UNIVERSIDADE DE UBERABA
PROGRAMA DE PÓS-GRADUAÇÃO EM ODONTOLOGIA – MESTRADO ACADÊMICO

ARIANE BEATRIZ BLANCATO

ASPECTOS ETIOLÓGICOS ASSOCIADOS COM A MORFOLOGIA DE MOLARES

UBERABA – MG
2023

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Dissertação apresentada ao Programa de Pós-Graduação em Odontologia - Mestrado Acadêmico da Universidade de Uberaba, como requisito para obtenção do título de Mestre em Odontologia, na Área de Concentração em Clínica Odontológica Integrada.

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Catalogação elaborada pelo Setor de Referência da Biblioteca Central UNIUBE

Blancato, Ariane Beatriz.
B591a Aspectos etiológicos associados com a morfologia de molares / Ariane Beatriz Blancato. – Uberaba, 2023.
84 f. : il. color.

Dissertação (Mestrado) – Universidade de Uberaba. Programa de Pós-graduação em Odontologia. Área de Concentração em Clínica Odontológica Integrada.
Orientador (a): Prof. Dr. Cesar Penazzo Lepri.
Co-orientador (a): Prof. Dra. Érika Calvano Küchler.

1. Dentes – Anatomia. 2. Dentes – Estrutura. 3. Odontologia. I. Universidade de Uberaba. Programa de Pós-graduação em Odontologia. Área de Concentração em Clínica Odontológica Integrada. II. Título.

CDD: 611.314

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Área de concentração: Clínica Odontológica Integrada

Aprovado (a) em: 06/03/2023

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DEDICATÓRIA

A Deus por sempre estar presente na minha caminhada, nas minhas escolhas e por sempre me conceder serenidade e fé.

Ao meu companheiro, Luís Filipe, por sempre acreditar no meu sucesso, me apoiando de todas as formas possíveis e não medindo esforços para que eu realize os meus sonhos.

Aos meus pais, Nilda e Glaysson, aos meus irmãos, Amanda e Felipe, à minha segunda mãe, Karla, aos meus avós, Prousolina e Antonio, a todos os meus familiares. Essa conquista não seria possível sem o amor, o apoio, as palavras de conforto e a confiança que depositaram nas minhas escolhas.

AGRADECIMENTO

À Universidade de Uberaba, através do Magnífico Reitor, Dr. Marcelo Palmério. À Pró-Reitoria de Pós-Graduação, Pesquisa e Extensão da Universidade de Uberaba, na pessoa do Pró-Reitor, Prof. Dr. André Luís Teixeira Fernandes.

À CAPES, pela concessão do auxílio financeiro sob a forma de PROSUP/Taxa de estudos. O presente trabalho foi realizado com apoio da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Código de Financiamento 001.

À Fundação Alexander von Humboldt (Alemanha) pelo apoio técnico e suporte financeiro.

Ao Prof. Dr. César Penazzo Lepri pelo aceite em me orientar e pela confiança depositada em mim. Obrigada por contribuir com meu crescimento.

À professora Érika Calvano Küchler agradeço imensamente todas as oportunidades que me ofereceu. Obrigada por contribuir com meu crescimento.

Aos professores Érika Calvano Küchler e Christian Kirschneck por me receberem na Universidade Regensburg, Alemanha.

À Eva Paddenberg pelo auxílio e orientação na coleta das imagens na Universidade de Regensburg.

À Flávia Michelle, secretária do Programa de Pós-Graduação em Odontologia da Universidade de Uberaba, pela dedicação ao trabalho e sempre disposta a ajudar.

Aos professores do Mestrado por todo conhecimento e aprendizado.

Agradeço a todos que direta ou indiretamente contribuíram para realização deste trabalho.

“Jedes Naturgesetz, das sich dem Beobachter offenbart, lässt auf ein höheres, noch unerkanntes schließen.”

Alexander von Humboldt

RESUMO

Os molares humanos são apresentados na dentição permanente e decídua e apresentam uma variação morfológica em tamanho e forma. O presente estudo teve como objetivo avaliar a frequência e a variação de 13 traços não-métricos da coroa dentária (NDCT) em molares permanentes e decíduos em sujeitos alemães vivos, e investigar a preferência do lado e o dimorfismo sexual. Foram avaliados registros dentários de 163 indivíduos (82 homens e 81 mulheres) com idades entre 8 e 14 anos. Primeiro e segundo molares permanentes e decíduos superiores e inferiores (do lado esquerdo e direito) foram considerados. Dentes com cárie dentária cavitada, desgaste oclusal, restaurações e deformidades dentárias aparentes não foram avaliados. Os NDCT para molares permanentes foram identificados e pontuados de acordo com o sistema de avaliação dental desenvolvido pelo Sistema de Antropologia Odontológica da Universidade Estadual do Arizona (ASUDAS). Os NDCT para molares decíduos foram identificados e avaliados de acordo com ASUDAS, método Hanihara e método Sciulli. O teste Qui-quadrado foi usado para investigar a preferência do lado e o dimorfismo sexual a um nível de significância de $p \leq 0.050$. Um dimorfismo sexual foi observado para o hipocone no primeiro molar permanente superior (p=0,041). O protostilídeo foi observado nos molares permanentes inferiores (variando de 2,1-10%). Os homens apresentaram mais hipoconulídeo do que as mulheres (p=0,019). Somente as mulheres apresentaram a crista distal do trigonídeo nos primeiros molares permanentes inferiores (p=0,002). O padrão de sulco mais comum em molares decíduos era Y. Os homens apresentaram mais padrão Y que as mulheres no segundo molar decíduo inferior (p=0,039). A assimetria foi observada em algumas características, variando de 0% a 100%. O presente estudo mostrou a variabilidade e a frequência de NDCT de molares e evidenciou que alguns traços morfológicos apresentaram dimorfismo sexual em dentes permanentes e decíduos.

Palavras chaves: Antropologia; Coroa do dente; Dente decíduo; Dente molar; Dentição permanente.

ABSTRACT

Humans molars are presented in the permanent and primary dentition and presents a morphological variation that ranges in size and shape. The present study aimed to assess the frequency and variation of 13 Non-Metrical Dental Crown Traits (NDCT) in permanent and primary molars in living German subjects, and to investigate side preference and sexual dimorphism. Dental records from 163 individuals (82 males and 81 females) aged 8 to 14 years were evaluated. First and second permanent and primary upper and lower molars (from left and right sides) were assessed. Teeth with cavitated dental caries, occlusal wear, restorations and obvious dental deformities were not evaluated. The NDCT for permanent molars were identified and scored according to the odontoscopic system developed by Arizona State University Dental Anthropology System (ASUDAS). The NDCT for primary molars were identified and scored according ASUDAS, Hanihara method and Sciulli method. Chi-squared test was used to investigated side preference and sexual dimorphism at a significance level of $p \leq 0.050$. A sexual dimorphism was observed for the hypocone in first upper permanent molar (p=0.041). The protostylid was observed in lower permanent molars (ranging from 2.1-10%). Males presented more hypoconulid than females (p=0.019). Only females presented the distal trigonid crest in lower first permanent molars (p=0.002). The most common groove pattern in primary molars was Y. Males presented more Y grade than females in the lower second primary molar (p=0.039). Asymmetry was observed in some trait, ranging from 0% to 100%. The present study showed the frequency of NDCT of molars and demonstrated that some traits present sexual dimorphism in permanent and primary teeth.

Key words: Anthropology; Dentition, Permanent; Molar; Tooth Crown; Tooth, Deciduous.

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LISTA DE ABREVIATURAS E SIGLAS

NDCT	Non-metrical dental crown traits
ASUDAS	Arizona State University Dental Anthropology System
UM	Permanent upper molar
LM	Permanent lower molar
um	Primary upper molar
lm	Primary lower molar
1	First molar
2	Second molar
(r)	Right
(l)	Left
UM1	Permanent upper first molar
UM2	Permanent upper second molar
LM1	Permanent lower first molar
LM2	Permanent lower second molar
um1	Primary upper first molar
um2	Primary upper second molar
lm1	Primary lower first molar
lm2	Primary lower second molar

SUMÁRIO

1 INTRODUÇÃO

A antropologia é o estudo da variação e evolução humana. A antropologia dentária é um segmento que se concentra em investigar a dentição humana como variações anatômicas, evolutivas, patológicas e culturais. Este campo de estudo está relacionado à odontologia, biologia e paleontologia (TURNER, 1967; AGUIRRE *et al.*; 2006).

A antropologia dentária inclui a identificação de estruturas como tamanho, número e localização de cúspides, padrão oclusal, configuração da raiz, número e disposição dos dentes e medições individuais (LOH,1991). A dentição humana, incluída na classificação dos mamíferos, tem sua divisão de anterior para posterior e regiões específicas para cada tipo de dente, como incisivos, caninos, pré-molares e molares (DAHLBERG, 1945; JERNVALL E THESLEFF, 2000). Um dente é dividido em duas partes principais, a coroa e a raiz. A cúspide é a parte singular que constitui a coroa, além dos lóbulos e cristas essenciais (AGUIRRE *et al.*; 2006; KONDO, MORITA, OHSHIMA; 2022). Os molares humanos, os maiores dentes da cavidade bucal, são apresentados na dentição permanente e decídua variando em tamanho e forma (CUNHA *et al*., 2020a; CUNHA *et al*., 2020b).

A morfologia dental humana, particularmente dos dentes molares, tem sido descrita através de padrões e com uma grande variedade de características morfológicas (KONDO, MORITA, OHSHIMA; 2022, POPOVICI *et al*., 2023). O estudo da morfologia da coroa dental, incluindo a identificação dos traços molares, é baseado na avaliação das superfícies oclusais (AOKI E ITO; 2022). Sua avaliação baseia-se na variação fenotípica dos dentes, considerando traços discretos como cúspides, tubérculos, ranhuras e sulcos oclusais, constituindo os traços não métricos da coroa dental (NDCT) (SCOTT E TURNER, 1997).

O fundamento dos estudos da morfologia dentária advém de dentistas, paleontólogos e antropólogos físicos. (TURNER, 1967; SCOTT E PILLOUD, 2018). Dentistas e antropólogos tendem a perceber o estudo da morfologia em ângulos diferentes, no qual os primeiros trazem a perspectiva do conhecimento em biologia oral e os segundos abordam uma questão histórica do tema (SCOTT E PILLOUD, 2018). Desde o século passado, características morfológicas têm sido usadas para descrever NDCT em superfícies oclusais dos molares mandibulares e maxilares (HRDLIčKA,1920; DAHLBERG, 1956; HANIHARA, 1961; TURNER *et al*., 1991).

Hrdlička (1920) foi o primeiro a classificar traços morfológicos, especificando as características dos incisivos permanentes com o propósito de diferenciar populações humanas. Este autor descreveu diferentes graus de expressões sobre a característica das cristas linguais marginais do incisivo permanente superior, denominada como “forma de pá”, nas quais o traço variava de mínima a máxima expressão (HRDLIčKA,1920; TURNER *et al*., 1991; SCOTT *et al*., 2018). A partir deste ponto iniciou-se o processo de classificação dos traços morfológicos na dentição (TURNER *et al*., 1991). Dahlberg (1956) introduziu escalas com graus de expressão de traço e uma série de placas padronizadas para estudar variações morfológicas dos dentes, tais como traço de carabelli, protostilídeo e hipocone (SCOTT *et al*., 2018). Em 1961, Hanihara publicou um importante estudo descrevendo novas classificações de traços morfológicos de molares na dentição decídua, no que se refere ao padrão da coroa de molares e a crista distal do trigonídeo.

Turner *et al.* (1991) desenvolveu um sistema de classificação de traços morfológicos para dentição permanente, reunindo inúmeros estudos para padronizar os conjuntos das frequências de cada característica dental possível de ser avaliada. O sistema chamado ASUDAS (Sistema de Antropologia Odontológica da Universidade Estadual do Arizona) possui uma extensa série de classificações de coroa e traços radiculares, sendo atualmente o sistema mais amplamente utilizado para a classificação da morfologia dental. Sciulli (1998) realizou um estudo avaliando características da coroa e raiz na dentição decídua, e desenvolveu um sistema de classificação de traços morfológicos a partir de outros estudos de avaliação da frequência, complementando com novas avaliações.

O uso destes sistemas na pesquisa odontológica e antropológica permite a replicabilidade entre observadores, e eles produzem dados que expressam a tendência de variação de todos os NDCT presentes na coroa do molar (TURNER *et al*., 1991; SCOOT *et al*., 2018, LÓPEZ-ONAINDIA *et al*., 2022). Na dentição decídua encontramos um critério de classificação específico para as características da coroa dental, entretanto com menor quantidade de traços avaliados quando comparado à dentição permanente (HANIHARA, 1961; TURNER *et al*., 1991). É observável que na dentição decídua e permanente temos os mesmos traços morfológicos passíveis de serem avaliados, entretanto alguns com padrões de frequências diferentes, como traço de carabelli, hipocone, metacónulo, hipoconulídeo, entre outros (HANIHARA, 1961; TURNER *et al*., 1991; SCIULLI, 1998; AGUIRRE *et al*., 2006).

A terminologia para o ramo da antropologia não utiliza de números para especificar a posição do dente na arcada dentária. Muitos pesquisadores utilizam uma letra para indicar o dente em específico fazendo referência à sua posição na maxila ou mandíbula (S = superior; I = inferior), outra letra para descrever o tipo de dente (I = incisivo; C = canino; P = pré-molar; M = molar), e um número para indicar a posição no campo morfogenético (1 = primeiro molar; 2 = segundo molar) (SCOTT E IRISH, 2017).

As cúspides nos molares podem ser numeradas e nomeadas. Molares superiores nomeiam suas principais cúspides seguindo a nomenclatura Cope-Osborn (trígono): protocone (mesiolingual), paracone (mesiovestibular) e metacone (distovestibular) (GREGORY, 1916). A última grande cúspide adicionada durante a evolução dos primatas é o hipocone (distolingual). Molares inferiores nomeiam suas cúspides a partir dos autores Osborn (1897) e Gregory e Hellman (1926): protoconídeo (mesiovestibular), metaconídeo (mesiolingual), hipoconídeo (distovestibular ou mediana), entoconídeo (distolingual). A última cúspide adicionada durante a evolução dos primatas é o hipoconulídeo (distovestibular) (SCOTT E IRISH, 2017).

As cúspides dos molares estão numeradas em relação à sua presença aparente no registro fóssil dos mamíferos. Nos molares superiores consideramos: protocone (1), paracone (2), metacone (3), hipocone (4) e como cúspide acessória o metacónulo (5). Nos molares inferiores consideramos: protoconídeo (1), metaconídeo (2), hipoconídeo (3), entoconídeo (4), hipoconulídeo (5) e como cúspides acessórias temos entoconulídeo (6) e metaconulídeo (7) (SCOTT E IRISH, 2017).

Além da intenção de realizar estudos para distinguir populações, traços morfológicos começaram a ser incluídos em pesquisas para compreender e analisar expressão genética (DAHLBERG, 1945; TURNER, 1967; AGUIRRE *et al.*, 2006; KIMURA *et al.*, 2015). É reconhecida a presença de diferentes graus de expressão e frequência na variação dos dentes em diferentes populações (LOH,1991). Há evidências de que essas múltiplas variações são multifatoriais (LEE E GOOSE, 1972). Scott e Pilloud (2018) cita que a morfologia dental consiste em elementos diferentes para pessoas diferentes.

A análise da morfologia dentária investiga a frequência, a existência de dimorfismo sexual e simetria bilateral de NDCT em dentes permanentes e decíduos (DÍAZ *et al.*, 2014), explorando os graus das expressões desses traços (LOH, 1991; SCOTT E PILLOUD, 2018) e permitindo a comparação entre diferentes populações. É importante destacar que embora os estudos de morfologia dentária não sejam novos, existem apenas poucos estudos que investigaram a anatomia dos molares em humanos (AGUIRRE, *et al.*, 2006; FELEMBAN E MANJUNATHA, 2017; VENKATESH *et al.*, 2019; SUJITHA *et al.*, 2021). A investigação desses traços em diferentes populações é necessária para contribuir na elucidação dos aspectos funcionais e evolutivos da variação humana (LOH,1991; SCOTT E PILLOUD, 2018).

