEYWORDS:
1. Gingival recession
2. Orthodontic treatment
3. Keratinized tissue
4. Prognostic factors
5. Retrospective study

MAIN TEXT:

INTRODUCTION

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The occurrence of gingival recessions (GR) after orthodontic treatment (OT) has been documented in previous studies. In a retrospective study (Renkema et al. 2013a), the presence of GR was compared between 100 orthodontic patients (cases) and 120 non-orthodontic patients (non-cases), showing a consistently higher proportion of GR in the cases. Another retrospective study (Renkema et al. 2013b) on 302 orthodontically treated patients also highlighted the time-dependent occurrence of GR, showing a higher prevalence five years post-treatment compared to the end of treatment.
However, there is a lack of studies in the literature that evaluate, in a homogeneous population treated with specific orthodontic objectives, the yearly incidence, distribution, and severity of GR as pre-treatment prognostic factors for their occurrence. So, the aim of this study is to: a) determine the annual incidence, distribution and severity of GR up to 5 years after orthodontic treatment; b) identify pre-treatment prognostic factors for the occurrence of GR 5 years after orthodontic treatment.

METHODS

This retrospective study included 149 young patients who underwent non-extraction orthodontic treatment with clear treatment objectives. GR were assessed in millimeters on intraoral photographs using a software-assisted image analysis (Supplementary File: Methods) to determine the annual prevalence, incidence, distribution, and severity up to 5 years after OT. Age, gender, type of sagittal malocclusion, vertical skeletal typology, pre-orthopaedic treatment (Lione et al. 2017), tooth type and position and initial keratinized tissue width (KTW) were analyzed using a multilevel multivariate logistic model to identify predictors of GR 5 years after OT

RESULTS AND DISCUSSION:

This study demonstrates a continuous increase in the prevalence of GR at the patient level, from the beginning of OT (4.69%) to the end of treatment (10.06%), and annually up to 5 years of follow-up (39.59%), with the peak incidence occurring between the end of OT and one year of follow-up. The severity of GR also worsens year by year: GR 3mm deep appear one year after the end of OT, and GR 4mm deep appear after two years of follow-up. Five years after OT, the majority of GR are 1mm deep (81%), followed by 2mm GR (15%), 3mm GR (3.5%), and 4mm GR (0.5%). Overall, there is one major factor that may explain the close correlation between fixed orthodontic treatment and the development of GR. Orthodontic movements can involve the displacement of the roots outside the buccal or lingual alveolar bone, leading to bone dehiscence and a reduced thickness of the gingival phenotype (Wennström et al. 1987). Even without the loss of attachment, a thin phenotype is a predisposing factor, as a traumatic toothbrushing technique or plaque accumulation can cause an inflammatory lesion in the entire gingival tissue, resulting in marginal tissue destruction over the avascular root surface, loss of attachment, and root exposure (Vignoletti et al. 2019, Romandini et al. 2020)
Gingival recessions observed in this study were not equally distributed across the dental arches (Figure 1): maxillary first premolars, maxillary first molars, mandibular premolars, and mandibular central incisors showed a significantly higher prevalence of GR compared to other teeth. The increased susceptibility of these teeth to GR may be attributed to the expansion movements in the lateral-posterior regions and the proclination of the lower incisors. These adjustments are often made

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to recover space within the arch and address specific malocclusions in patients treated orthodontically without extractions.

This study also observed that gender, age, malocclusion, pre-orthopaedic treatment,, and vertical skeletal typology do not affect the likelihood of developing GR at 5 years. Conversely, an increased probability of developing GR was noted in the upper arch teeth OR=1.831, [1.276, 2.629], in the premolars (OR=2.141, [1.260, 3.639], and in sites where the baseline keratinized tissue (KT) width was less than 2mm (OR = 5.003, [2.363; 10.592]) (Supplementary File: table analysis) These findings are consistent with an observational study on lower incisors by Alias & Melsen (2003), which stated that baseline recession, KT width, gingival biotype were significantly correlated with the development or increase of GR. This clearly highlights the importance of gingival morphology and periodontal health, rather than the amount of proclination, in the occurrence of GR.

