applied sciences

MDPI

Article

Effects of Nail Biting (Onychophagy) on Upper Central Incisors in Children and Young Adolescents

Domenico Ciavarella [1], Graziano Montaruli [1], Lidia Giuliani [1], Maria Bisceglia [1,*], Michele Laurenziello [1], Carlotta Fanelli [1], Mauro Lorusso [1], Rosa Esposito [1,2] and Michele Tepedino [2]

[1] Department of Clinical and Experimental Medicine, Dental School of Foggia, University of Foggia, 71122 Foggia, Italy; domenico.ciavarella@unifg.it (D.C.); graziano.montaruli@unifg.it (G.M.); lidia.giuliani@unifg.it (L.G.); michele.laurenziello@unifg.it (M.L.); carlotta.fanelli@unifg.it (C.F.); mauro.lorusso@unifg.it (M.L.); rosa.esposito1@graduate.univaq.it (R.E.)

[2] Department of Biotechnological and Applied Clinical Sciences, Dental School of L'Aquila, University of L'Aquila, 67100 L'Aquila, Italy; michele.tepedino@univaq.it

* Correspondence: maria.bisceglia@unifg.it

Featured Application: Nail biting is a very common oral disorder whose dental and clinical implication are not well-known. Therefore, this study is a novelty in the field of oral disease since it considers changes on tooth shape caused by nail biting.

Abstract: Nail biting (NB) is a repetitive and uncontrolled parafunctional activity that can affect oral health by altering tooth shape and intraoral position. Nowadays, there is not enough scientific evidence about the impact of NB on teeth; therefore, this study aimed to evaluate the effects of NB on the length, width and inclination of upper central incisors. This retrospective study involved 76 patients, 40 males and 36 females, with a mean age of 10.6 ± 0.3 years. Digital scans of the maxillary arch of each patient were recorded. Next, the length, width and inclination of upper central incisors used and not used for NB were measured. Finally, data were analysed with a paired *t*-test. Statistical analysis showed statistically significant differences in the length and inclination of upper central incisors used for NB compared with those of upper central incisors not used for NB, while the width did not show a significant difference. There were relevant changes in upper central incisors subjected to NB, demonstrating that NB impairs the shape, morphology and inclination of teeth. Therefore, because of the potentially negative consequences of NB, it is recommended that NB not be underestimated.

Keywords: nail biting; orthodontics; tooth shape; young patients; oral health

Citation: Ciavarella, D.; Montaruli, G.; Giuliani, L.; Bisceglia, M.; Laurenziello, M.; Fanelli, C.; Lorusso, M.; Esposito, R.; Tepedino, M. Effects of Nail Biting (Onychophagy) on Upper Central Incisors in Children and Young Adolescents. *Appl. Sci.* **2024**, *14*, 6856. https://doi.org/10.3390/app14166856

Academic Editors: Bruno Chrcanovic and Andrea Scribante

Received: 29 June 2024
Revised: 22 July 2024
Accepted: 31 July 2024
Published: 6 August 2024

1. Introduction

Nail biting (NB), also called onychophagy, is a chronic condition sorted as a body-focused repetitive behaviour disorder; it is considered an obsessive–compulsive disorder in the Diagnostic and Statistical Manual of Mental Disorders, [1] and is classified by the International Classification of Diseases 10 Revision (ICD-10) with the code F98.8 [2]. It is described as a voluntary, repetitive and nonfunctional movement that is not part of any recognized psychiatric or neurological condition [2]. This specific behavioural and emotional disorder has an onset in childhood and adolescence, and is considered not only as a conventional oral disorder, but also as pathological skin-picking [3]. NB is a common disorder: its prevalence is 20–25% in children and up to 45% in young adolescents. Moreover, some authors assessed that these data are likely underestimated because patients usually hide their nails or are unwilling to share information about NB with clinicians [4]. Different studies have analysed NB over the years, evaluating the aetiology, complications and management of this disorder, and considering the severity, they report two forms of NB: mild and severe [5].