Portanto, este estudo teve como objetivo investigar a frequência e variação de 13 NDCT em molares permanentes e decíduos em sujeitos alemães vivos. Além disso, também foi investigado a presença de simetria bilateral e dimorfismo sexual.

2 OBJETIVOS

2.1 OBJETIVO GERAL

O objetivo do presente estudo foi investigar a frequência e a variação de 13 traços não métricos da coroa dental em molares permanentes e decíduos em sujeitos alemães vivos.

2.2 OBJETIVOS ESPECÍFICOS

Investigar a presença e a frequência de simetria bilateral.

Investigar a presença de dimorfismo sexual.

3 JUSTIFICATIVA

Apesar de estudos da morfologia dental não serem novos, há poucos estudos que avaliam a frequência de traços morfológicos dos molares em humanos e a avaliação desses traços em diferentes populações é necessária. Portanto, este trabalho tem como justificativa realizar a avaliação da frequência e variabilidade de traços não métricos da coroa de molares permanentes e decíduos em um grupo alemão e assim contribuir na elucidação dos aspectos funcionais e evolutivos da variação humana.

4 CAPÍTULO 1

Assessing the frequency and variability of non-metric crown traits of permanent and primary molars in a German group

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5 ABSTRACT

Background

The present study aimed to assess the frequency and variation of 13 Non-Metrical Crown Traits (NDCT) in permanent and primary molars in living German subjects.

Methods

Dental records from 163 individuals (82 males and 81 females) aged 8 to 14 years were evaluated. First and second permanent and primary upper and lower molars (from left and right sides) were assessed. Teeth with cavitated dental caries, occlusal wear, restorations and obvious dental deformities were not evaluated. The NDCT for permanent molars were identified and scored according to the odontoscopic system developed by Arizona State University Dental Anthropology System (ASUDAS). The NDCT for primary molars were identified and scored according to ASUDAS, Hanihara method and Sciulli method. Chi-squared test was used to investigate side preference and sexual dimorphism at a significance level of $p \leq 0.050$.

Results

A sexual dimorphism was observed for the hypocone in first upper permanent molar (p=0.041). The protostylid was observed in lower permanent molars (ranging from 2.1-10%). Males presented more hypoconulid than females (p=0.019). Only females presented the distal trigonid crest in lower first permanent molars (p=0.002). The most common groove pattern in primary molars was Y, male presented more Y grade than females in the lower second primary molar (p=0.039). Asymmetry was observed in some traits, ranging from 0% to 100%.

Conclusion

The present study showed the frequency of NDCT of molars and demonstrated that some traits present sexual dimorphism.

Keywords: Anthropology; Dentition, Permanent; Molar; Tooth Crown; Tooth, Deciduous.

***Abbreviations**:* NDCT, Non-metrical dental crown traits; ASUDAS, Arizona State University Dental Anthropology System; UM, Permanent upper molar; LM, Permanent lower molar; um, Deciduous upper molar; lm, Deciduous lower molar; 1, First molar; 2, Second molar; (r), Right; (l), Left; UM1, Permanent upper fisrt molar; UM2, Permanent upper second molar; LM1, Permanent lower first molar; LM2, Permanent lower second molar; um1, Primary upper fisrt molar; um2, Primary upper second molar; lm1, Primary lower first molar; lm2, Primary lower second molar.

6 INTRODUCTION

Molars are the largest teeth in the oral cavity. Human molars are found in the permanent and primary dentition and present a morphological variation that ranges in size and shape (Cunha et al., 2020a; Cunha et al., 2020b). The human dental morphology, particularly the molars' morphology, has been described as presenting several parameters with a variety of morphological traits (Kondo, Morita and Ohshima, 2022; Popovici et al., 2023). The study of the crown morphology, including the identification of the molars' traits, is based on the evaluation of the occlusal surfaces (Aoki and Ito, 2022). Morphological categories have been used over the past century to describe non-metric dental crown traits (NDCT) in occlusal surfaces of the mandibular and maxillary molars (Hrdlička,1920; Dahlberg, 1956; Hanihara, 1961; Turner et al., 1991).

The first study of dental morphological characteristics in humans was reported by Hrdlička in 1920. This author described different expressions of a shovel shape on upper permanent incisors, in which the trait ranged from minimal to maximal expression (Hrdlička,1920; Turner et al., 1991; Scott et al., 2018b). Dahlberg (1956) introduced scales with grades of trait expressions and a series of standardized plaques to study teeth's morphological variations, such as carabelli trait, protostylid and hypocone (Scoot et al., 2018b). In 1961, Hanihara published an important study describing new classifications of morphological traits of the molars on primary dentition, as well as the crown pattern and distal trigonid crest. Turner et al. (1991) developed a dental system for permanent molars called the ASUDAS (Arizona State University Dental Anthropology System) with an extensive series of crown and root trait classifications, which is currently the most widely used system for scoring dental morphology. The use of these systems in dental and anthropological research allows replicability among observers, and they produce data that express the variation tendency of all NDCT present on the molar crown (Turner et al., 1991; Scoot et al., 2018b, López-Onaindia et al., 2022).

The analysis of dental morphology aims to explore the frequency, the existence of sexual dimorphism and bilateral symmetry of NDCT in permanent and primary teeth (Díaz et al., 2014), evaluating the degrees of expression of these traits (Loh,1991; Scott and Pilloud, 2018a) and allowing the comparison among different populations. It is important to highlight that although dental morphology studies are not new, there are only few studies that investigated molars' anatomy in humans (Aguirre, et al., 2006; Felemban and Manjunatha, 2017; Venkatesh et al., 2019; Sujitha et al., 2021), and the investigation of these traits in different populations are necessary (Loh, 1991; Scott and Pilloud, 2018a). Therefore, this study aimed to investigate the frequency and variation of 13 NDCT in permanent and primary molars in living German subjects. Additionally, the presence of bilateral symmetry and sexual dimorphism was also investigated.

7 MATERIAL AND METHODS

7.1Population and sampling

This descriptive cross-sectional study was approved by the institutional review board from the University of Regensburg (approval number ID: 19-1549-101). All included subjects and/or their legal guardians signed the informed consent prior to the inclusion in the study. Age-appropriate assent documents were also used for individuals younger than 14 years. This project was performed according to the Helsinki Declaration. This study was reported following the Statement of Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) (Vandenbroucke et al., 2007).

Dental casts (orthodontic diagnostic casts) from individuals (children older than 8 years old and teenagers) undergoing orthodontic treatment were consecutively selected by convenience at the University of Regensburg and private orthodontic practices in Regensburg-Germany. Dental cast from patients with syndromes, oral cleft, congenital alterations including tooth agenesis (except for third molar agenesis), and severe bruxism with dental tissue loss were excluded to prevent distortion of the data. To maximize data interpretability, only patients with a Middle-European ancestry (at maximum one grandparent not from Middle Europe) were included. Included individuals should have at least one set (maxilla and mandible) of dental casts. Some individuals presented more than one set of dental cast (at different ages and from different stages of the orthodontic treatment), in these cases, both dental casts were assessed in order to evaluate the majority of molars possible (primary and permanent), however, each tooth was evaluated only once.

7.2 Morphological analysis

All dental casts were scanned and processed into the software using the 3-D measuring OrthoXScan 2.8 of Dentaurum (Ispringen, Germany). The software OnyxCeph³™ (version 3.2.52) (Image Instruments GmbH, Chemnitz, Germany) was used to take images of the molars from the virtual 3D casts. First and second permanent and primary maxillary and mandibular molars (from left and right side) were assessed. Teeth with cavitated dental caries, occlusal wear, restorations and obvious dental deformities were not evaluated.

The NDCT for permanent molars were identified and scored according to the odontoscopic system developed from Arizona State University Dental Anthropology System (ASUDAS) (Turner et al., 1991). The ASUDAS uses standard recording forms to evaluate traits and the variability of their expressions, which are shown in **Table 1** and illustrated in **Figure 1**. For the hypocone trait, grades 1 and 2, and grades 3 and 4 were grouped and assessed as having the same degree of expression. The name and position of each cusp are also illustrated in **Figure 1**.

The NDCT for primary molars were identified and scored according to the ASUDAS (Turner et al., 1991), Hanihara (1961) and Sciulli methods (1998). The evaluated traits and the variability of their expressions are shown in **Table 2** and illustrated in **Figure 2**. The name and position of each cusp are illustrated in **Figure 2**.

To describe the jaw, letters were used: **UM** for permanent upper molar, **um** for primary upper molar, and **LM** for permanent lower molar, **lm** for a primary lower molar. To describe the tooth position, numbers were used: **1** for the first molar, and **2** for the second molar (Scott and Irish, 2017).

All analyses were performed by one single trained and calibrated examiner. The Kappa test for intra-observer reliability was performed, in which the assessments were carried out twice by the same examiner within a 2-week interval. The kappa values for agreement ranged from 0.71 to 1.00.

7.3 Statistical analysis

The prevalence of each trait as well as each variability expression were described. Left-right symmetry/asymmetry were evaluated only in subjects that presented the molar and its contralateral available for analysis. Also, symmetry and asymmetry were only investigated when the trait (regardless the expression) was present.

Chi-squared test was used to investigate, if there is a side (laterality) and/or gender (sexual dimorphism) preference. The odds ratio (OR) and 95% confidence interval (CI) were also calculated. Data were analyzed using the software PRISM 9 (GraphPad Software, 9.0) at a significance level of $p \leq 0.050$.

8 RESULTS

Dental records from 163 individuals (82 males and 81 females) were included, in primary molars, a total of 40 um1 (r), 39 um1 (l), 65 um2 (r), 68 um2 (l), 32 lm1 (r), 37 lm1 (l), 59 lm2 (r), and 64 lm2 (l). In permanent molars, a total of 162 UM1 (r), 162 UM1 (l), 160 UM2 (r), 158 UM2 (l), 160 LM1 (r), 160 LM1 (l), 149 LM2 (r), and 143 LM2 (l) were investigated. Their age ranged from 8 to 14 years, and they were in mixed or permanent dentition.

The prevalence of each trait in UM is presented in the **Table 3**. The most common cusp was the metacone, in which none of the UM showed the absence of metacone (grade 0). The grade 4/5 of hypocone was highly prevalent in UM1. In Carabelli trait negative expression traits (grades 1 to 4) were more frequent compared to positive expressions (grades 5 to 7). The metaconule trait presented low frequency in UM. The parastyle cusp was highly uncommon, only 2 teeth were affected. A sexual dimorphism was observed for the hypocone in UM1, in which only females presented reduced expression of the traits (p=0.041) (the whole data are presented in **Supplementary Table 1**).

The prevalence of each trait in LM is presented in **Table 4**. In LM1 the Y groove pattern was the most commonly observed. The hypoconulid was highly prevalent in LM1. Cusp 6 was an uncommon trait and appeared only in LM1. A similar pattern was observed in cusp 7, however, 4 teeth in LM2 presented the trait. The protostylid (a pit feature) was observed in LM1 and LM2 (LM1r = 10.0%; LM1l = 8.7%; LM2r = 2.1%; and LM2l = 2.1%). Anterior fovea was observed in about half of the teeth. Deflecting wrinkles were highly frequent in LM1. The distal trigonid crest was not a common trait. Males presented more hypoconulids than females, when the analysis is performed grouping grades 1-5 compared with grade 0, males (11.3%) presented statistically more hypoconulid traits than females (2.8%) (p=0.019; OR = 4.2, CI 95% = 1.3-14.3). Gender differences were also observed for cusp 7, in which only males presented the trait in LM2 (p=0.050). On the other hand, the distal trigonid crest was more common in females. In the LM1 only females (6.2%) presented the distal trigonid crest (p=0.002). In the LM2 the prevalence of distal trigonid crest was 8.2% in males, but 24.1% in females (p=0.0003; OR=3.6, CI95%=1.7-7.0) (the whole data are presented in **Supplementary Table 2**).

The prevalence of each trait for um is presented in **Table 5**. The Carabelli trait was observed only in um2. The most common crown pattern in um1 was the protocone and paracone; and large hypocone in um2. Metaconule cusp was a rare found, and parastyle trait was absent in the sample. There was no gender or side preference observed in primary molars (the whole data are presented in **Supplementary Table 3**).

The prevalence of each trait for lm is presented in **Table 6**. The most common groove pattern was Y (in which cusps 2 and 3 are in contact). Hypoconulid appeared in all lm2. Cusp 6 and cusp 7 were uncommon traits and were observed only in lm2. Protostylid was an uncommon trait in lm1, but a common trait in lm2. The presence of the different expressions of anterior fovea was prevalent in lm2. The central ridge of metaconid showed that this trait described as the ‘cusp 2 ridge is similar to the other cusp’ is more prevalent in lm1 and lm2. The distal trigonid crest was an uncommon trait in lm1 and lm2. Gender difference was present for groove pattern, in which males presented more Y grade and females more + grade in lm2 (p=0.039). Side preferences were not observed (the whole data are presented in **Supplementary Table 4**).

Asymmetry was observed in some traits in low frequency, as follows: for Carabelli’s trait in um2 (12.5%), UM1 (21.1%); hypocone in UM2 (17.5%); groove pattern in LM1(4.2%), LM2 (8.4%), lm1 (5.6%), lm2 (3.2%); hypoconulid in LM1 (7.1%); LM2 (57.1%), lm1 (25%); protostylid in lm2 (6.9%); anterior fovea in LM1 (4.7%), LM2 (10.9%), lm2 (0.03%); deflecting wrinkle in LM1 (17.2%); LM2 (11.8%); and central ridge of the metaconid in lm2 (5%). Other traits presented high prevalence of asymmetry: Carabelli’s trait in UM2 (40.0%); metaconule in UM1 (40.0%), UM2 (66.7%), um2 (100%); cusp 6 in LM1 (40.0%), lm2 (100%); cusp 7 in LM1 (85.7%), lm2 (53.8%); protostylid in LM1 (33.3%), LM2 (50%) and distal trigonid crest in LM2 (55.2%). Trait asymmetry was not present in metacone, crown pattern and parastyle in UM2.

9 DISCUSSION

The present study investigated the frequency and variability of non-metric permanent and primary molars’ crown traits. Additionally, the presence of laterality and sexual dimorphism were also investigated. Although several studies have been focusing on specific traits, such as Carabelli’s trait (Bhavyaa et al., 2021), so far, only few studies have been converging many aspects of dental morphology in living humans, and these studies investigated only few populations and ethnicities, such as Venkatesh et al. (2019) and Sujitha et al. (2021) that evaluated populations from India, Felemban and Manjunatha (2017) that examined a sample from Saudi Arabian, and Aguirre et al. (2006) a sample from Colombia. Therefore, in the present study, we investigated a sample of German children and teenagers in order to access molar morphology in a population with a Middle-European ancestry. One important aspect to be emphasized is that dental morphology is studied from an interdisciplinary viewpoint, such as anthropology, dentistry, paleopathology, archeology and forensic science, and to investigate dental traits requires a comprehensive knowledge of morphology, comparative anatomy, and function (Kondo, Morita and Ohshima, 2022; Keil, et al., 2022). Anthropology is the study of human variation and evolution. Dental anthropology is a branch, which focuses on investigating the human dentition. Dental anthropology involves the study of the origin and variations of the human dentition, including the identification of structures such as cusp size, number and location of cusps, occlusal pattern, root configuration, number and position of teeth, and individual measurements (Loh, 1991; Turner, 1967; Aguirre et al., 2006). In our study, we used similar methods to investigate the frequency, the sexual dimorphism and the left-right symmetry of molar traits.