Due to the retrospective nature of this study, some limitations can be identified. One limitation is the measurements of KT on photographs and moreover the absence of gingival thickness (GT) assessment at the tooth site. Gingival phenotype includes not only keratinized tissue (KT) width but also GT, which can be measured with a periodontal probe inserted into the buccal sulcus (Jepsen et al. 2018) or with a needle penetrating the gingiva (Clementini et al. 2018). The last Consensus workgroup 3 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions (Jepsen et al. 2018) stated that a thin phenotype (less than 1mm of GT and less than 2mm of KT width) is a major predisposing factor for the occurrence of GR.

Other factors not assessed in this study, related to orthodontic therapy and periodontal maintenance during treatment, could also provide insights into the development of GR. Single-tooth movements, which may alter the periodontal phenotype at the tooth site, as well as gingival inflammation or traumatic toothbrushing, should be investigated in future studies.

Despite these limitations, it can be stated that periodontal evaluation, at least including KTW measurement, should be incorporated into orthodontic treatment planning to assess the risk of labial GR occurrence.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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FIGURES:

Figure 1 : Distribution of gingival recessions among the teeth at the different time points

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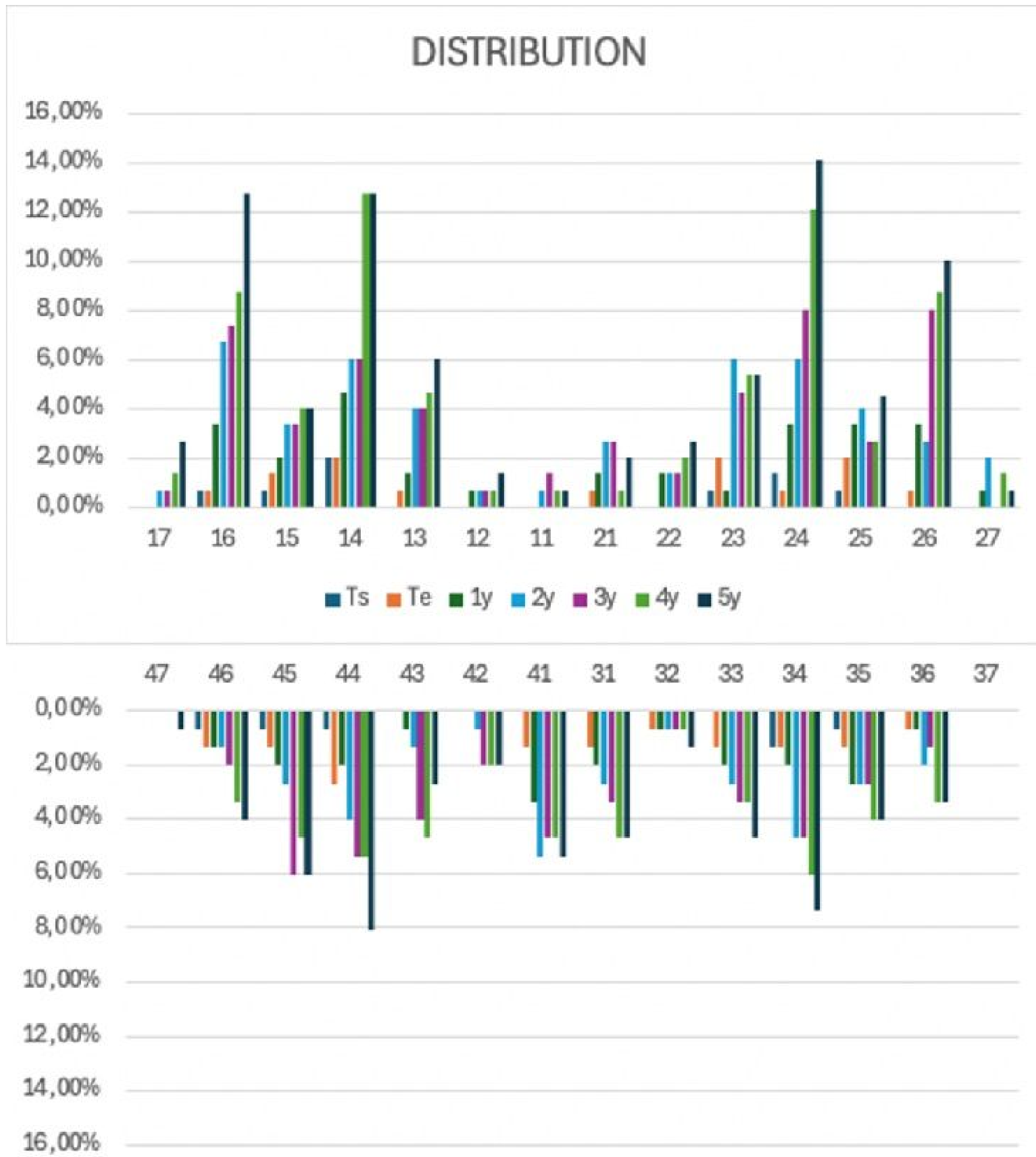