In general, most oral parafunctional habits are related to abnormal hyperactivity of the stomatognathic system, even if the exact aetiology is unknown [5]. There are strong genetic and environmental influences, and more than 30% of patients with NB have at least one family member with the same disorder [6]. In fact, NB is associated with indications of a low quality of life, such as higher levels of stress, psychiatric disorders, poorer physical health, feelings of depression and social problems [7]. It is known that the aetiology of malocclusions is multifactorial: in fact, in addition to its well-known association with genetic factors, it can also be related to environmental factors, such as NB [8]. Furthermore, NB can also induce oral and dental complications: it was assessed that children with NB have a higher risk of developing malocclusions of anterior teeth [8]. Moreover, even though some authors have stated that oral habits can determine changes in the normal position of teeth, others have assessed that this link is rather unclear [5]. Additionally, NB can affect the morphology of upper central incisors and the relationship between teeth and soft tissues [9].

Therefore, NB can impair oral health and the intraoral microbiome; it has been stated that patients with NB have a higher oral bacterial count, and their oral microbiome is typically colonised by Escherichia coli and Enterobacteriaceae [10], which can cause local and systemic disease due to ingestion of enteric bacteria. [11] Enteric bacteria can induce other intraoral diseases of the oral mucosae, such as abscesses, erosive tooth wear and gingival injuries [4,12]. Finally, NB can affect the nail plate and the periungual area [13] and predispose subjects to secondary infections affecting the nails, such as acute paronychia, subungual warts and herpetic whitlow (Figure 1) [14,15]. For all these reasons, NB should be intercepted and properly treated as soon as possible. Sometimes, the fear of these infections leads to spontaneously stopping NB; in fact, there is usually no need for any treatment in mild cases, [16] while in severe cases a multidisciplinary approach that involves stimulus control, pharmacotherapy and improving self-esteem is required [17].

Figure 1. Hand of a young patient with NB.

Despite the high prevalence of NB and diseases caused by it, there are no studies evaluating the effects of this parafunction on the anatomical features of teeth and on the upper central incisors, which are the teeth most often used for NB. Therefore, considering this latter consideration, the aim of the present study was to assess the effects of NB on anatomical features of upper central incisors by measuring the length, width and inclination of upper central incisors involved in NB and not involved in NB in the same patient. The

null hypothesis was that no changes exist between the length, width and inclination of teeth used for NB and teeth not used for NB.

2. Materials and Methods

This manuscript was prepared following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines, and all procedures followed were in accordance with the Declaration of Helsinki from 1975 and subsequent revisions. All procedures of this research protocol were approved by the Ethics Committee of the University of Foggia (Approval no. 43/CE/2019). The parents of each subject provided written informed consent.

This retrospective study was conducted on patients treated at the Orthodontic Department of the University of Foggia. Patients were selected consecutively from January 2019 to December 2021 based on the following inclusion criteria:

1. Age between 9 and 12 years;
2. Skeletal and dental class I;
3. Patients with NB and who used only one central incisor for NB;
4. Absence of other bad oral habits and parafunctions;
5. Absence of previous orthodontic treatments.

Exclusion criteria were as follows:

1. Presence of anterior and posterior crossbite;
2. Previous maxillary surgical treatments;
3. Absence of upper central incisors;
4. Dental trauma and conservative treatments of upper central incisors.

For the power analysis (G*Power 3.1.9.2, Franz Faul, Universitat Kiel, Kiel, Germany), as no previous studies were available, it was decided to use Cohen thresholds with a medium effect size [18]. Therefore, to detect a medium effect size of 0.5 with a *t*-test according to Cohen, considering an α of 0.05 and a power of 0.95, 59 subjects were needed to confidently reject the null hypothesis that no changes exist between the length, width and inclination of teeth used for NB and teeth not used for NB. Among patients who visited the Orthodontic Department of the Dental Clinic of the University of Foggia, those with NB and who met the inclusion criteria were enrolled in this study after providing written informed consent to participate. Recruited patients were previously examined for the presence of obstructive sleep apnea (OSA).