One of the most well-known methods for assessing the morphology of the permanent dentition is the 'Arizona State University Dental Anthropology System' (ASUDAS) (Turner et al., 1991) that describes dental root and crown. A tooth is split into two main parts: the root and the crown, and cusp is the singular part constituting the crown in addition to essential lobes and ridges (Aguirre et al.; 2006; Kondo, Morita and Ohshima, 2022) composing the NDCT. In our study, we used ASUDAS to access and describe 13 NDCT of the permanent dentition, including Carabelli's trait, metacone, hypocone, metaconule, parastyle, groove pattern, hypoconulid, cusp 6, cusp 7, protostylid, anterior fovea, deflecting wrinkle and distal trigonid crest. For primary dentition, different methods have been proposed to classify primary molars. So, additionally to ASUDAS (Turner et al., 1991), we also used other methods to access NDCT in primary molars (Hanihara, 1961; Sciulli, 1998). The NDCT for primary molars were identified and scored according to ASUDAS (Turner et al., 1991), Hanihara method (1961) was used for the crown pattern of 1st an 2nd upper molar, cusp 7, central ridge of the metaconid and distal trigonid crest. For Carabelli's trait, metaconule and hypoconulid classification, the Sciulli method (1998) was used, and for parastyle, groove pattern, cusp 6, protostylid and anterior fovea the ASDUDAS system was used. The three studies established systems for classification allowing measurement of minimal and maximal trait expressions and degrees between these two points (Scott and Irish, 2017). It is important to highlight the importance of using the same method of classification for the permanent and primary dentition (Sujitha et al., 2021) for some traits observed in both dentitions.

According to Scott and Pilloud (2018a), over 90% of the published manuscripts on human dental morphology focus on permanent teeth, despite primary teeth offer another perspective on morphological variation. It has been described that primary teeth hold more primitive traits than permanent teeth (Kondo, Morita and Ohshima, 2022). Classic studies from the past century stated that teeth are independent of each other in variation and evolution (Butler, 1939). Butler (1939) and Dahlberg (1945) published studies describing the role of cusp variations as a field effect. The most distal member on the tooth crown is the most variable element. In our study third molars were not included. In our samples, some traits were more frequent in the second molars, while others were more frequent in first molars, such as

Carabelli's trait in permanent molars. Carabelli's trait is a singular derivate expressed on the lingual surface of the protocone and researchers assumed for decades that this is a feature of European-descendant dentition, however, this latter trait was identified in other populations (Scott, 1980; Scott and Irish, 2017). In our sample, the prevalence of Carabelli's trait was high in UM1. In the primary dentition, Carabelli's trait is observed only in um2. A recent systematic review and meta-analysis from Bhavyaa et al. (2021) observed a similar prevalence. For um2 the authors reported an estimated prevalence of 72%, likewise the overall prevalence was 59% for UM1 and 8% for UM2. Also, the subgroup analysis showed that the European continent reported the highest prevalence of Carabelli's trait (Bhavyaa et al., 2021). Interestingly, Neanderthals are characterized by the presence of a larger Carabelli trait (Fiorenza et al., 2020).

Upper molars have 3 major main cusps and one of them is the metacone (cusp 3) (Gregory, 1916). The last major cusp added during primate evolution is the hypocone (cusp 4) (Scott and Irish, 2017). The metaconule (cusp 5) is an occlusal cusp on the distal border (Harris and Bailit, 1980). In our study we observed mesial cusps, such as metacone (cusp 3), demonstrating less variation as compared to distal cusps, such as hypocone (cusp 4) and metaconule (cusp 5). Metacone (cusp 3) was prevalent in grades 4 and 5. Yadav et al. (2015) showed similar frequencies for these traits in Indians. In the primary dentition, our results showed low prevalence of metacone (cusp 3) in um1 and higher prevalence of the hypocone (cusp 4) in um2. Sujitha et al. (2021) also investigated Indians and reported that metacone (cusp 3) had a high frequency in um1. The parastyle is an accessory cusp on the mesiobuccal surface of upper molars and sometimes linked to Bolk's paramolar tubercle (Turner et al., 1991). This morphological trait had frequencies below 10% (Scott and Irish, 2017), and indeed, in our study only one case was observed in UM2.

Lower molar cusp number depends on the presence of cusp 5, or the hypoconulid. Each cusp is named and numbered. The last major cusp added during primate evolution is the hypoconulid (cusp 5) as a distal cusp integrated more closely with the hypoconid (cusp 3) than entoconid (cusp 4) (Scott and Irish, 2017). In the present study, the frequency of five-cusped molars was predominant on LM1 and lm2. Previous studies support the same result in other populations (Khraisat et al., 2013; Díaz et al., 2014; Sujitha et al., 2021). Cusp 6, or the entoconulid, is a supernumerary cusp positioned on the distal portion and associated with the entoconid (cusp 4) (Scott and Irish, 2017). Similar to that found in Europeans (5-15%) (Scott and Irish, 2017) and in agreement with Kirthiga et al. (2015), our study showed a frequency of 5% on LM1. Primary dentition had only one case, which was different from the previous studies that showed a frequency higher than 5% (Kirthiga et al., 2015; Sujitha et al., 2021), this difference could be explained by the population difference or by the sample size that was small for primary teeth in our study.

Gregory and Hellman (1926) noted a distinct pattern in terms of contact between major cusps of lower molars. This trait is one of the earliest morphological features described and classified. As the Y pattern is close to 100% on LM1 of all human groups, Scott and Turner (1997) designated the LM2 as key tooth for scoring groove pattern. In the present study, the highest frequency on LM2 was the pattern + (41.0% to 45.1%), followed by the pattern Y (27.3% to 27.8%). Our results agreed with previous studies (Díaz et al., 2014; Dholia and Manjunatha, 2015; Scott and Irish, 2017). The pattern Y was more prevalent in lm1 (95.2% to 95.5%). Other studies also supported that pattern Y was more frequent on LM1(Dholia and Manjunatha, 2015) and lm2 (Díaz et al., 2014).

A second supernumerary cusp of the lower molar is cusp 7, or metaconulid, expressed between metaconid (cusps 2) and entoconid (cusp 4). Cusp 7 is relatively rare ranging from 3% to 8% worldwide (Scott and Irish, 2017), which is in agreement with the prevalence observed in our study. In contrast to the permanent dentition and similar to previously studies, the frequency on lm2 was higher ranging from 17.2% to 15.8% (Aguirre et al., 2006; Díaz et al., 2014). Different methods to classify the permanent and primary dentition were used (Hanihara, 1961; Turner et al., 1991), although both considered similar features from cusp 7.

The protostylid trait occurs on the buccal surface of the mesiobuccal cusp or protoconid (cusp 1) and is a cingular derivative as Carabelli's trait (Scott and Irish, 2017). It is important to highlight that the two traits are linked to some extent, reflected by a long term developmental in the modern human (Scott, 1978). The present study reported in lm2 negative expression. Díaz et al. (2014) indicated a high prevalence of this trait on lm2, whereas Sujitha et al. (2021) showed a low prevalence. The protostylid was more common in Australopithecines than in modern humans (Hlusko, 2004).

The major mesial cusps of the lower molars, protoconid (cusp 1) and metaconid (cusp 2), from the trigonid and they can exhibit connected ridges (Scott and Irish, 2017). When the distal accessory ridges run a direct path along the distal portion of the cusps (protoconid and metaconid) and come in contact at a point close to the central occlusal sulcus, the distal trigonid crest is present (Hanihara,1961). This trait is not common in modern humans and was found by Weidenreich (1937) on lm2. The noteworthy reduction in trigonid crest prevalence is one hallmark of the modern human dentition (Scott and Irish, 2017). In the present study, the prevalence was 2.9% (LM1) and 18.7% (LM2) in permanent dentition and 5.4% (lm2) to 8.8% (lm1) in the primary dentition. Hanihara (1961) reported results similar to our study, whereas

King, Tongkoom and Wong (2010) (in a Chinese population) and Sujitha et al. (2021) (in an Indian population) reported higher prevalences (33.6% and 65.25% to 93.06%, respectively).

Deflector wrinkle and central ridge of the metaconid are different terms, but all relate to a common feature on lower molars (Hanihara, 1961; Turner et al., 1991). This trait is expressed on the occlusal surface of metaconid (cusp 2) and is considered a manifestation of the essential ridge. In most instances, this ridge runs from the cusp tip to the central occlusal fossa. The deflecting wrinkles present a wide result variation of the results ranging from lower and high prevalence on a global level (Scott and Irish, 2017). Our study showed more prevalence of presence degrees on LM1 (66.4% and 68.1%). King, Tongkoom and Wong (2010) and Sujitha et al. (2021) evaluated also the primary dentition using the NDCT classification for the permanent dentition (Turner et al., 1991). In their results, deflecting wrinkle was higher on lm2 (63.0% and 87.4% respectively) differing from our study (5.4% and 7.9%). A possible explanation for these result differences may be the variability in the methods used.

The anterior fovea is a polymorphic trait present in the mesial ridges aspect on the protoconid (cusp 1) and metaconid (cusp 2) (Hrdlička, 1924). Data for this feature have not been tabulated on a world scale owing to Turner et al. (1991) did not consider the anterior fovea as one of Turner’s key 29 traits. Our study had prevalent results from presence of different degrees on lm2, LM1 and LM2. It has been reported that Europeans have higher frequencies of this trait in lower molars (Scott and Irish, 2017).

Left-right asymmetry is observed in many conditions, including tooth agenesis and tooth morphological alterations, such as microdontia (Küchler, et al., 2008). Deviation from perfect symmetry expressed by changes in structure, as seen in dental morphology studies, is called fluctuating asymmetry (Townsend, 1981; Aguirre et al., 2006; Kondo, Morita and Ohshima, 2022). In our study, the Carabelli trait, metaconule (cusp 5), hypoconulid (cusp 5), cusp 6, cusp 7, protostylid and distal trigonid crest were very often observed to be asymmetrical. However, a statistically significant difference was not observed between left and right teeth, showing no side preference.

The investigation of the difference in morphological characteristics of teeth between men and women corroborates the elucidation of sexual dimorphism. Sexual dimorphism is known to be more significant in areas of the dental crown that have a later development (Kieser, 1990; Kondo, Morita and Ohshima, 2022), which explains our results that observed a male-female difference in permanent molars. Dental development is influenced by genes located in X and Y chromosomes. The X chromosome is associated with enamel thickness, while the Y chromosome promotes growth of enamel and dentin thickness (Alvesalo, 1997; Alvesalo, 2009; Kondo, Morita and Ohshima, 2022). The morphological structure, in terms of size and shape of the cusps, is influenced by the sex chromosomes in the formation of their phenotype, although they may not be equally influenced in the formation of enamel and dentin (Mayhall and Alvesalo, 1992; Alvesalo, 2009; López-Lázaro et al., 2018; Nakayama et al., 2018). In our study, gender difference was observed for hypocone, groove pattern, distal trigonid crest and cusp 7, which suggests that sexual chromosomes are carrying markers for these traits.

10 CONCLUSION

The present study showed the frequency of NDCT of primary and permanent molars and demonstrated that some traits present sexual dimorphism in the permanent and primary teeth.

11 ETHICAL STATEMENT

This research project was approved by the institutional review board from the University of Regensburg (approval number ID: 19-1549-101). This project was performed according to the Helsinki Declaration. The guideline STROBE (STrengthening the Reporting of OBservational studies in Epidemiology) was followed for this study.

12 ACKNOWLEDGEMENTS

Not applicable.

13 CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

14 FUNDING

This work was supported by Alexander von Humboldt Foundation of Germany and Coordenação de Aperfeiçoamento de Pessoa de Nível Superior - Brasil (CAPES - Finance Code 001).

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TABLES

Table 1. Classification used to assess the morphology of the permanent upper and lower molars.

TRAIT	FEATURES	GRADE
Carabelli's trait(UM)	It occurs on the lingual surface of the protocone (mesiolingual cusp) and is expressed from complete absence, groove or pit (regarded a negative expression) to a large cusp (positive expression).	**0.** Smooth mesiolingual surface; **1.** Vertical groove present; **2.** Pit present; **3.** Small Y-shaped depression; **4.** Large Y-shaped depression; **5.** Small cusp without free apex; **6.** Medium cusp with free apex making contact with the medial lingual groove; **7.** Large free cusp.
Metacone(UM)	The upper molar has 3 major main cusps regarding the metacone cusp. It is named the distobuccal cusp or cusp 3.	**0.** Absent; **1**. There is a ridge but no free apex; **2.** Faint cuspule with a free apex; **3.** Weak cusp; **3.5.** Intermediate-sized cusp that falls between grades 3 and 4; **4.** Large cusp; **5.** Very large cusp, equal in size to a large hypocone.
Hypocone(UM)	The distolingual cusp is derived from the cingulum and attached to the distolingual surface of the trigon (protocone or cusp 1, paracone or cusp 2 and metacone or cusp 3).	**0.** Smooth surface; **1.** Faint ridge; **2.** Faint cuspule; **3.** Small cusp; **3.5.** Moderate-sized cusp; **4.** Large cusp; **5.** Very large cusp.
Metaconule(UM)	A 5th cusp on the distal border between the metacone (cusp 3) and hypocone (cusp 4). The cusp shows two parallel vertical grooves.	**0.** Trait is absent; **1.** Faint cuspule; **2.** Trace cuspule; **3.** Small cuspule; **4.** Small cusp; **5.** Medium-sized cusp.
Parastyle(UM)	It is most commonly expressed on the paracone (mesiobuccal cusp or cusp 2). In some instances, it occurs on the metacone (cusp 3).	**0**. Smooth buccal surface; **1**. A small pit near the buccal groove; **2**. Small cusp without free apex; **3**. Medium cusp with free apex; **4**. Large cusp with free apex; **5**. Very large cusp that may extend onto the surfaces of both cusps 2 and 3; **6**. Peg-shaped crown attached to root of second or third molar
Groove pattern(LM)	Lower molars can have 5 cusps: cusp 1 (protoconid), cusp 2 (metaconid), cusp 3 (hypoconid), cusp 4 (entoconid) and cusp 5 (hypoconulid). The cusps can make contacts creating patterns.	**Y**. Cusps 2 and 3 are in contact; **+**. Cusps 1–4 are in contact; **X**. Cusps 1 and 4 are in contact.
Hypoconulid(LM)	The cusp 5 occurs on the distal occlusal surface and it associated with cusp 3 (hypoconid).	**0.** Absent. The molar has only 4 cusps; **1.** Very small; **2.** Small;

		3. Medium-sized; **4.** Large; **5.** Very large.
Cusp 6(LM)	This cusp is expressed on the distal portion, but it is associated with the cusp 4 (entoconid). It is important to note that cusp 5 (hypoconulid) has to be present.	**0**. Absent; **1**.Much smaller than cusp 5; **2**.Smaller than cusp 5; **3**.Equal in size to cusp 5; **4**.Large than cusp 5; **5**.Much larger than cusp 5.
Cusp 7(LM)	It is a wedge-shaped accessory cusp expressed in the lingual groove between cusps 2 (metaconid) and 4 (entoconid). Cusp 7 is never considered in determining cusp number.	**0.** Absent; **1.**Faint cusp, two weak lingual grooves; **1A.** Faint tipless displaced on the lingual surface of cusp 2; **2.** Small; **3.** Medium-sized; **4.** Large.
Protostylid(LM)	This trait is a cingular derivate on the buccal surface associated with the buccal groove, particularly separating cusp 1 (protoconid) and cusp 3 (hypoconid).	**0**. Smooth surface; **1**. Pit present; **2**. Buccal groove curve distal; **3**. Faint groove extending mesial from the buccal groove; **4**. Groove more pronounced; **5**. Groove stronger; **6**. Groove extend across the buccal surface; **7**. Free cusp.
Anterior Fovea(LM)	This trait is expressed on the mesial occlusal surface. It involves distinct essential ridges on cusp 1 (protoconid) and cusp 2 (metaconid) that meet close to the center of the trigonid, and a mesial marginal ridge that is expressed to varying degrees.	**0**. Absent; **1**.Trace, with a weak ridge connecting the mesial aspects; **2**.Essential ridges on trigonid better developed and resulting groove deeper than in grade 1; **3.**Essential ridges pronounced and marginal ridge well developed, producing a distinctive fovea on the anterior portion of the trigonid; **4**. The mesial ridge is robust and the marginal ridge produces a well-defined fovea with a very long groove.
Deflecting Wrinkle(LM)	The form of manifestation of the essential medial ridge on cusp 2 (metaconid).	**0**. Absent; **1.** The essential ridge is straight and shows a midpoint constriction; **2.** The essential ridge is deflected distally. There is no contact with cusp 4 (entoconid); **3.** The essential ridge shows strong deflection at the midpoint forming an L-shaped ridge. There is contact with cusp 4 (entoconid).
Distal Trigonid Crest(LM)	The major mesial cusps of the trigonid (protoconid or cusps 1, and metaconid or cusp 2) express distal accessory ridges that are directly connected along the distal portion of the cusps. They can be continuous or discontinuous.	**0**. Absent; **1**. Present: distal borders are connected by a ridge.