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Study Design

This study is a monocentric retrospective study performed at "Vita-Salute San Raffaele University" in Milan. All procedures were submitted and approved by the San Raffaele Hospital Ethic Committee (protocol number 161/INT/2021). The study was performed in accordance with recommendations of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

Population

Eligible patients were treated and observed for at leat 5 years post treatment from 2011 to 2021. After informed consent was obtained, they were selected according to the following inclusion criteria: (1) age at the beginning of treatment between 10-20 years; (2) orthodontic treatment performed with full fixed appliances; all patients were treated by the same orthodontists, in the same setting; at the beginning, all patients were instructed on the oral hygiene procedure using an electric toothbrush, and their teeth were polished at each appointment" (3) first molar and canine class, upper and lower midlines centered, leveled Spee curve and absence of rotations at the end of the treatment; (4) upper (1.2 – 2.2) and lower (3.3 – 4.3) lingual retainer placed directly after active orthodontic treatment associated with removable night retention; (5) presence of plaster models, orthopantomography, lateral teleradiography at the beginning and at the end of the treatment; (6) presence of intraoral photographs at the beginning, at the end of the treatment and at a follow up at 1, 2, 3, 4 and 5 years.

Patients who had undergone combined surgical-orthodontic treatment, extractive cases, patients who underwent post-orthodontic muco-gingival surgery, orthodontic retreatments, patients with visible wear of the incisal margins and syndromic cases were excluded from the study.

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Study Outcomes measurements:

Medical records, sagittal malocclusion and facial typology

From the medical records of each patient was assessed:

- The age of the patient at the first stage of fixed orthodontic treatment
- Whether the patient had undergone orthopedic treatment of maxillary expansion before fixed orthodontics.
- Type of skeletal malocclusion on the sagittal plane and the facial typology were obtained from the pre-treatment cephalometric analysis:
    - The sagittal malocclusion was evaluated at the beginning of the treatment considering the ANB angle and classifying the analyzed sample into three groups: class I skeletal sagittal malocclusion for ANB values between 0 and 4°, class II malocclusion for ANB

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values greater than 4° and class III malocclusion for ANB values less than 0° (Steiner 1959).

- The vertical skeletal typology has been defined on the basis of the divergence angle SnGoGn, classifying the analyzed sample as normo-divergent for SN^GoGn values between 27° and 37°, hyper-divergent for SN^GoGn values greater than 37° and hypo-divergent for SN^GoGn values less than 27° (Steiner 1959) [14]

Gingival recession and keratinized tissue width.

Measurements of GR were made on 3 intraoral photographs (frontal, right and left lateral) at baseline, at the end of the treatment and year by year up to 5 years of follow up. (Fig. 1 and 2). All intraoral photographs were calibrated with the corresponding cast model. In particular, the intraoral photos at the beginning of the treatment were calibrated with the initial cast, while the photos at the other time points were calibrated with the post treatment cast. Teeth 2.1, 1.4 and 2.4 were chosen, respectively for the calibration of the frontal, right and left lateral photos. The measurements of the clinical crowns made with the manual caliber were then reported as linear measurements on all the photographs, using a computer software (ZeroBase © - T.I.M. srl Tecnologie Informatiche Mediche, Azzano Decimo PN). When digital scans of the plaster models obtained with a laboratory scanner (SINERGIASCAN ©, Nobil Metal S. p. A.) were documented, the calibration of the photographs was performed by measuring the same elements on the digital model. The STL files of the pre- and post- treatment scans were imported into the 3D Slicer software (3D Slicer, image computing platform), through which the pre- and post- treatment clinical crowns of the teeth 2.1, 1.4 and 2.4 were measured.