For the identification of children affected by NB during orthodontic check-ups at the dental clinic, the following questions were asked by the clinician:

1. Do you eat or incise your nails?
2. How often do you eat or incise them?
3. Do you use one tooth or more teeth?
4. Do you use only central incisors?
5. Do you use only one tooth among the central incisors?

To assess which tooth was implied in the parafunction, each patient and their parents kept a diary for one week indicating whether the patient used one tooth for NB and which tooth was used. Patients who used only one upper central incisor for NB were enrolled in this study.

For each patient, the upper central incisor involved with NB and not involved with NB were analysed, and variables such as length, width and inclination were analysed for each tooth. The impression of the maxillary arch was obtained using an intraoral scanner (TRIOS, 3Shape, Copenhagen, Denmark). During the arch recording, the protocol recommended by the manufacturer was precisely followed. To capture a digital impression of each arch, the intraoral scanner was positioned as close as possible to the surface of the most distal erupted molar on the right side. Next, the intraoral scanner was moved along the dental arch at the same distance, and angulated towards the most distal erupted molar on the left side. At this point, the procedure was repeated. The impression was completed by

scanning all missing areas and undercuts while checking for scanning errors. After the scan, files were exported by the scanner software, and then imported into dental CAD software (Meshmixer version 3.5; Disruptive Dental Specialist, Rockford, MI, USA) to create virtual models. Measurements were performed with either Ortho AnalyzerTM software (3Shape 2023.1) or Meshmixer (version 3.5; Disruptive Dental Specialist), and the length, width and inclination of teeth were evaluated as described in Table 1 and presented in Figure 2. Patients were selected by authors D.C. and G.M. Measurements were performed by author G.M., an orthodontist experienced in the field of digital software.

Table 1. Dental measurements.

Upper Central Incisor Measurements	Description
Length (mm)	The length of the tooth was determined measuring the linear distance from the most apical point of the gingival margin to the most incisal point of the crown (Figure 2a).
Width (mm)	The width of the tooth was determined measuring the linear mesio-distal distance of the tooth considering the distance between contact points mesially and distally, perpendicular to the tooth's long axis (Figure 2b).
Inclination (mm)	The inclination of the tooth was determined considering the distance of the perpendicular line between the mesio-buccal cusps of the left and right of the first permanent molar measured in the middle of the incisal margin of the teeth (Figure 2c).