Note: ASUDAS methods was used (Turner et al.1991); (UM) means permanent upper molar; (LM) means permanent lower molar.

Table 2. Classification used to assess the morphology of the primary upper and lower molars.

TRAIT	FEATURES	GRADE
Carabelli's trait[3] (um)	It occurs on the lingual surface of the protocone (mesiolingual cusp). This tuberculum projection is expressed from complete absence, groove or pit to a large cusp.	**0**.Smooth surface; **1**.Pit, groove; **2**.Two grooves are roughly parallel; **3**.The area between grooves raised, apex not free; **4**.The expression is similar to type 3 but there is a free apex.
Crown Pattern 1st molar[2] (um)	The pattern is based on the development of the crown cusps of the upper 1st deciduous molars.	**2**. Protocone and paracone; **3M**. Protocone,paracone and metacone; **3H**. Protocone, paracone and hypocone; **4–**. All four cusps but hypocone reduced; **4**. All four cusps but hypocone not reduce.
Crown Pattern 2nd molar[2] (um)	The pattern is based on the development of the crown cusps of the upper 2nd deciduous molars.	**3**. Protocone, paracone, metacone, and a small hypocone. The distal marginal ridge can be interrupted by a groove. **4–**. Protocone, paracone, metacone, and a small hypocone. The distal marginal ridge follows its course without interruption; **4**. Protocone, paracone, metacone, and large hypocone.
Metaconule[3] (um)	A 5th cusp on the distal border between the metacone and hypocone. The cusp shows two parallel vertical grooves.	**0**. Absent; **P**. Present.
Parastyle[1] (um)	It is most common expressed on the paracone (mesiobuccal cusp). In some instances, it occurs on the metacone.	**0**. Smooth buccal surface; **1**. A small pit near the buccal groove; **2**. Small cusp without free apex; **3**. Medium cusp with free apex; **4**. Large cusp with free apex; **5**. Very large cusp that may extend onto the surfaces of both cusps 2 (paracone) and 3 (metacone); **6**. Peg-shaped crown attached to root of second or third molar.
Groove pattern[1] (lm)	Lower molars can have 5 cusps: cusp 1 (protoconid), cusp 2 (metaconid), cusp 3 (hypoconid), cusp 4 (entoconid) and cusp 5 (hypoconulid). The cusps can make contacts creating patterns.	**Y**. Cusps 2 and 3 are in contact; +. Cusps 1–4 are in contact; **X**. Cusps 1 and 4 are in contact.
Hypoconulid[3] (lm)	The cusp 5 occurs on the distal occlusal surface and is associated with cusp 3 (hypoconid).	**0**. Absent; **P**. Present;
Cusp 6[1] (lm)	This cusp is expressed on the distal portion, but it is associated with the cusp 4 (entoconid). It is important to note that cusp 5 (hypoconulid) has to be present.	**0**. Absent; **1**.Much smaller than cusp 5; **2**.Smaller than cusp 5; **3**.Equal in size to cusp 5; **4**.Large than cusp 5; **5**.Much larger than cusp 5.
Cusp 7[2] (lm)	It is a wedge-shaped accessory cusp expressed in the lingual groove between cusps 2 (metaconid) and 4 (entoconid). Cusp 7 is never considered in determining cusp number.	**0**.Absent; **1**.Only a very weak short groove extends downward from the lingual ridge of cusp 3 (hypoconid). There is no cusp; **2**.There are two grooves on the lingual surface and a small cusp is present; **3**.The cusp is well developed.

Protostylid[1] (lm)	This trait is a cingular derivate on the buccal surface associated with the buccal groove, particularly separating cusp 1(protoconid) and cusp 3 (hypoconid).	**0**. Smooth surface; **1**. Pit present; **2**. Buccal groove curve distal; **3**. Faint groove extending mesial from the buccal groove; **4**. Groove more pronounced; **5**. Groove stronger; **6**. Groove extend across the buccal surface; **7**. Free cusp.
Anterior Fovea[1] (lm)	This trait is expressed on the mesial occlusal surface. It involves distinct essential ridges on cusp 1 (protoconid) and cusp 2 (metaconid) that meet close to the center of the trigonid, and a mesial marginal ridge that is expressed to varying degrees.	**0**. Absent; **1**.Trace, with a weak ridge connecting the mesial aspects; **2**.Essential ridges on trigonid better developed and resulting groove deeper than in grade 1; **3.**Essential ridges pronounced and marginal ridge well developed, producing a distinctive fovea on the anterior portion of the trigonid; **4**. The Mesial ridge is robust and the marginal ridge produces a well-defined fovea with a very long groove.
Central Ridge of the Metaconid[2] (lm)	The form of manifestation of the essential medial ridge on cusp 2 (metaconid). This trait is the same as Deflecting Wrinkle on permanent dentition.	**1**. The essential ridge of the cusp 2 is expressed similar in size and prominence as that of the other cusps; **2**. The essential ridge is very well developed in its thickness on cusp 2 and also expands its width in the trigonid basin. The ridge sometimes seems to curve distally at its inner end.
Distal Trigonid Crest[2] (lm)	The major mesial cusps of the trigonid (cusps 1 and 2) express distal accessory ridges that are directly connected along the distal portion of the cusps. They can be continuous or discontinuous.	**0**. Absent; **1**. Present: distal borders are connected by a ridge.

Note: **(1)** means ASUDAS methods (Turner et al. ,1991); **(2)**means Hanihara methods (1961); **(3)**Sciulli methods (1998); **(um)** means deciduous upper molar; and **(lm)** means deciduous lower molar.

Table 3. Trait prevalence in the upper permanent molars

Trait / Grade	First molars		Second molars		Chi-squared test			
					(laterality)		(dimorphism)	
	UM1 (r)	UM1 (l)	UM2 (r)	UM2 (l)	UM1	UM2	UM1	UM2
CARABELLI TRAIT n(%)								
0. Smooth surface	86 (54.1)	88 (55.0)	14 (91.2)	147 (93.0)	0.985	0.910	0.637	0.279
1. Vertical groove	17 (10.7)	12 (7.5)	5 (3.1)	4 (2.5)				
2. Pit	6 (3.8)	7 (4.4)	4 (2.5)	1 (0.6)				
3. Small Y-shaped	14 (8.8)	16 (10.0)	2 (1.3)	3 (1.9)				
4. Large Y-shaped	7 (4.4)	9 (5.6)	1 (0.6)	1 (0.6)				
5. Small cusp	9 (5.7)	8 (5.0)	1 (0.6)	1 (0.6)				
6. Medium cusp	17 (10.7)	17 (10.6)	1 (0.6)	1 (0.6)				
7. Large free cusp	3 (1.9)	3 (1.9)	-	-				
METACONE n(%)								
2. Faint cuspule	-	-	-	1 (0.7)	0.850	0.713	0.791	0.698
3. Weak cusp	-	-	8 (5.3)	10 (6.8)				
4. Large cusp	20 (12.6)	21(13.3)	85 (56.3)	82 (55.8)				
5. Very large cusp	139 (87.4)	137(86.2)	58 (38.4)	54 (36.7)				
HYPOCONE n(%)								
0. Smooth surface	-	-	23 (16.5)	17 (12.7)	0.999	0.818	0.041*	0.578
1 / 2. Faint ridge and Faint cuspule	1 (0.6)	1 (0.6)	34 (24.5)	35 (26.1)				
3. Small cusp	2 (1.3)	2 (1.3)	52 (37.4)	54 (40.3)				
4 / 5. Large and very large cusp	157 (98.1)	157 (98.1)	30 (21.6)	28 (20.9)				
METACONULE n(%)								
0. Trait is absent	142 (89.9)	145 (92.4)	116 (87.2)	115 (91.3)	0.950	0.962	0.054	0.617
1. Faint cuspule	6 (3.8)	3 (1.9)	4 (3.1)	4 (3.2)				
2. Trace cuspule	5 (3.2)	4 (2.5)	7 (5.4)	5 (3.9)				
3. Small cuspule	1 (0.6)	1 (0.6)	2 (1.5)	1 (0.8)				
4. Small cusp	1 (0.6)	1 (0.6)	1 (0.75)	1 (0.8)				
5 .Medium-sized cusp	3 (1.9)	3 (1.9)	-	-				
PARASTYLE n(%)								
0. Smooth surface	162 (100.0)	162 (100.0)	158 (99.4)	154 (99.4)	-	0.999	-	0.150
4. Large cusp	-	-	1 (0.6)	1 (0.6)				

Note: U means upper, M means molar, 1 means first, 2 means second, (r) means right, and (l) means left. *means statistical significant difference ($p \leq 0.05$).

Table 4. Trait prevalence in the lower permanent molars

Trait / Grade	First molars		Second molars		Chi-squared test			
					(laterality)		(dimorphism)	
	LM1 (r)	LM1 (l)	LM2 (r)	LM2 (l)	LM1	LM2	LM1	LM2
GROOVE PATTERN n(%)								
Y. Cusps 2 and 3 are in contact	94(74.0)	97(77.6)	38(27.3)	37(27.8)	0.623	0.685	0.247	0.067
+. Cusps 1–4 are in contact	22(17.3)	21(16.8)	57(41.0)	60(45.1)				
X. Cusps 1 and 4 are in contact	11(8.7)	7(5.6)	44(31.7)	36(27.1)				
HYPOCONULID n(%)								
0. Absent	22(13.8)	19(11.9)	104(91.2)	89(94.7)	0.994	0.692	0.204	0.070
1. Very small	11(6.9)	13(8.2)	1(0.9)	1(1.1)				
2. Small	34(21.4)	33(20.8)	6(5.3)	2(2.1)				
3. Medium-sized	72(45.3)	74(46.5)	3(2.6)	2(2.1)				
4. Large	17(10.7)	17(10.7)	-	-				
5. Very large	3(1.9)	3(1.9)	-	-				
CUSP 6 n(%)								
0. Absent	150(94.3)	151(94.9)	107(100.0)	87(100.0)	0.908	-	0.168	-
1. Much smaller than cusp 5	4(2.5)	3(1.9)	-	-				
2. Smaller than cusp 5	3(1.9)	2(1.3)	-	-				
3. Equal in size to cusp 5	2(1.3)	3(1.9)	-	-				
CUSP 7 n(%)								
0. Absent	155(96.9)	157(98.1)	147(98.7)	141(98.6)	0.733	0.967	0.091	0.050*
1. Faint cusp	1(0.6)	1(0.6)	2(1.3)	2(1.4)				
2. Small	1(0.6)	-	-	-				
3. Medium-sized	2(1.3)	2(1.3)	-	-				
4. Large	1(0.6)	-	-	-				
PROTOSTYLID n(%)								
0. Smooth surface	144(90.0)	146(91.3)	141(97.9)	143(97.9)	0.701	0.986	0.701	0.999
1. Pit present	16(10.0)	14(8.7)	3(2.1)	3(2.1)				
ANTERIOR FOVEA n(%)								
0. Absent	77(55.4)	76(53.1)	66(46.1)	56(39.4)	0.983	0.708	0.591	0.184
1. Trace with a weak ridge	14(10.1)	15(10.5)	18(12.6)	19(13.4)				
2. Essential ridges on trigonid developed	43(30.9)	47(32.9)	55(38.5)	63(44.4)				
3. Essential ridges pronounced	5(3.6)	5(3.5)	4(2.8)	4(2.8)				
DEFLECTING WRINKLE n(%)								
0. Absent	45(33.6)	44(31.9)	111(77.1)	111(77.6)	0.871	0.795	0.437	0.932
1. Midpoint constriction	45(33.6)	49(35.5)	19(13.2)	21(14.7)				
2. Deflected distally	37(27.6)	35(25.4)	14(9.7)	11(7.7)				
3. L-shaped ridge	7(5.2)	10(7.2)	-	-				
DISTAL TRIGONID CREST n(%)								
0. Absent	130(97.0)	132(97.1)	123(87.2)	113(81.3)	0.983	0.172	0.002*	0.0003*
1. Present	4(2.9)	4(2.9)	18(12.8)	26(18.7)				

Note: L means lower, M means molar, 1 means first, 2 means second, (r) means right, and (l) means left. *means statistical significant difference ($p \leq 0.05$).

Table 5. Trait prevalence in the upper primary molars

Trait / Grade	First molars		Second molars		Chi-squared test			
					(laterality)		(dimorphism)	
	um1 (r)	um1 (l)	um2 (r)	um2 (l)	um1	um2	um1	um2
CARABELLI TRAIT n(%)								
0. Smooth mesiolingual surface	40(100.0)	39(100.0)	18(28.6)	21(31.8)	-	0.957	-	0.383
1. Pit, groove	-	-	26(41.3)	24(36.4)				
2. Two grooves are parallel	-	-	6(9.5)	7(10.6)				
3. The area between grooves raised	-	-	8(12.7)	10(15.1)				
4. Free apex	-	-	5(7.9)	4(6.1)				
CROWN PATTERN (first molars) n(%)								
2. Protocone and paracone	28(73.7)	27(77.1)	-	-	0.905	-	0.133	-
3M. Protocone, paracone and metacone	3(7.9)	3(8.6)	-	-				
3H. Protocone, paracone and hypocone	3(7.9)	3(8.6)	-	-				
4–. Four cusps present but hypocone reduced	4(10.5)	2(5.7)	-	-				
CROWN PATTERN (second molars) n(%)								
3. The distal marginal ridge has a groove	-	-	7(10.9)	8(12.1)	-	0.976	-	0.469
4–. Distal marginal ridge without interruption	-	-	15(23.4)	15(22.7)				
4. Large hypocone	-	-	42(65.2)	43(65.1)				
METACONULE n(%)								
0. Absent	38(100.0)	35(100.0)	61(98.4)	64(98.5)	-	0.973	-	0.227
1. Present	-	-	1(1.6)	1(1.5)				
PARASTYLE n(%)								
0. Absent	40(100.0)	39(100.0)	65(100.0)	68(100.0)	-	-	-	-

Note: u means upper, m means molar, 1 means first, 2 means second, (r) means right, and (l) means left.

Table 6. Trait prevalence in the lower primary molars

Trait / Grade	First molars		Second molars		Chi-squared test			
					(laterality)		(dimorphism)	
	lm1 (r)	lm1(l)	lm2 (r)	lm2 (l)	lm1	lm2	lm1	lm2
GROOVE PATTERN n(%)								
Y. Cusps 2 and 3 are in contact	20 (95.2)	21 (95.5)	28 (77.8)	34 (89.5)	0.973	0.290	0.701	0.039
+. Cusps 1–4 are in contact	-	-	4 (11.1)	3 (7.9)				
X. Cusps 1 and 4 are in contact	1 (4.8)	1 (4.5)	4 (11.1)	1 (2.6)				
HYPOCONULID n(%)								
0. Absent	25 (89.3)	29 (85.3)	-	-	0.640	-	0.549	-
1. Present	3 (10.7)	5 (14.7)	57 (100.0)	63(100.0)				
CUSP 6 n(%)								
0. Absent	28 (100.0)	34 (100.0)	57 (100.0)	62 (98.4)	-	0.339	-	0.275
2. Cusp 6 smaller than cusp 5	-	-	-	1 (1.6)				
CUSP 7 n(%)								
0. Absent	29 (100.0)	35 (100.0)	48 (84.2)	53 (82.8)	-	0.968	-	0.422
1. Weak short groove of cusp 3 *	-	-	8 (14.0)	10 (15.6)				
2 .Small cusp	-	-	1 (1.7)	1 (1.6)				
PROTOSTYLID n(%)								
0. Smooth surface	31 (96.9)	36 (97.3)	29 (49.1)	31 (48.4)	0.917	0.936	0.101	0.089
1. Pit present	1 (3.1)	1 (2.7)	30 (50.9)	33 (51.6)				
ANTERIOR FOVEA n(%)								
0. Absent	24 (100.0)	29 (93.6)	12 (30.0)	7 (16.7)	0.447	0.396	0.603	0.136
1. Trace with a weak ridge	-	1 (3.2)	6 (15.0)	11 (26.2)				
2. Essential ridges on trigonid developed	-	1 (3.2)	21 (52.5)	21 (50.0)				
3. Essential ridges pronounced	-	-	1 (2.5)	2 (4.8)				
4 .Well-defined fovea	-	-	-	1 (2.4)				
CENTRAL RIDGE OF METACONID n(%)								
1. Cusp 2 ridge is similar to the other cusps *	24 (92.3)	3 1(91.2)	40 (88.9)	46 (92.0)	0.875	0.605	0.065	0.934
2. Ridge is well developed and expands to trigonid ***	2 (7.7)	3 (8.8)	5 (11.1)	4 (8.0)				
DISTAL TRIGONID CREST n(%)								
0. Absent	27(93.1)	31 (91.2)	35 (94.6)	35 (92.1)	0.777	0.665	0.087	0.080
1.Distal borders are connected by a ridge	2 (6.9)	3 (8.8)	2 (5.4)	3 (7.9)				

Note: l means lower, m means molar, 1 means first, 2 means second, (r) means right, and (l) means left.
* Weak short groove on the lingual ridge of cusp 3; ** The essential ridge of the cusp 2 is expressed similar in size and prominence as that of the other cusps; *** The essential ridge is very well developed in its thickness on cusp 2 and also expands its width in the trigonid basin.