Once the photographs were calibrated, the following linear measurements in mm. were assessed:

- Labial GR, as the distance from the visible cemento-enamel junction (CEJ) to the gingival margin. When the CEJ was not visible for the presence of a non-carious cervical lesion (NCCL), an ideal CEJ was drawn, using the contralateral tooth as a reference [15].
  When the CEJ was not visible because it was covered by the gingiva, a value of zero was attributed [16]
- Keratinized tissue (KT) width as the distance from the gingival margin to the mucogingival junction.

FIGURES:

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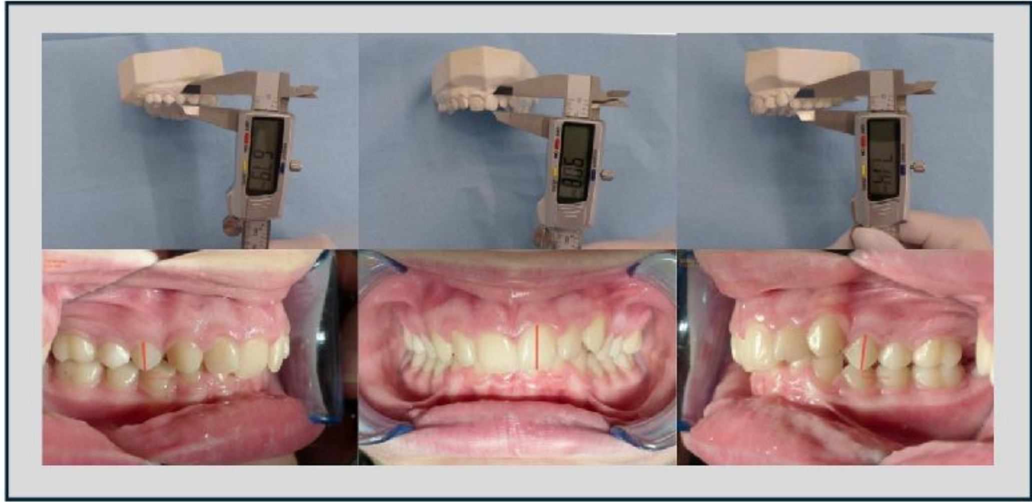