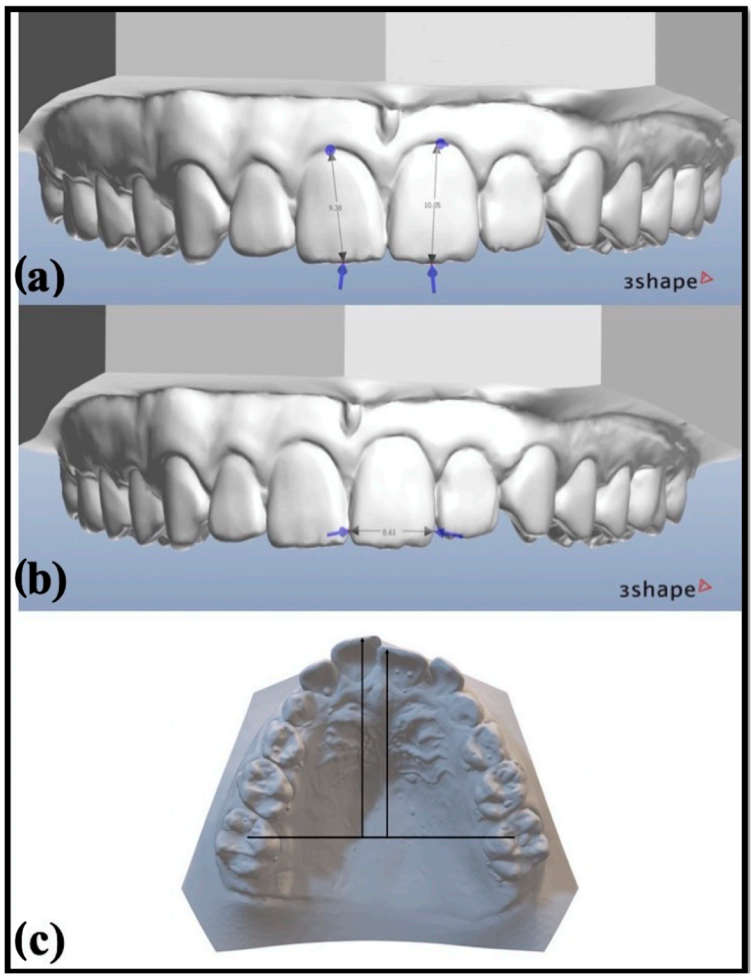

Figure 2. Representation of measurements taken using digital software: (**a**) length, (**b**) width and (**c**) inclination.

Statistical Analysis

Data were analysed using GraphPad Prism 6.0 (GraphPad Prism Software, San Diego, CA, USA). The Shapiro–Wilk test was used to evaluate whether data had a normal distribution. A paired *t*-test was used to analyse normally distributed data, while the Wilcoxon signed-rank test was used to evaluate non-normally distributed data. The level of significance was set at $p < 0.05$.

3. Results

Seventy-six patients (40 males and 36 females) with a mean age of 10.6 ± 0.3 years were involved in this study. Descriptive statistics are presented in Table 2. As data were non-normally distributed, the Wilcoxon signed-rank test was used to evaluate differences in variables between NB sites and non-NB sites. Upper central incisors used for NB were longer than upper incisors not used for NB (Table 3). There was no significant difference between the width of teeth used for NB and the width of teeth not used for NB (Table 3). Finally, upper central incisors used for NB showed an increased inclination compared with upper central incisors not used for NB (Table 3).

Table 2. Descriptive statistics of the length, width and inclination of upper central incisors with and without NB.

Variables	Length		Width		Inclination	
	NB Site	Non-NB Site	NB Site	Non-NB Site	NB Site	Non-NB Site
Number of values	76	76	76	76	76	76
Mean	10.17	9.25	8.61	8.68	307.2	299.5
Std. deviation	0.86	1.02	0.55	0.67	51.79	50.13
Median	9.25	10.16	8.68	8.73	322.2	315.7
Std. error of mean	0.09	0.11	0.06	0.07	6.10	5.91
Lower 95% CI of mean	9.98	9.02	8.48	8.53	295	287.7
Upper 95% CI of mean	10.37	9.48	8.73	8.84	319.3	311.3
Passed normality test (alpha = 0.05)?	No	Yes	No	Yes	No	No

Table 3. Wilcoxon signed-rank test for comparing differences in variables between NB Sites and Non-NB Sites.

Variables	*p* Value
Length	$p < 0.001$ **
Width	$p = 0.7478$
Inclination	$p = 0.034$ *

* Statistically significant for $p < 0.05$; ** statistically significant for $p < 0.001$.

4. Discussion

NB is a common oral parafunction, but its clinical implication in dentistry is not entirely clear. Therefore, the present study aimed to assess effects of NB on teeth morphology. As previously described, NB is a self-injury behaviour that is uncontrolled by patients [1]. It involves close contacts between fingernails and upper central incisors in a repetitive way and causes trauma to teeth. There are different hypotheses regarding the aetiology of NB: some authors believe that anxiety and stress are responsible [5], while others believe that NB may have an anxiety-reducing function [17]. Moreover, Silber and Haynes stated that NB is not related to emotional disorders [19], even if it can be associated with poorer psychosocial health. As previously mentioned, complications caused by NB can affect