SUPPLEMENTARY TABLES

Supplementary Table 1. Trait prevalence in the upper permanent molars

Trait / Grade	First molars		Second molars		Chi-squared test dimorphism	
	UM1 (m)	UM1 (f)	UM2 (m)	UM2 (f)	UM1	UM2
CARABELLI TRAIT n(%)						
0. Smooth surface	85(52.5)	89(56.7)	149(93.1)	144(91.1)	0.637	0.279
1. Vertical groove	12(7.4)	17(10.8)	3(1.9)	6(3.8)		
2. Pit	9(5.6)	4(2.5)	3(1.9)	2(1.3)		
3. Small Y-shaped	16(9.9)	14(8.9)	3(1.9)	2(1.3)		
4. Large Y-shaped	8(4.9)	8(5.1)	-	2(1.3)		
5. Small cusp	10(6.2)	7(4.5)	2(1.2)	-		
6. Medium cusp	20(12.3)	14(8.9)	-	2(1.3)		
7. Large free cusp	2(1.2)	4(2.5)	-	-		
METACONE n(%)						
2. Faint cuspule	-	-	1(0.7)	-	0.791	0.698
3. Weak cusp	-	-	8(5.5)	10(6.6)		
4. Large cusp	22(13.4)	19(12.4)	80(54.8)	87(57.2)		
5. Very large cusp	142(86.6)	134(87.6)	57(39.0)	55(36.2)		
HYPOCONE n(%)						
0. Smooth surface	-	-	23(16.9)	17(12.4)	0.041*	0.578
1 / 2. Faint ridge and Faint cuspule	-	2(1.3)	36(26.5)	33(24.1)		
3. Small cusp	-	4(2.5)	48(35.3)	58(42.3)		
4 / 5. Large and very large cusp	163(100.0)	151(96.2)	29(21.3)	29(21.2)		
METACONULE n(%)						
0. Trait is absent	146(89.6)	141(92.8)	115(90.6)	116(89.9)	0.054	0.617
1. Faint cuspule	3(1.8)	6(3.9)	4(3.1)	4(3.1)		
2. Trace cuspule	4(2.5)	5(3.3)	7(5.5)	5(3.9)		
3. Small cuspule	2(1.2)	-	1(0.8)	2(1.6)		
4. Small cusp	2(1.2)	-	-	2(1.6)		
5 .Medium-sized cusp	6(3.7)	-	-	-		
PARASTYLE n(%)						
0. Smooth surface	164(100.0)	160(100.0)	153(98.7)	159(100.0)	-	0.150
4. Large cusp	-	-	2(1.3)	-		

Note: U means upper, M means molar, 1 means first, 2 means second, (m) means male, and (f) means female. *means statistical significant difference ($p \leq 0.05$).

Supplementary Table 2. Trait prevalence in the lower permanent molars

Trait / Grade	First molars		Second molars		Chi-squared test (dimorphism)	
	LM1 (m)	LM1(f)	LM2 (m)	LM2 (f)	LM1	LM2
GROOVE PATTERN n(%)						
Y. Cusps 2 and 3 are in contact	94(71.7)	97(80.2)	46(32.6)	29(22.1)	0.247	0.067
+. Cusps 1–4 are in contact	25(19.1)	18(14.9)	52(36.9)	65(49.6)		
X. Cusps 1 and 4 are in contact	12(9.2)	6(4.9)	43(30.5)	37(28.2)		
HYPOCONULID n(%)						
0. Absent	24(14.8)	17(10.9)	94(88.7)	99(97.1)	0.204	0.070
1. Very small	7(4.3)	17(10.9)	1(0.9)	1(0.9)		
2. Small	32(19.8)	35(22.4)	6(5.7)	2(1.9)		
3. Medium-sized	75(46.3)	71(45.5)	5(4.7)	-		
4. Large	20(12.3)	14(8.9)	-	-		
5. Very large	4(2.5)	2(1.3)	-	-		
CUSP 6 n(%)						
0. Absent	155(95.7)	146(93.6)	101(100.0)	93(100.0)	0.168	-
1. Much smaller than cusp 5	2(1.2)	5(3.2)	-	-		
2. Smaller than cusp 5	4(2.5)	1(0.6)	-	-		
3. Equal in size to cusp 5	1(0.6)	4(2.6)	-	-		
CUSP 7 n(%)						
0. Absent	154(95.1)	158(100.0)	146(97.3)	142(100.0)	0.0915	0.050*
1. Faint cusp	2(1.2)	-	4(2.6)	-		
2. Small	1(0.6)	-	-	-		
3. Medium-sized	4(2.5)	-	-	-		
4. Large	1(0.6)	-	-	-		
PROTOSTYLID n(%)						
0. Smooth surface	144(90.0)	146(91.3)	142(97.9)	142(97.9)	0.701	0.999
1. Pit present	16(10.0)	14(8.8)	3(2.1)	3(2.1)		
ANTERIOR FOVEA n(%)						
0. Absent	79(52.7)	74(56.1)	61(39.9)	61(46.2)	0.591	0.184
1. Trace with a weak ridge	13(8.7)	16(12.1)	23(15.0)	14(10.6)		
2. Essential ridges on trigonid developed	52(34.7)	38(28.8)	67(43.8)	51(38.6)		
3. Essential ridges pronounced	6(4.0)	4(3.0)	2(1.3)	6(4.5)		
DEFLECTING WRINKLE n(%)						
0. Absent	51(36.7)	38(28.6)	118(78.1)	104(76.5)	0.437	0.932
1. Midpoint constriction	47(33.8)	47(35.3)	20(13.2)	20(14.7)		
2. Deflected distally	32(23.0)	40(30.1)	13(8.6)	12(8.8)		
3. L-shaped ridge	9(6.5)	8(6.0)	-	-		
DISTAL TRIGONID CREST n(%)						
0. Absent	140(100.0)	122(93.8)	135(91.8)	101(75.9)	0.002*	0.0003*
1. Present	-	8(6.2)	12(8.2)	32(24.1)		

Note: L means lower,M means molar, 1 means first, 2 means second, (m) means male, (f) means female. *means statistical significant difference ($p \leq 0.05$).

Supplementary Table 3. Trait prevalence in the upper primary molars

Trait / Grade	First molars		Second molars		Chi-squared test (dimorphism)	
	um1 (m)	**um1 (f)**	**um2 (m)**	**um2 (f)**	**um1**	**um2**
CARABELLI TRAIT n(%)						
0. Smooth mesiolingual surface	45(100.0)	34(100.0)	21(28.0)	18(33.3)	-	0.383
1. Pit, groove	-	-	30(40.0)	20(37.0)		
2. Two grooves are parallel	-	-	5(6.7)	8(14.8)		
3. The area between grooves raised	-	-	13(17.3)	5(9.3)		
4. Free apex	-	-	6(8.0)	3(5.6)		
CROWN PATTERN (first molars) n(%)						
2. Protocone and paracone	33(82.5)	22(66.7)	-	-	0.133	-
3M. Protocone, paracone and metacone	2(5.0)	4(12.1)	-	-		
3H. Protocone, paracone and hypocone	4(10.0)	2(6.1)	-	-		
4–. All four cusps present but hypocone reduced	1(2.5)	5(15.1)	-	-		
CROWN PATTERN (second molars) n(%)						
3. The distal marginal ridge has a groove	-	-	8(10.8)	7(12.5)	-	0.469
4–. Distal marginal ridge without interruption	-	-	20(27.0)	10(17.9)		
4. Large hypocone	-	-	46(62.2)	39(69.6)		
METACONULE n(%)						
0. Absent	41(100.0)	32(100.0)	72(97.3)	53(100.0)	-	0.227
1. Present	-	-	2(2.7)	-		
PARASTYLE n(%)						
0. Absent	45(100.0)	34(100.0)	75(100.0)	58(100.0)	-	-

Note: u means upper, m means molar, 1 means first, 2 means second, (m) means male, (f) means female.

Supplementary Table 4. Trait prevalence in the lower primary molars

Trait / Grade	First molars		Second molars		Chi-squared test (dimorphism)	
	lm1 (m)	**lm1(f)**	**lm2 (m)**	**lm2 (f)**	**lm1**	**lm2**
GROOVE PATTERN n(%)						
Y. Cusps 2 and 3 are in contact	26(96.3)	15(93.8)	37(88.1)	25(78.1)	0.701	0.039*
+. Cusps 1–4 are in contact	-	-	1(2.4)	6(18.8)		
X. Cusps 1 and 4 are in contact	1(3.7)	1(6.2)	4(9.5)	1(3.1)		
HYPOCONULID n(%)						
0. Absent	33(89.2)	21(84.0)	-	-	0.549	-
1. Present	4(10.8)	4(16.0)	65(100.0)	55(100.0)		
CUSP 6 n(%)						
0. Absent	37(100.0)	25(100.0)	65(100.0)	54(98.2)	-	0.275
2. Cusp 6 smaller than cusp 5	-	-	-	1(1.8)		
CUSP 7 n(%)						
0. Absent	39(100.0)	25(100.0)	54(81.8)	47(85.5)	-	0.422
1. Weak short groove on the lingual ridge of cusp 3	-	-	10(15.2)	8(14.5)		
2 .Small cusp	-	-	2(3.0)	-		
PROTOSTYLID n(%)						
0. Smooth surface	39(100.0)	28(93.3)	28(41.8)	32(57.1)	0.101	0.089
1. Pit present	-	2(6.7)	39(58.2)	24(42.9)		
ANTERIOR FOVEA n(%)						
0. Absent	35(94.6)	18(100.0)	14(29.2)	5(14.7)	0.603	0.136
1. Trace with a weak ridge	1(2.7)	-	7(14.6)	10(29.4)		
2. Essential ridges on trigonid developed	1(2.7)	-	23(47.9)	19(55.9)		
3. Essential ridges pronounced	-	-	3(6.2)	-		
4 .Well-defined fovea	-	-	1(2.1)	-		
CENTRAL RIDGE OF METACONID n(%)						
1. Cusp 2 ridge is similar to the other cusps **	32(86.5)	23(100.0)	49(90.7)	37(90.2)	0.065	0.934
2. Ridge is well developed and expands to trigonid ***	5(13.5)	-	5(9.3)	4(9.8)		
DISTAL TRIGONID CREST n(%)						
0. Absent	36(87.8)	22(100.0)	42(97.7)	28(87.5)	0.087	0.080
1.Distal borders are connected by a ridge	5(12.2)	-	1(2.3)	4(12.5)		

Note: l means lower, m means molar, 1 means first, 2 means second, (m) means male, (f) means female. *means statistical significant difference ($p \leq 0.05$).
** The essential ridge of the cusp 2 is expressed similar in size and prominence as that of the other cusps; *** The essential ridge is very well developed in its thickness on cusp 2 and also expands its width in the trigonid basin.

FIGURES

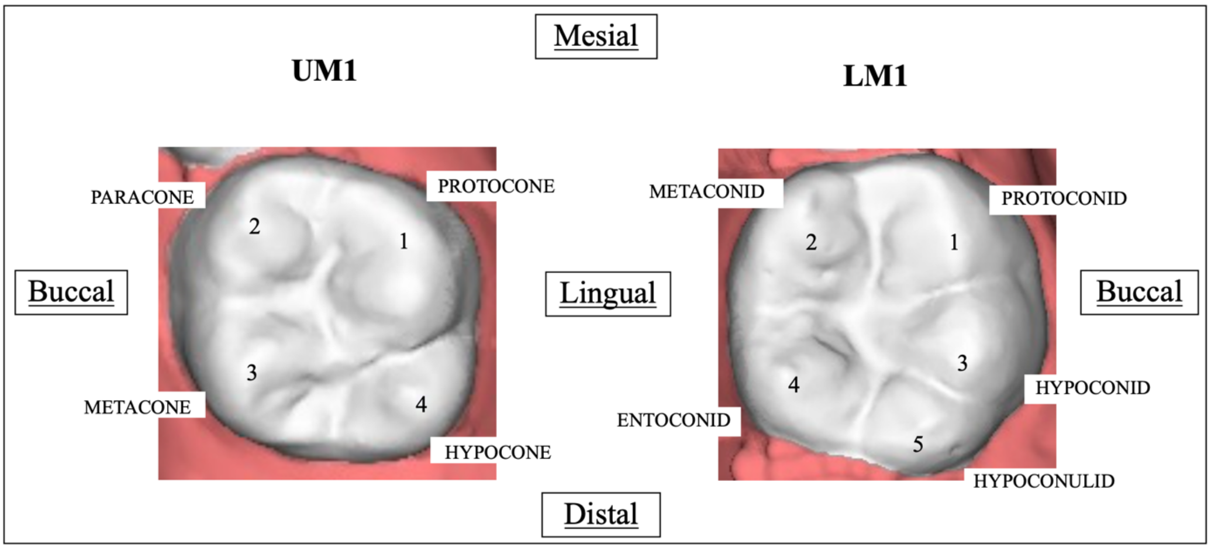


Fig.1. Permanent maxillary and mandibular right first molar showing cusps indicated by numbers according to their location.