Figure 1a: calibration of analogic model

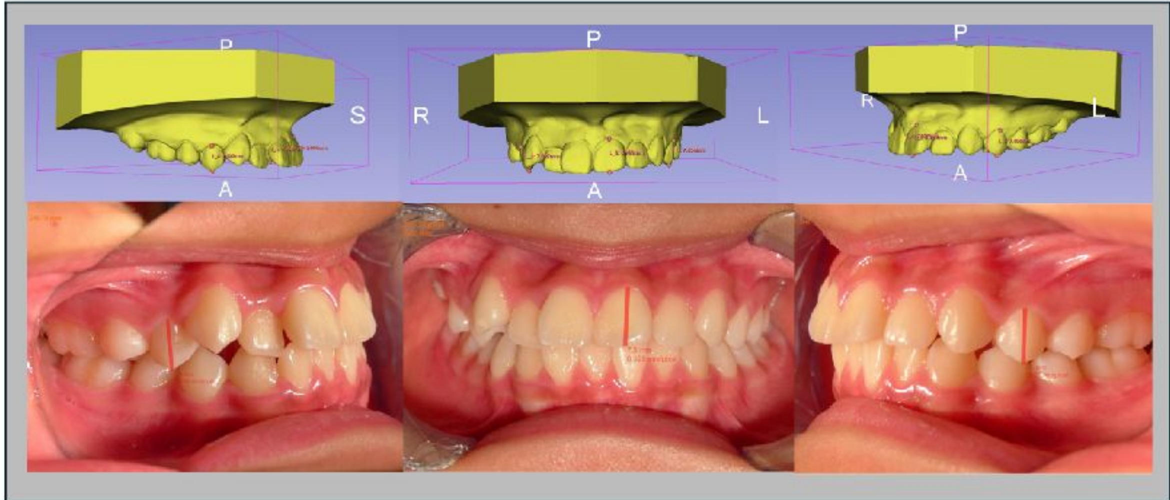

Figure 1b: calibration of digital model

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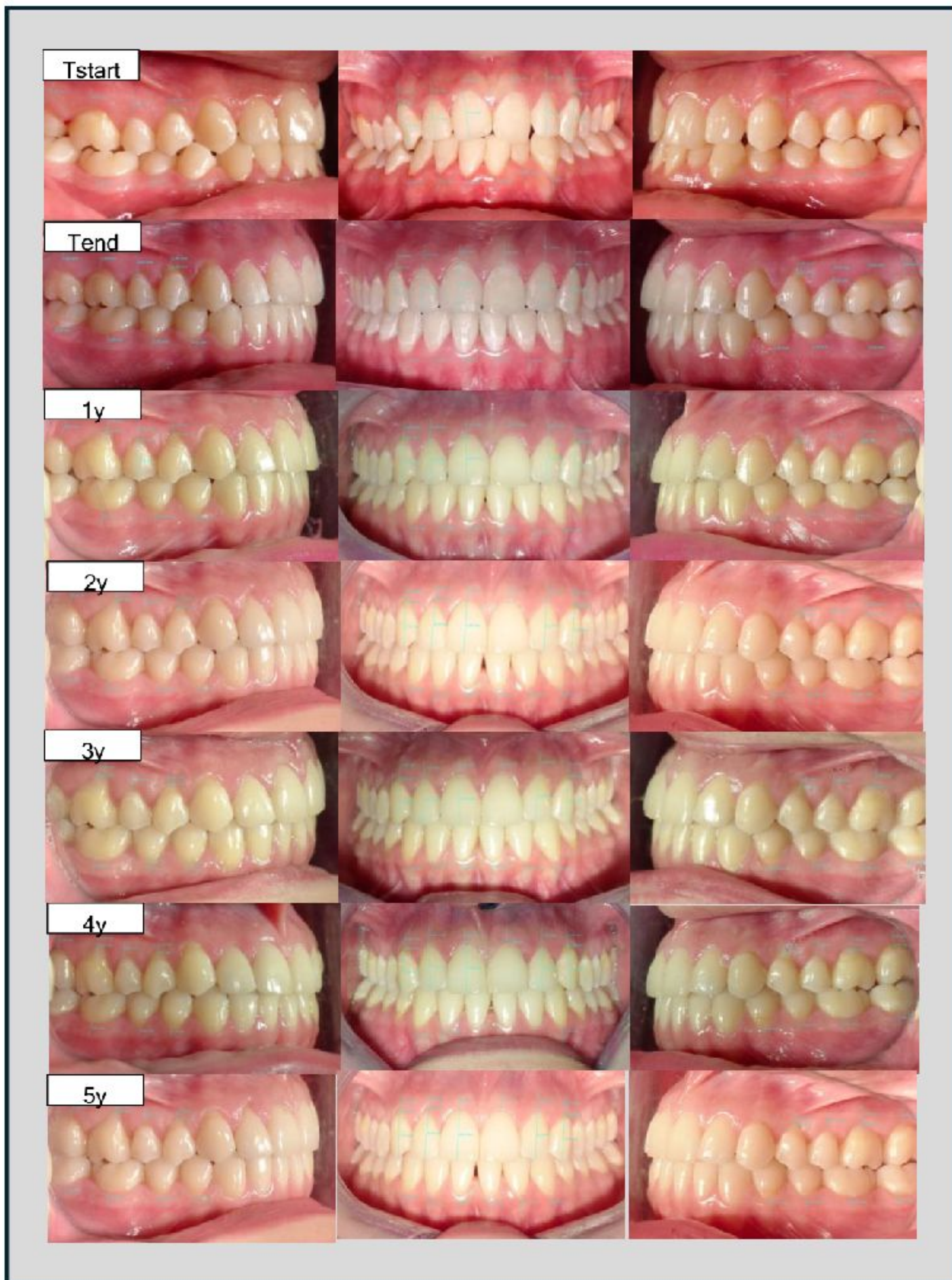

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Figure 2: Clinical case with the measurements of gingival recession and keratinied tissue width at the different time points