the nail plate and the periungual region, as well as the oral cavity and teeth. Regarding the stomatognathic system, it is well known that NB can cause infective disease of the whole oral cavity or disease involving only mucosae or teeth separately. In this study, only changes in teeth were evaluated, showing that there were differences between teeth used in NB and teeth not used in NB. In particular, upper central incisors used for NB were significantly longer compared with upper central incisors not used for NB (Table 2). The longer length of teeth used for NB may be caused either by extrusion of incisors because of the incision movement of NB or by the elevation of the gingival margin caused by the traumatic action of NB. In a previous research study that performed a similar evaluation, the authors did not find any associations between tooth length and the gingival margin, except in cases of inadequate orthodontic treatment or oral piercing [20]. It has been stated that NB-related forces can cause apical root resorption of both orthodontically treated and untreated teeth [21], demonstrating that root changes were related to the presence of parafunction and not to orthodontic movements. In fact, teeth affected by severe NB may have a high root resorption index, indicating that this parafunction may cause apical root reabsorption [21]. Bonetti et al. [22] described how recessions also develop as an indirect effect of NB: they analysed mandibular incisors subjected to NB and showed that there was an uncontrolled buccal displacement of the root. Of course, elevation of the gingival margin can also be related to other features, such as the periodontal biotype [23,24], which was not analysed in this study.

There were no statistically significant differences in the width of upper central incisors used and not used for NB (Table 3), probably because NB-related force involves the vertical axis and component of teeth, and not sagittal and transversal ones. Additionally, statistical analysis showed statistically significant differences between NB and the inclination of upper central incisors. Incisors used for NB showed a more vestibular inclination than incisors not used for NB (Table S1). This increased inclination may be due to the oscillatory movement of upper central incisors subjected to NB. The different inclination of teeth may be the consequence of the application of force at the margins of teeth when a patient bites their nails, resulting in a more vestibular inclination of upper central incisors used for NB.

It is well known that NB can cause malocclusion of anterior teeth [5]; however, there are other oral habits that cause protrusion of upper incisors, including sucking on a finger, a pacifier or a baby bottle [25]. Furthermore, sucking habits can evolve to NB during growth [26]. Dean et al. found associations between tongue thrusting and upper incisors resulting in increased protrusion of anterior teeth [27]. Although NB cannot be considered one of the primary causes of malocclusion, it is associated with other problems, such as gingivitis, small fractures of the incisors and temporomandibular dysfunction in mixed dentition [28], resulting in problems with the entire stomatognathic system.

As most of studies conducted on NB have focused on consequences concerning oral [29] and nail [13] infections rather than on anatomical changes in teeth, the present study is a novelty, providing a new perspective in the field. In conclusion, NB is not healthy for children and young adolescents. Thus, it is important to intercept this problem in children and young adolescents, as dental impairments are still present at these ages, and it would be helpful to promote psychoeducational programmes in association with the first orthodontic check to intervene immediately when NB is detected. A multidisciplinary approach should help children understand that they should not bite their nails, show them the problems related to NB [30], and build up their self-confidence and self-esteem.

Limitations of this study. The main limitation of the present study is the retrospective recruitment of the sample, although care was taken to avoid any selection bias, for example, by using consecutive enrolment. Moreover, examinations of periodontal status and gingival biotype were not performed. Finally, social status and gender were not assessed, so inherent biases might be present.

5. Conclusions

Within the limits of this study, conclusions can be summarized as follows:

Statistically significant differences were found in the length and inclination of central incisors used for NB compared with those not used for NB.

Early prevention of NB and the role of the clinician during the first visit are crucial to intercept this parafunction. It is important not to underestimate NB to avoid anatomical and functional alterations of both central incisors and other teeth.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/app14166856/s1, Table S1: Wilcoxon signed rank test for comparison of variables by gender between NB site and No NB site.

Author Contributions: D.C.; investigation and methodology, G.M.; software, investigation and data curation, L.G. and M.B.; writing—original draft preparation, M.B. and R.E.; writing—review and editing, M.L. (Michele Laurenziello), M.L. (Mauro Lorusso) and C.F.; supervision, M.T. All authors have read and agreed to the published version of the manuscript.