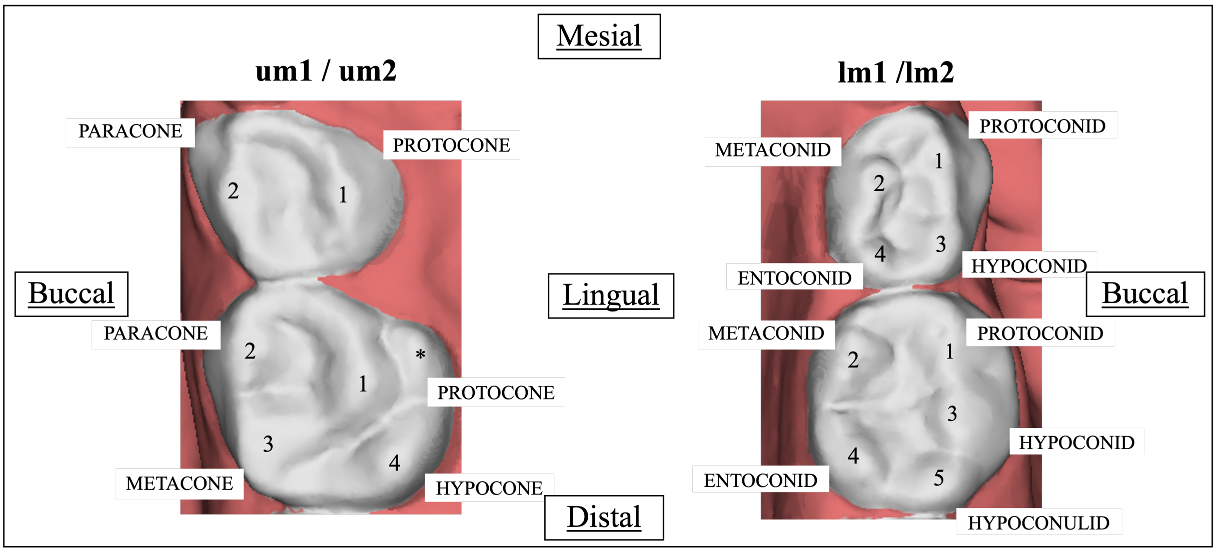
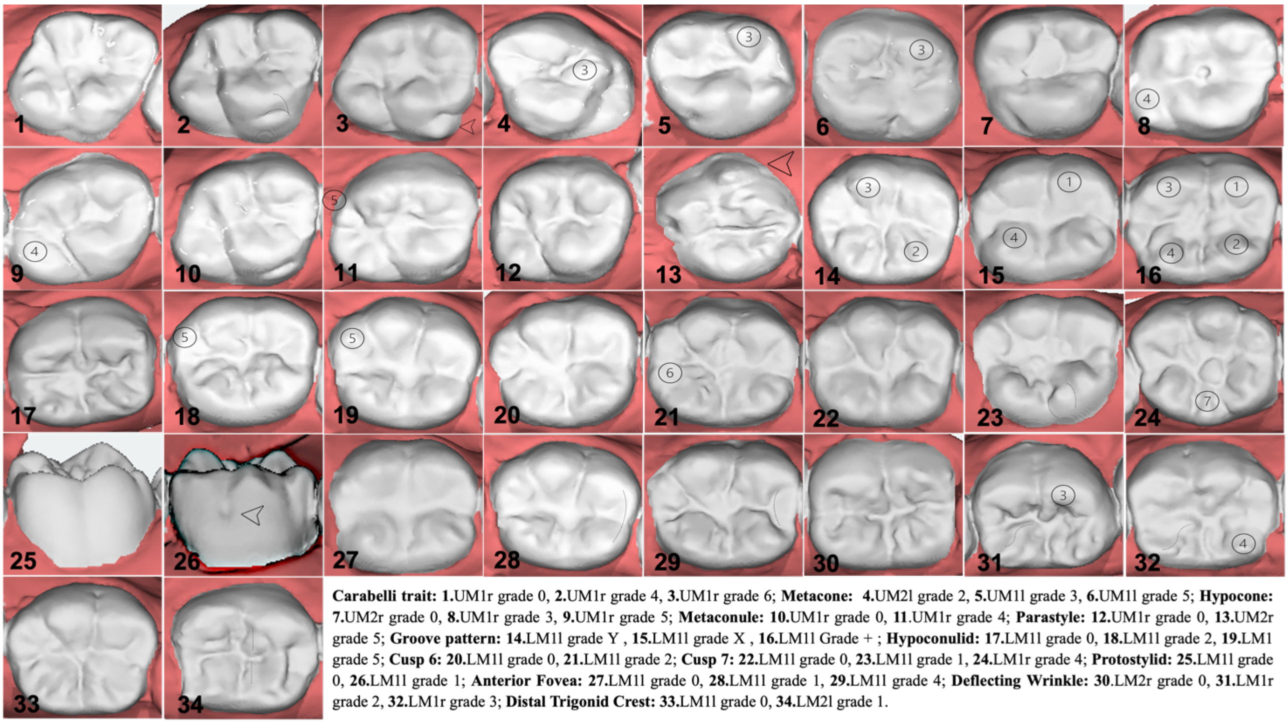
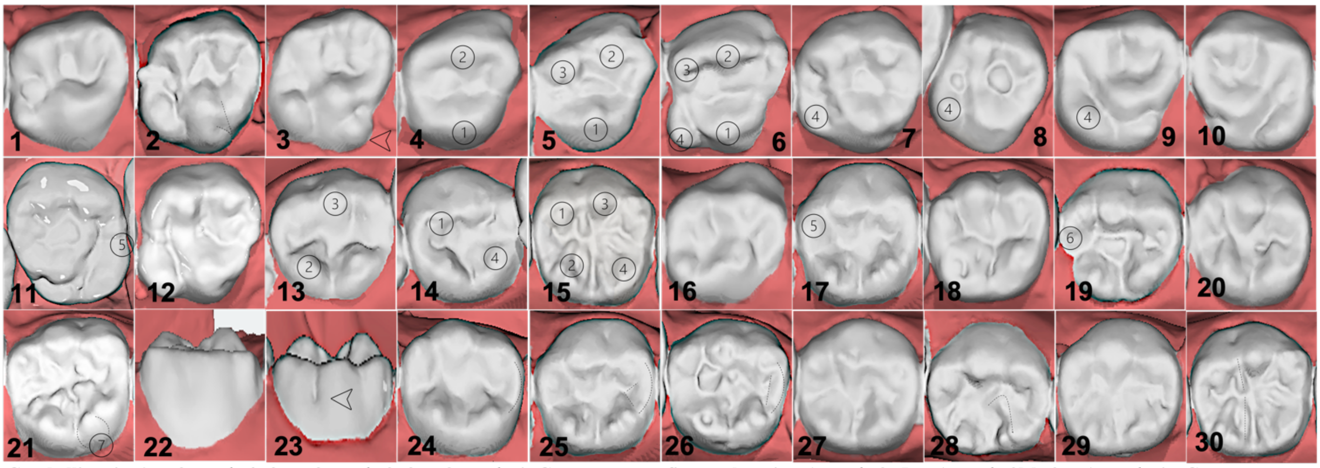


Fig. 2. Primary maxillary and mandibular right first and second molars showing cusps indicated by numbers according to their location. * means Carabelli's trait.



Carabelli trait: 1.UM1r grade 0, **2.**UM1r grade 4, **3.**UM1r grade 6; **Metacone: 4.**UM2l grade 2, **5.**UM1l grade 3, **6.**UM1l grade 5; **Hypocone: 7.**UM2r grade 0, **8.**UM1r grade 3, **9.**UM1r grade 5; **Metaconule: 10.**UM1r grade 0, **11**.UM1r grade 4; **Parastyle: 12.**UM1r grade 0, **13.**UM2r grade 5; **Groove pattern: 14.**LM1l grade Y , **15.**LM1l grade X , **16.**LM1l Grade + ; **Hypoconulid: 17.**LM1l grade 0, **18.**LM1l grade 2, **19.**LM1 grade 5; **Cusp 6: 20.**LM1l grade 0, **21.**LM1l grade 2; **Cusp 7: 22.**LM1l grade 0, **23.**LM1l grade 1, **24.**LM1r grade 4; **Protostylid: 25.**LM1l grade 0, **26.**LM1l grade 1; **Anterior Fovea: 27.**LM1l grade 0, **28.**LM1l grade 1, **29.**LM1l grade 4; **Deflecting Wrinkle: 30**.LM2r grade 0, **31.**LM1r grade 2, **32.**LM1r grade 3; **Distal Trigonid Crest: 33.**LM1l grade 0, **34.**LM2l grade 1.

Fig. 3. Permanent maxillary and mandibular molars showing NDCT assessed.



Carabelli trait: 1.um2r grade 0, **2.** um2r grade 2, **3.**um2r grade 4; **Crown pattern first molar: 4.**um1r grade 2, **5.**um1r grade 3M, **6.**um1r grade 4 ; **Crown pattern second molar: 7.**um2r grade 3, **8.**um2r grade 4–, **9.**um2r grade 4; **Metaconule: 10.**um2r grade 0, **11**.um2r grade P; **Parastyle: 12.**um2r grade 0; **Groove pattern: 13.**lm2r grade Y , **14.**lm2r grade X , **15.**lm2r grade + ; **Hypoconulid: 16.**lm1l grade 0, **17.**lm2 grade P; **Cusp 6: 18.**lm2l grade 0, **19.**lm2l grade 3; **Cusp 7: 20.**lm2l grade 0, **21.**lm2l grade 2; **Protostylid: 22.**lm2l grade 0, **23.**lm2l grade 1; **Anterior Fovea: 24.**lm2l grade 1, **25.**lm2l grade 2, **26.**lm2l grade 4; **Central ridge of metaconid: 27**.lm2l grade 1, **28.**lm2l grade 2; **Distal Trigonid Crest: 29.**lm2r grade 0, **30.**lm2r grade 1.

Fig. 4. Primary maxillary and mandibular molars showing NDCT assessed.

12 CONCLUSÃO

O presente estudo mostrou a variabilidade e a frequência de NDCT de molares e evidenciou que alguns traços morfológicos apresentaram dimorfismo sexual em dentes permanentes e decíduos.

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APÊNDICE

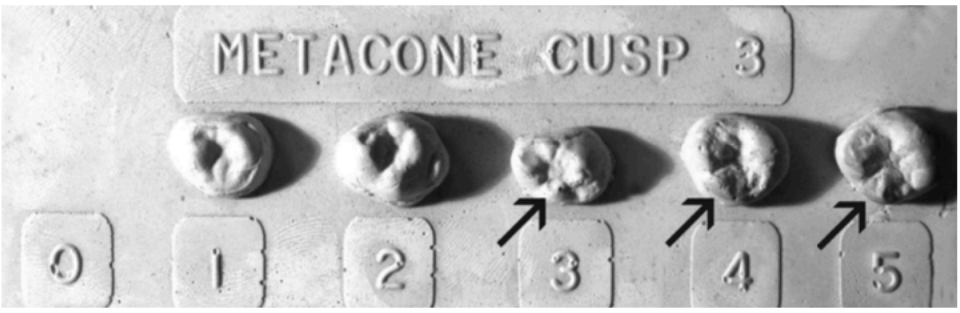
Apêndice A. Practical Guide.

PRACTICAL GUIDE

Ariane Beatriz Blancato

1

METACONE (cusp 3) – Permanent Upper Molars



Scott and Irish (2017)

0. Metacone is absent.
1. An attached ridge is present at the metacone site, but there is no free apex.
2. A faint cuspule with a free apex is present.
3. Weak cusp is present.

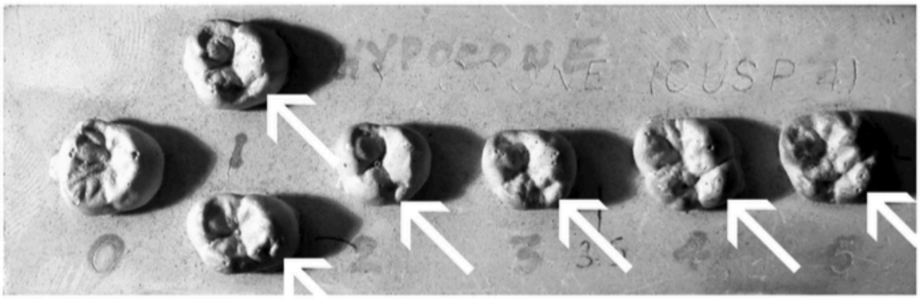
3.5 An intermediate-sized cusp is present (not shown on plaque, interpolation necessary).

4. Metacone is large.
5. Metacone is very large (equal in size to a large M1 Hypocone).

Turner II *et al.*(1991)

2

HYPOCONE (cusp 4) – Permanent Upper Molars



Scott and Irish (2017)

0. No hypocone. Site is smoth.
1. Faint ridging present at the site.
2. Faint cuspule present.
3. Small cusp present.

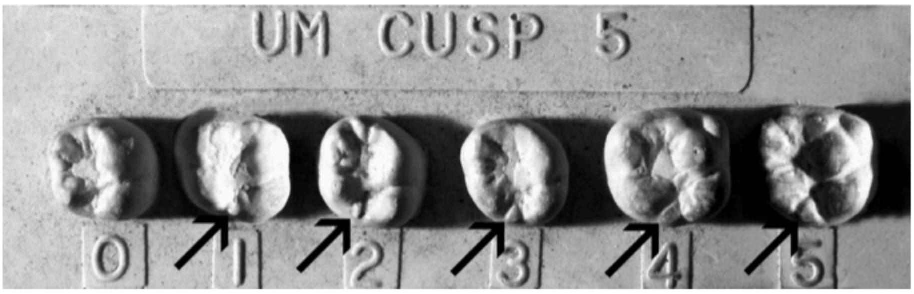
3.5. Moderate-sized cusp present.

4. Large cusp present.
5. Very large cusp present.

Turner II *et al.*(1991)

3

METACONULE (Cusp 5) – Permanent Upper Molars



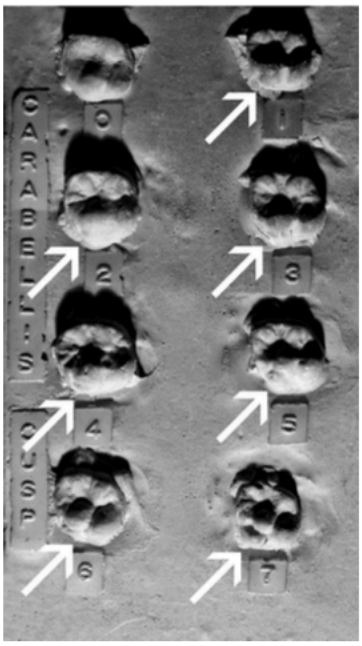
Scott and Irish (2017)

0. Site of cusp 5 is smooth, there being only a single distal groove present separating cusps 3 and 4.
1. Faint cuspule is present.
2. Trace cuspule present.
3. Small cuspule present.
4. Small cusp present.
5. Medium-sized cusp present.

Turner II *et al.*(1991)

4

CARABELLI'S TRAIT – Permanent Upper Molars



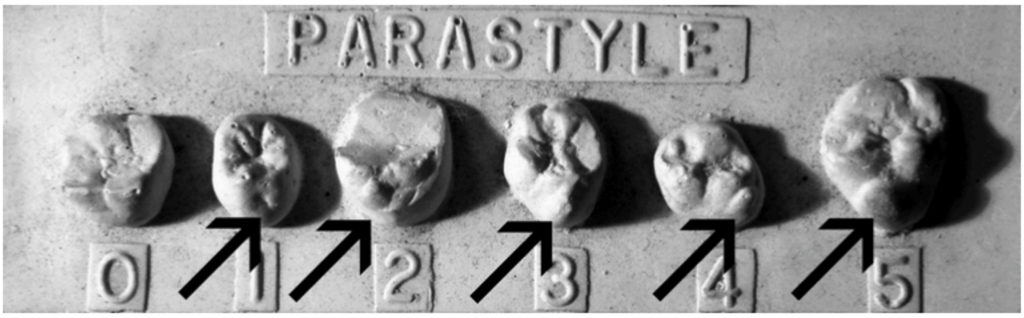
Scott and Irish (2017)

0. The mesiolingual aspect of cusp 1 is smooth.
1. A groove is present.
2. A pit is present.
3. A small Y-shaped depression is present.
4. A large Y-shaped depression is present.
5. A small cusp without a free apex occurs. The distal border of the cusp does not contact the lingual groove separating cusps 1 and 4.
6. A medium-sized cusp with an attached apex making contact with the medial lingual groove is present.
7. A large free cusp is present.

Turner II *et al.*(1991)

5

PARASTYLE – Permanent Upper Molars



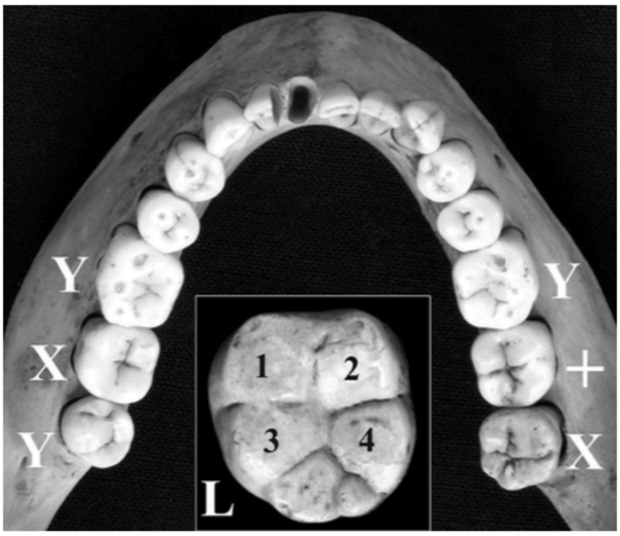
Scott and Irish (2017)

0. The buccal surfaces of cusps 2 and 3 are smooth.
1. A pit is present in or near the buccal groove between cusps 2 and 3.
2. A small cusp with an attached apex is present.
3. A medium-sized cusp with a free apex is present.
4. A large cusp with a free apex is present.
5. A very cusp with a free apex is present. This form usually involves the buccal surface of both cusps 2 and 3.
6. An effectively free peg-shaped crown attached to the root of the third molar is present.