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Table: Multilevel Analysis

	OR	IC 95%	SE	Z value	p-value
Intercept	0.005	0.002; 0.015	0.5947	-8.972	<0.001
Kt (< 2 mm)	5.003	2.363; 10.593	0.3827	4.207	<0.001
Gender (Female)	0.724	0.306; 1.716	0.4400	-0.733	0.463
TYPE_MALOCCLUSION (III CLASSE (ANB < 0°))	5.538	0.385; 79.707	1.3606	1.258	0.208
TYPE_MALOCCLUSION (II CLASSE (ANB > 4°))	1.350	0.562; 3.243	0.4470	0.672	0.502
FACIAL_TYPE (IPODIVERGENTE)	1.492	0.480; 4.633	0.5781	0.692	0.489
FACIAL_TYPE (IPERDIVERGENTE)	1.729	0.528; 5.662	0.6053	0.904	0.366
Age (14-20)	1.430	0.593; 3.448	0.4490	0.797	0.426
PRE_ORTHOPAEDIC_TX (Yes)	0.815	0.316; 2.104	0.4835	-0.422	0.673
Arch (Upper)	1.831	1.276; 2.629	0.1845	3.279	0.001
Tooth (Premolar)	2.141	1.260; 3.639	0.2705	2.815	0.005

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Tooth (Incisive)	0.492	0.264; 0.918	0.3177	-2.231	0.026
Tooth (Molar)	1.684	0.942; 3.013	0.2967	1.757	0.079
Random effects	**Variance**	**Std.Dev.**	**Number of obs**	**groups**	
	4.052	2.013	3522	149	

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Gingival Recession occurrence is highly prevalent after Orthodontic Treatment, and Keratinised Tissue Width at baseline is significantly correlated with the prevalence, extension and severity of Gingival Recession, clearly demonstrating the importance of evaluating periodontal factors in planning Orthodontic Treatment.

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Graphical Abstract

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Annual Incidence and Pre-Treatment Prognostic Factors of Labial Gingival Recessions in Young Orthodontically Treated Patients

Mandelli G., Mandelli A., Fiorillo G, Gastaldi G., Medoro L., Clementini M.

1 Aim

a) to determine the annual incidence, distribution and severity of Gingival Recession (GR) up to 5 years after orthodontic treatment;
b) to identify pre-treatment prognostic factors for the occurrence of GR

2 Methods

Design:
Retrospective study

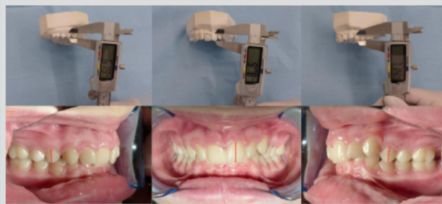
Population:
149 patients

Exposures:
Non-extraction Orthodontic Treatment (OT)

Outcome:

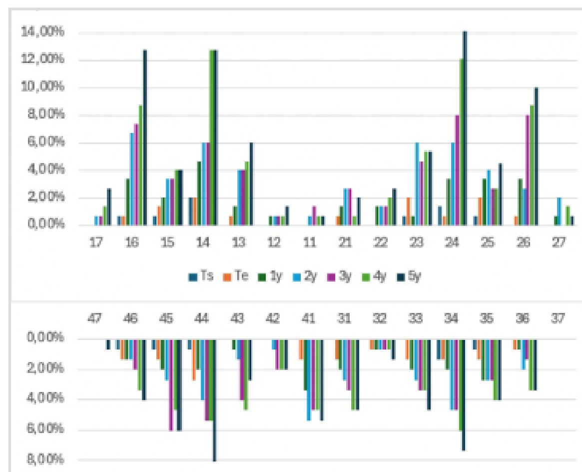
Gingival Recession (annual incidence, distribution, severity up to 5 years after OT)

Statistical Analysis:
Multivariate analysis



3 Results

- Increase of GR (patient level) from the beginning of OT (4.69%) to the end of treatment (10.06%), and annually up to 5 years of follow-up (39.59%)
- Increase of GR (tooth level):



- Five years after OT, the majority of GR are 1mm deep (81%), followed by 2mm GR (15%), 3mm GR (3.5%), and 4mm GR (0.5%).
- Increased probability of developing GR in the upper arch teeth (OR=1.83) in the premolars (OR=2.14), and in sites where the baseline KT width was less than 2mm (OR = 5)

4 Conclusion

GR occurrence is highly prevalent after OT, and periodontal evaluation, at least including KT width measurement, should be incorporated into OT planning to assess the risk of labial GR occurrence.

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