Funding: This study received no external funding.

Institutional Review Board Statement: This study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Ethics Committee of the University of Foggia (protocol code 38/SeCE/2019, 7 May 2019).

Informed Consent Statement: Informed consent was obtained from all subjects involved in this study.

Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors on request.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. American Psychiatric Association. *DSM-5 Task Force. Diagnostic and Statistical Manual of Mental Disorders: DSM-5*; American Psychiatric Association: Washington, DC, USA, 2013.
2. WHO. *The ICD-10 Classification of Mental Behavioral Disorders Clinical Descriptions and Diagnostic Guidelines*; WHO Library Cataloguing in Publication Data: Geneva, Switzerland, 1993.
3. Stein, D.J.; Simeon, D. The nosology of compulsive skin picking. *J. Clin. Psychiatry* **1999**, *60*, 618–619. [CrossRef] [PubMed]
4. Pacan, P.; Reich, A.; Grzesiak, M.; Szepietowski, J.C. Onychophagia is associated with impairment of quality of life. *Acta Derm. Venereol.* **2014**, *94*, 703–706. [CrossRef] [PubMed]
5. Tanaka, O.M.; Vitral, R.W.; Tanaka, G.Y.; Guerrero, A.P.; Camargo, E.S. Nailbiting, or onychophagia: A special habit. *Am. J. Orthod. Dentofac. Orthop.* **2008**, *134*, 305–308. [CrossRef] [PubMed]
6. Erdogan, H.K.; Arslantas, D.; Atay, E.; Eyuboglu, D.; Unsal, A.; Dagtekin, G.; Kilinc, A. Prevalence of onychophagia and its relation to stress and quality of life. *Acta Dermatovenerol. Alp. Pannonica Adriat.* **2021**, *30*, 15–19. [CrossRef] [PubMed]
7. Gavish, A.; Halachmi, M.; Winocur, E.; Gazit, E. Oral habits and their association with signs and symptoms of temporomandibular disorders in adolescent girls. *J. Oral Rehabil.* **2000**, *27*, 22–32. [CrossRef] [PubMed]
8. Proffit, W.R. Equilibrium theory revisited: Factors influencing position of the teeth. *Angle Orthod.* **1978**, *48*, 175–186. [PubMed]
9. Bronson, J.R.; Stoner, C.C. Optimal sagittal appliance mechanics. *Funct. Orthod.* **1984**, *1*, 43–44. [PubMed]
10. Ghanizadeh, A.; Shekoohi, H. Prevalence of nail biting and its association with mental health in a community sample of children. *BMC Res. Notes* **2011**, *4*, 116. [CrossRef] [PubMed]
11. Chinnasamy, A.; Ramalingam, K.; Chopra, P.; Gopinath, V.; Bishnoi, G.P.; Chawla, G. Chronic nail biting, orthodontic treatment and Enterobacteriaceae in the oral cavity. *J. Clin. Exp. Dent.* **2019**, *11*, e1157–e1162. [CrossRef] [PubMed]
12. Motghare, V.; KuMar, J.; KaMate, S.; KuShwaha, S.; Anand, R.; Gupta, N.; Gupta, B.; Singh, I. Association Between Harmful Oral Habits and Sign and Symptoms of Temporomandibular Joint Disorders Among Adolescents. *J. Clin. Diagn. Res.* **2015**, *9*, ZC45–ZC48. [CrossRef]
13. Shin, J.O.; Roh, D.; Son, J.H.; Shin, K.; Kim, H.S.; Ko, H.C.; Kim, B.S.; Kim, M.B. Onychophagia: Detailed clinical characteristics. *Int. J. Dermatol.* **2022**, *61*, 331–336. [CrossRef] [PubMed]
14. Tosti, A.; Piraccini, B.M. Warts of the nail unit: Surgical and nonsurgical approaches. *Dermatol. Surg.* **2001**, *27*, 235–239. [CrossRef] [PubMed]
15. Szinnai, G.; Schaad, U.B.; Heininger, U. Multiple herpetic whitlow lesions in a 4-year-old girl: Case report and review of the literature. *Eur. J. Pediatr.* **2001**, *160*, 528–533. [CrossRef]
16. Bakwin, H. Thumb and finger-sucking in children. *J. Pediatr.* **1948**, *32*, 99–101. [CrossRef]