Turner II *et al.*(1991)

6

GROOVE PATTERN – Permanent Lower Molars



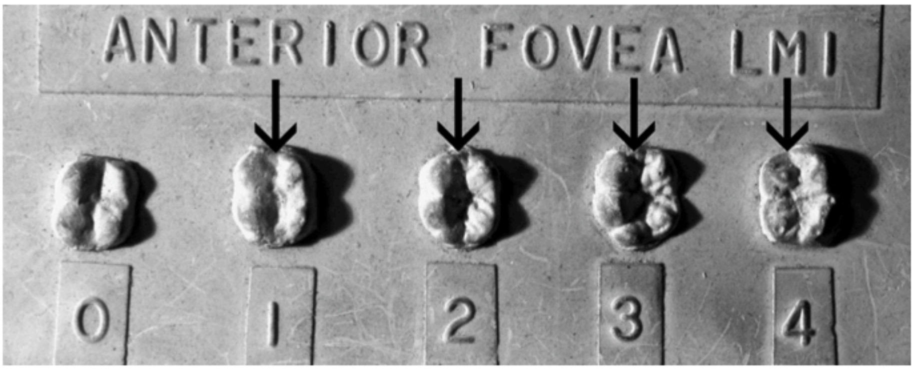
Scott and Irish (2017)

Y. Cusps 2 and 3 are in contact.
+. Cusps 1–4 are in contact.
X. Cusps 1 and 4 are in contact.

Turner II *et al*.(1991)

7

ANTERIOR FOVEA – Permanent Lower Molars



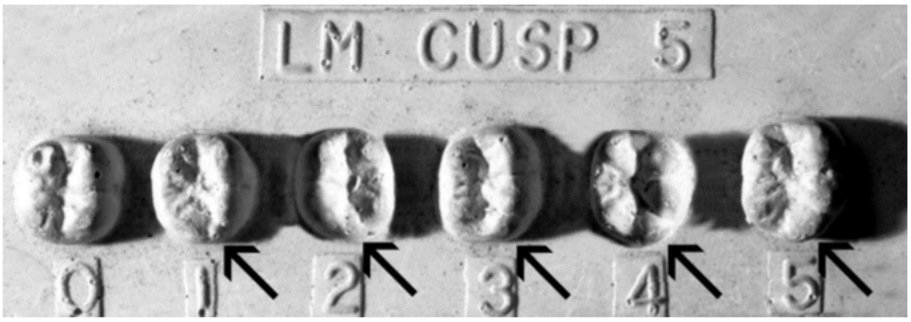
Scott and Irish (2017)

0. Anterior fovea is absent. The sulcus between cusps 1 and 2 continues without interruption from the center of the occlusal surface to the mesial border.
1. A weak ridge connects the mesial aspects of cusps 1 and 2 producing a faint groove.
2. The connecting ridge is larger and the resulting groove deeper than in grade 1.
3. Groove is longer than in grade 2.
4. Groove is very long and mesial ridge is robust.

Turner II *et al*.(1991)

8

HYPOCONULID (cusp 5) – Permanent Lower Molars



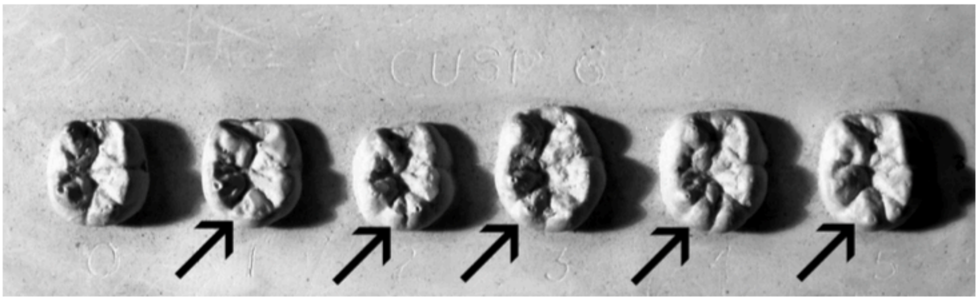
Scott and Irish (2017)

0. No occurrence of cusp 5. The molar has only 4 cusps (cusps 1–4).
1. Cusp 5 is present and very small.
2. Cusp 5 is small.
3. Cusp 5 is medium-sized.
4. Cusp 5 is large.
5. Cusp 5 is very large.

Turner II *et al.*(1991)

9

ENTOCONULID (cusp 6) – Permanent Lower Molars


Scott and Irish (2017)

0. Cusp 6 is absent.
1. Cusp 6 is much smaller than cusp 5.
2. Cusp 6 is smaller than cusp 5.
3. Cusp 6 is equal in size to cusp 5.
4. Cusp 6 is larger than cusp 5.
5. Cusp 6 is much larger than cusp 5.

Turner II *et al.*(1991)

10

METACONULID (cusp 7) – Permanent Lower Molars

Scott and Irish (2017)

0. No occurrence of cusp 7.
1. Faint cusp is present. Two weak lingual grooves are present instead of one.

1A. A faint tipless cusp 7 occurs displaced as a bulge on the lingual surface of cusp 2.

2. Cusp 7 is small.
3. Cusp 7 is medium sized.
4. Cusp 7 is large.

Turner II *et al.*(1991)

11

PROTOSTYLID – Permanent Lower Molars

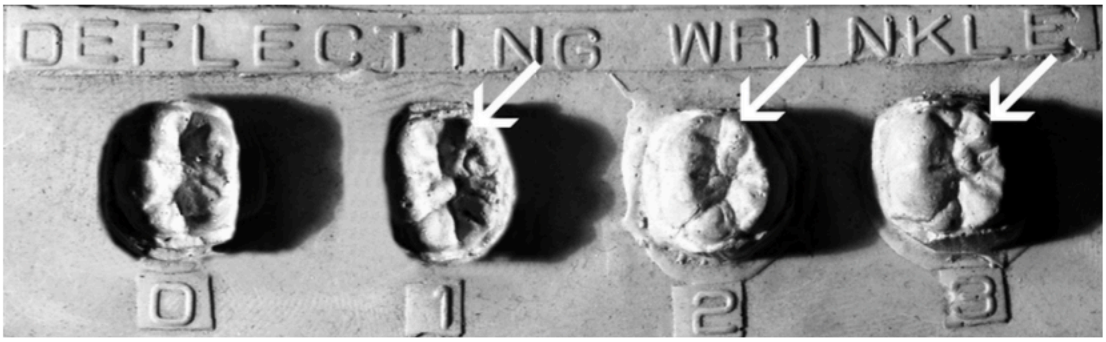
Scott and Irish (2017)

0. No expression of any sort. Buccal surface is smooth.
1. A pit occurs in the buccal groove.
2. Buccal groove is curved distally.
3. A faint secondary groove extends mesially from the buccal groove.
4. Secondary groove is slightly more pronounced.
5. Secondary groove is stronger and can be easily seen.
6. Secondary groove extends across most of the buccal surface of cusp 1. This is considered a weak or small cusp.
7. A cusp with a free apex occurs.

Turner II *et al.*(1991)

12

DEFLECTING WRINKLE – Permanent Lower Molars



Scott and Irish (2017)

0. Deflecting wrinkle absent; essential ridge of metaconid runs a straight course from cusp tip to central occlusal fossa.
1. Cusp 2 medial ridge is straight, but shows a midpoint constriction.
2. Medial ridge is deflected distally, but does not make contact with cusp 4.
3. Media ridge is deflected distally forming an L-shaped ridge. The medial ridge contacts cusp 4.

Turner II *et al.*(1991)

13

DISTAL TRIGONID CREST– Permanent Lower Molars

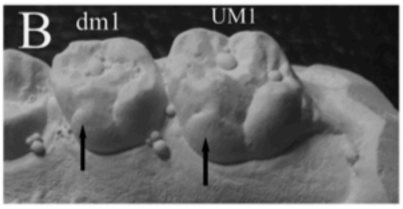
Scott and Irish (2017)

0. Absent: Distal borders of cusps 1 and 2 are not connected by a crest or loph.
1. Present: Distal borders are connected by a ridge.

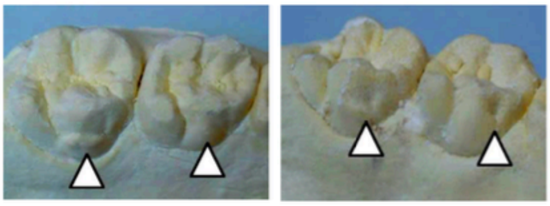
Turner II *et al.*(1991)

14

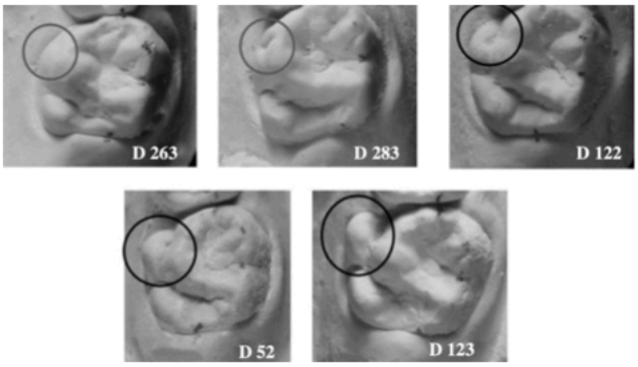
CARABELLI'S TRAIT – Primary Upper Molars



Scott *et al.* (2018)



Aguirre *et al.* (2018)



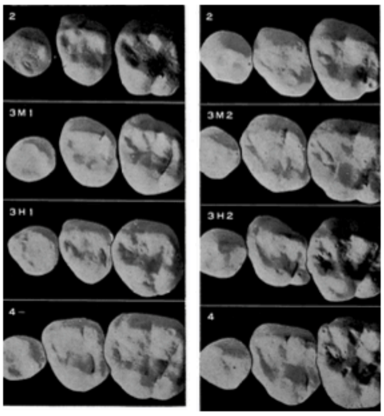
Lukacs and Kuswandari (2013)

0. Absent: mesiolingual surface smooth.
1. Pit, groove: present.
2. Two grooves: roughly parallel grooves.
3. Welt: area between grooves raised, apex not free.
4. Cusp: same as 3 but apex free.

Sciulli (1998)

15

CROWN PATTERN –Primary Upper 1st Molars



Hypocone – Primary Upper 1st Molars

2. Paracone(eo) and protocone(pr) present.

3M. Eo, pr, and metacone(me) present.

3H. Eo, pr, and hypocone(hy) present.

4–. All four cusps present but hy reduced.

4. All four cusps present but hy not reduced.

Sciulli (1998)

2. Only two cusps, protocone and paracone, are present.

3M1 and 3M2. Metacone is displayed in addition to the protocone and the paracone, but there is no hypocone. The metacone is divided from the paracone by a shallow groove and its size is always much smaller than the paracone. The difference between 3M1 and 3M2 is due to the size of the metacone.

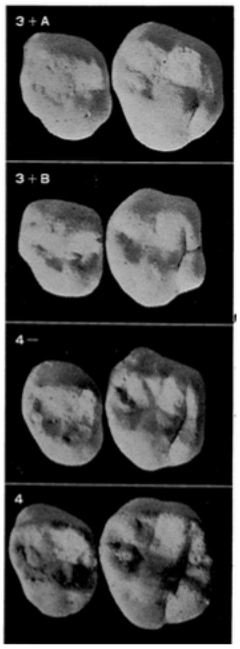
3Hl and 3H2 : Hypocone is present as the " third cusp " and there is no metacone. The hypocone is separated from the protocone by a shallow groove. 3H1 presents an extremely small hypocone. 3H2 shows a well-developed hypocone.

4– and 4 : All four main cusps are in evidence. In the specimen designated as 4–,both metacone and hypocone are small in size but each cusp is clearly recognized. A tooth with all four cusps, three of which are prominent (usually the protocone, paracone, and metacone), should be classified as type " 4 ".

Hanihara (1961)

16

CROWN PATTERN – Primary Upper 2st Molars



Hanihara(1961)

3. This type has never been observed in the deciduous upper 2nd molar.

3+A. The tooth has three main cusps and the hypocone is represented as only a very small cusp located on the distal side of the crown.

3+B. This tooth is almost the same as the "4–" type, but the distal marginal ridge connecting the hypocone with the metacone is interrupted by a groove. It is such that the small hypocone seems to be more or less attached independently to the distal side of the crown.

4–. The hypocone is very small in its relative size and the distal marginal ridge takes its course to the tip of the metacone without interruption.

4. All of four main cusps are well developed.

Hanihara(1961).

Hypocone – Primary Upper 2st Molars

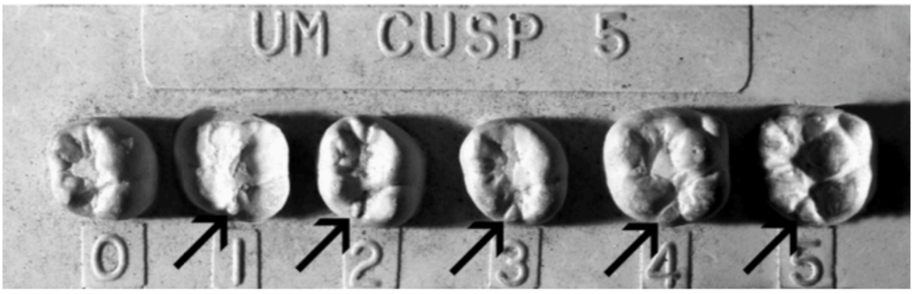
3. Eo, pr, me, and a small distally placed hy.

4–. Eo, pr, and me attached to small hy by distal ridge.

4. Eo, pr, me, and large hy.

Sciulli(1998)

METACONULE (cusp 5) – Primary Upper Molars



Scott and Irish (2017)

Accessory cusp located between the metacone and hypocone of the upper posterior premolar is scored as **present** or **absent**. P is the frequency of occurrence of this cusp, and W is not calculated.

Sciulli(1998)

1. Site of cusp 5 is smooth, there being only a single distal groove present separating cusps 3 and 4.
2. Faint cuspule is present.
3. Trace cuspule present.
4. Small cuspule present.
5. Small cusp present.

Turner II *et al.* (1991)

PARASTYLE – Primary Upper Molars

Scott and Irish (2017)

0. The buccal surfaces of cusps 2 and 3 are smooth.
1. A pit is present in or near the buccal groove between cusps 2 and 3.
2. A small cusp with an attached apex is present.
3. A medium-sized cusp with a free apex is present.
4. A large cusp with a free apex is present.
5. A very cusp with a free apex is present. This form usually involves the buccal surface of both cusps 2 and 3.
6. An effectively free peg-shaped crown attached to the root of the third molar is present.

Turner II *et al.* (1991)

19

GROOVE PATTERN – Primary Lower Molars

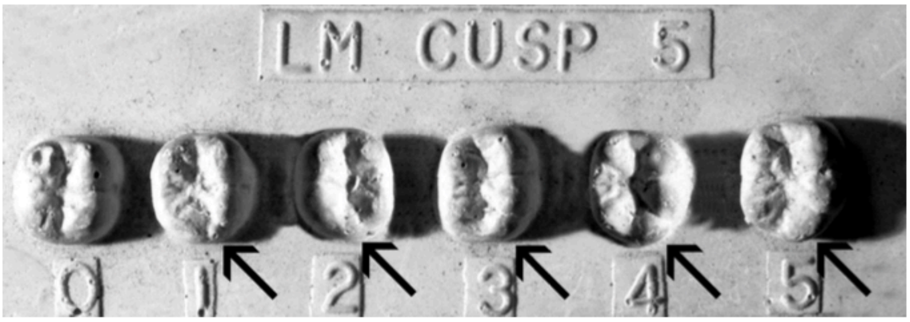
Aguirre *et al.* (2018)

Y. Cusps 2 and 3 are in contact.
+. Cusps 1–4 are in contact.
X. Cusps 1 and 4 are in contact.

Turner II *et al.* (1991)

20

HYPOCONULID (Cusp 5) – Primary Lower Molars



The distal cusp of the lower posterior premolar is scored as **present** or **absent**. P is the frequency of the presence of the hypoconulid.