17. Lee, D.K.; Lipner, S.R. Update on Diagnosis and Management of Onychophagia and Onychotillomania. *Int. J. Environ. Res. Public Health* **2022**, *19*, 3392. [CrossRef] [PubMed]
18. Cohen, J. Statistical power analysis. *Curr. Dir. Psychol. Sci.* **1992**, *1*, 98–101. [CrossRef]
19. Silber, K.P.; Haynes, C.E. Treating nailbiting: A comparative analysis of mild aversion and competing response therapies. *Behav. Res. Ther.* **1992**, *30*, 15–22. [CrossRef]
20. Slutzkey, S.; Levin, L. Gingival recession in young adults: Occurrence, severity, and relationship to past orthodontic treatment and oral piercing. *Am. J. Orthod. Dentofac. Orthop.* **2008**, *134*, 652–656. [CrossRef]
21. Odenrick, L.; Brasttstrom, V. The effect of nailbiting on root resorption during treatment. *Eur. J. Orthod.* **1983**, *5*, 185–188. [CrossRef]
22. Bonetti, G.A.; Incerti Parenti, S.; Zucchelli, G. Onychophagia and postorthodontic isolated gingival recession: Diagnosis and treatment. *Am. J. Orthod. Dentofac. Orthop.* **2012**, *142*, 872–878. [CrossRef]
23. Ciavarella, D.; Tepedino, M.; Gallo, C.; Montaruli, G.; Zhurakivska, K.; Coppola, L.; Troiano, G.; Chimenti, C.; Laurenziello, M.; Russo, L.L. Post-orthodontic position of lower incisors and gingival recession: A retrospective study. *J. Clin. Exp. Dent.* **2017**, *9*, e1425–e1430. [CrossRef] [PubMed]
24. Lo Russo, L.; Zhurakivska, K.; Montaruli, G.; Salamini, A.; Gallo, C.; Troiano, G.; Ciavarella, D. Effects of crown movement on periodontal biotype: A digital analysis. *Odontology* **2018**, *106*, 414–421. [CrossRef] [PubMed]
25. Larsson, E. Sucking, chewing and feeding habits and the development of crossbite: A longitudinal study of girls from birth to 3 years of age. *Angle Orthod.* **2001**, *71*, 116–119. [PubMed]
26. Leme, M.; Barbosa, T.; Castelo, P.; Gavião, M.B. Associations between psychological factors and the presence of deleterious oral habits in children and adolescents. *J. Clin. Pediatr. Dent.* **2014**, *38*, 313–317. [CrossRef] [PubMed]
27. Dean, J.A.; McDonald, R.E.; Avery, D.A. *Managing the Developing Occlusion*; Mosby and Co.: St. Louis, MO, USA, 2000; pp. 178–217.
28. Sari, S.; Sonmez, H. Investigation of the relationship between oral parafunctions and temporomandibular joint dysfunction in Turkish children with mixed and permanent dentition. *J. Oral Rehabil.* **2002**, *29*, 108–112. [CrossRef] [PubMed]
29. Baydaş, B.Ü.; Uslu, H.; Yavuz, I.; Ceylan, İ.; Dağsuyu, I.M. Effect of a chronic nail-biting habit on the oral carriage of Enterobacteriaceae. *Oral Microbiol. Immunol.* **2007**, *22*, 1–4. [CrossRef] [PubMed]
30. Gur, K.; Erol, S.; Incir, N. The effectiveness of a nail-biting prevention program among primary school students. *J. Spec. Pediatr. Nurs.* **2018**, *23*, e12219. [CrossRef]