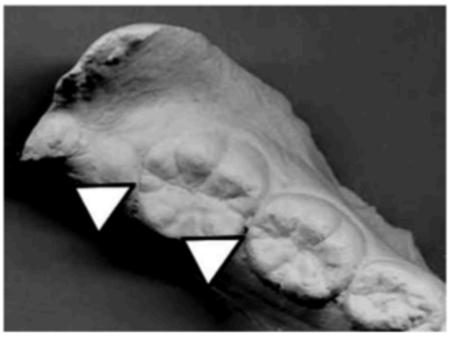
Sciulli(1998)

1. No occurrence of cusp 5. The molar has only 4 cusps (cusps 1–4).
2. Cusp 5 is present and very small.
3. Cusp 5 is small.
4. Cusp 5 is medium-sized.
5. Cusp 5 is large.

Turner II *et al.* (1991)

21

ENTOCONULID (Cusp 6) – Primary Lower Molars



Aguirre *et al.*(2018)

0. Absent: no accessory cusp present.
1. Hyld >> C6.
2. Hyld > C6.
3. Hyld = C6.
4. Hyld < C6.
5. Hyld << C6.

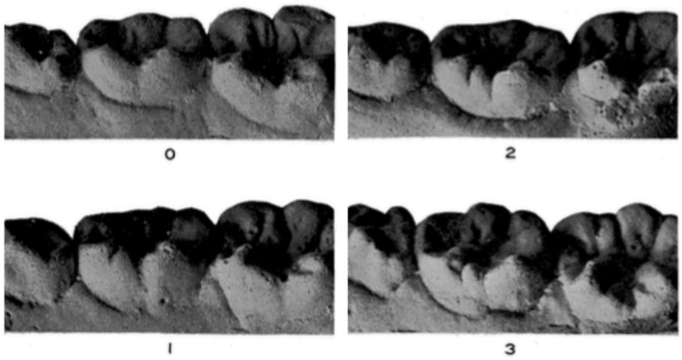
Sciulli(1998)

0. Cusp 6 is absent.
1. Cusp 6 is much smaller than cusp 5.
2. Cusp 6 is smaller than cusp 5.
3. Cusp 6 is equal in size to cusp 5.
4. Cusp 6 is larger than cusp 5.
5. Cusp 6 is much larger than cusp 5.

Turner II *et al.* (1991)

22

METACONULID (Cusp 7) – Primary Lower Molars

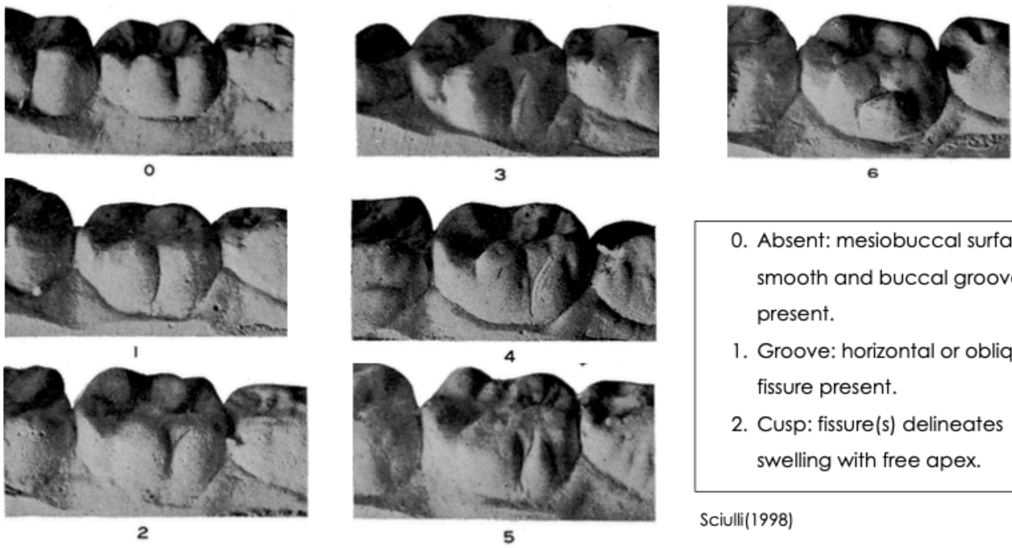


Hanihara(1961)

0. No trace of the 7th cusp is observed.
1. A very weak short groove extends downward from the lingual ridge of the metaconid, but any cusp-like formation indicating a trace of the cusp is not yet identified.
2. This groove is more definite so that in this category are two grooves on the lingual surface of which the distal one is the lingual groove. A small cusp-like formation is recognized between these two grooves.
3. The 7th cusp is well developed and looks like an independent accessory cusp. It is very small in appearance compared either with the metaconid or with the entoconid.

Hanihara(1961)

PROTOSTYLID – Primary Lower Molars



Hanihara(1961)

0. Absent: mesiobuccal surface smooth and buccal groove present.
1. Groove: horizontal or oblique fissure present.
2. Cusp: fissure(s) delineates swelling with free apex.

Sciulli(1998)

PROTOSTYLID – Primary Lower Molars

0. No trace of the protostylid.

1. No protostylid is in evidence, but the beginning of one is suggested by the curvature and branching of the buccal groove.

2. The divergence of the buccal Groove is barely recognized but it is not definite.

3. Two branches of the buccal groove are observed. A small triangular area with its tip downwards is seen between the branches of the groove.

4. A very shallow Groove appears at the mesial corner of the buccal surface. The area between this Groove and the mesial branch of the buccal groove bulges slightly and gives a triangular shape with its tip upwards.

5. The triangular area is decidedly more prominent .

6. In this specimen the protostylid is strongly developed so that the tooth seems to have na extra cuspo n the buccal side.

Hanihara(1961)

25

CENTRAL RIDGE OF THE METACONID – Primary Lower Molars

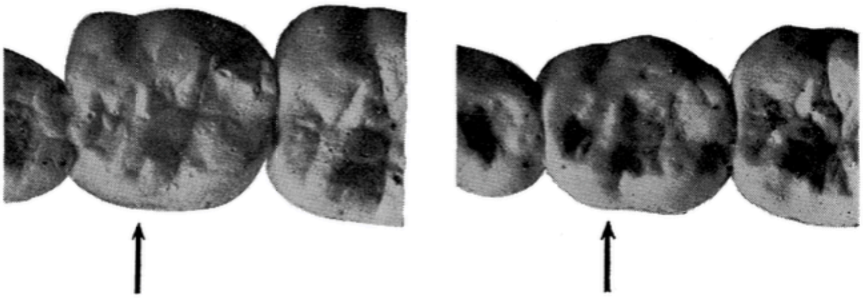
Hanihara(1961)

1. The central ridge of the metaconid is expressed similarly in size and prominence so that of the other cusps.
2. The central ridge is very well developed in its thickness on the metaconid. In such a case, the ridge is usually not only very wide and long but also expands its breadth at the trigonid basin. As a result, the ridge sometimes seems to curve distalward at its inner end.

Hanihara(1961)

26

DISTAL TRIGONID CREST – Primary Lower Molars

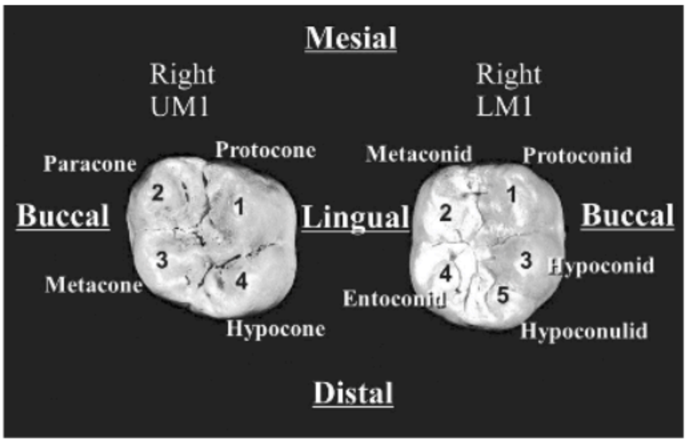


Hanihara(1961)

0. Absent: Distal borders or cusps 1 and 2 are not connected by a crest or loph.
1. Present: Distal borders are connected by a ridge.

Turner II *et al.*(1991)

CUSPS NAMES AND NUMBERS FOR UPPER AND LOWER RIGHT FISRTS MOLARS



Scott and Irish (2017)

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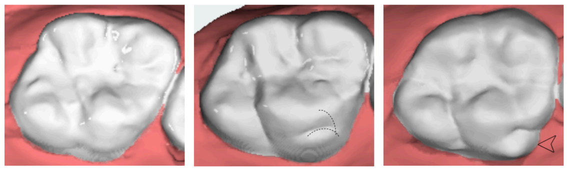
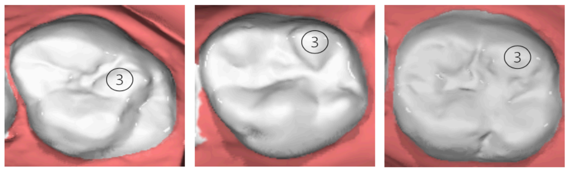
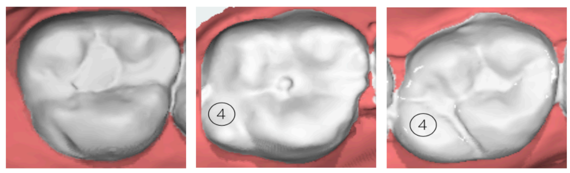
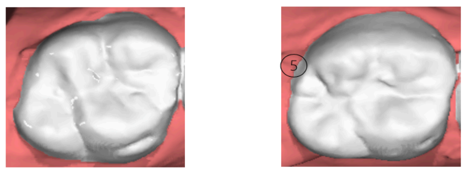
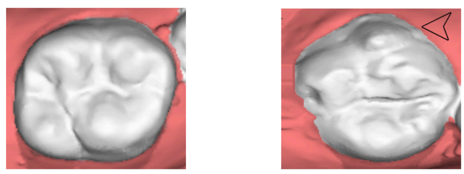
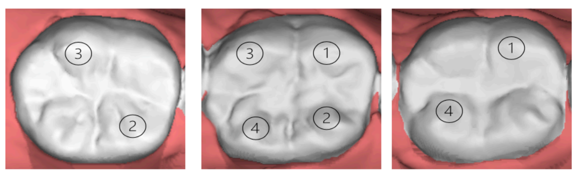
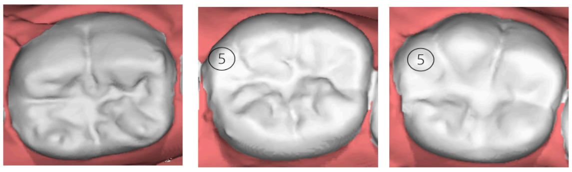
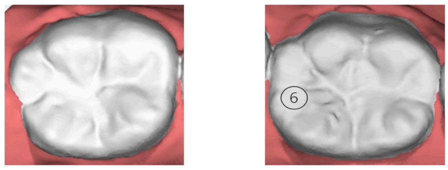
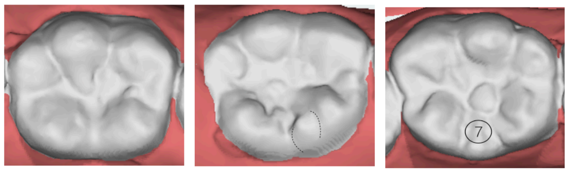
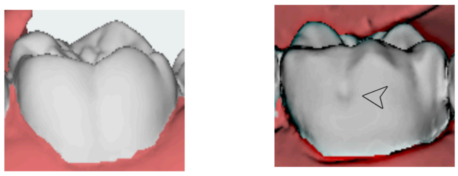
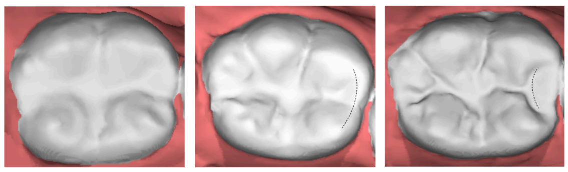
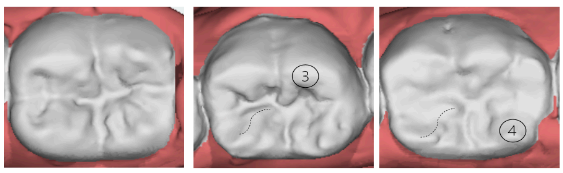
Apêndice B. Morphological Feature

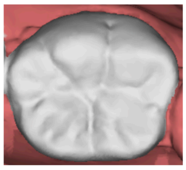
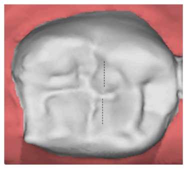
	TRAIT	FEATURES	GRADE	EXAMPLES
PERMANENT UPPER MOLARS	**Carabelli's trait**[1]	It occurs on the lingual surface of the protocone (cusp 1/mesiolingual cusp) and is expressed from complete absence, groove or pit to a large cusp.	**0.** Smooth mesiolingual surface; **1.**Vertical groove present; **2.** Pit present; **3.** Small Y-shaped depression; **4.**Large Y-shaped depression; **5.**Small cusp without free apex; **6.**Medium cusp with free apex making contact with the medial lingual groove; **7.**Large free cusp.	 UM1r Grade 0 · UM1r Grade 3 · UM1r Grade 6
PERMANENT UPPER MOLARS	**Metacone**[1]	It is the distobuccal cusp or cusp 3.	**0.** Absent; **1.** There is a ridge but no free apex; **2.** Faint cuspule with a free apex; **3.** Weak cusp; **3.5.**Intermediate-sized cusp that falls between grades 3 and 4; **4.** Large cusp; **5.** Very large cusp, equal in size to a large hypocone.	 UM2l Grade 2 · UM1l Grade 3 · UM1l Grade 7
PERMANENT UPPER MOLARS	**Hypocone**[1]	The distolingual cusp or cusp 4. It is derived from the cingulum and attached to the distolingual surface of the trigon(protocone/cusp 1, paracone/cusp 2 and metacone / cusp 3).	**0.** Smooth surface; **1.** Faint ridge; **2.** Faint cuspule; **3.** Small cusp; **3.5.** Moderate-sized cusp; **4.** Large cusp; **5.** Very large cusp.	 UM2r Grade 0 · UM1r Grade 3 · UM1r Grade 5
PERMANENT UPPER MOLARS	**Metaconule**[1]	A fifth cusp on the distal border between the metacone (cusp 3) e hypocone (cusp 4). The cusp should show two parallel vertical grooves.	**0.** Trait is absent; **1.** Faint cuspule; **2.** Trace cuspule; **3.** Small cuspule; **4.** Small cusp; **5.** Medium-sized cusp.	 UM1r Grade 0 · UM1r Grade 4
PERMANENT UPPER MOLARS	**Parastyle**[1]	It is most common expressed on the paracone (cusp 2 /mesiobuccal cusp). In some instances, it occurs on the metacone (cusp 3).	**0.** Smooth buccal surface; **1.** A small pit near the buccal groove between cusps 2 and 3; **2.** Small cusp without free apex; **3.** Medium cusp with free apex; **4.** Large cusp with free apex; **5.** Very large cusp that may extend onto the surfaces of both cusps 2 and 3; **6.** Peg-shaped crown attached to root of second or third molar.	 UM1r Grade 0 · UM2r Grade 5
PERMANENT LOWER MOLARS	**Groove pattern**[1]	Lower molars have 5 cusps: cusp 1 - protoconid, cusp 2 - metaconid, cusp 3 - hypoconid, cusp 4- entoconid and cusp 5- hypoconulid. The cusps can make contacts by creating patterns.	**Y.** Cusps 2 and 3 are in contact; **+.** Cusps 1–4 are in contact; **X.** Cusps 1 and 4 are in contact.	 LM1l Grade Y · LM1l Grade + · LM1l Grade X

PERMANENT LOWER MOLARS

Trait	Description	Grades	Examples
Hypoconulid[1]	The cusp 5. It occurs on the distal occlusal surface and it associated with cusp 3 (hypoconid).	**0.** Absent. The molar has only 4 cusps; **1.** Very small; **2.** Small; **3.** Medium-sized; **4.** Large; **5.** Very large.	 LM1l Grade 0 LM1l Grade 2 LM1l Grade 5
Cusp 6[1]	This cusp is expressed on the distal portion, but it is associated with the cusp 4 (entoconid). It is important to note that cusp 5 (hypoconulid) has to be present.	**0.** Absent; **1.** Much smaller than cusp 5; **2.** Smaller than cusp 5; **3.** Equal in size to cusp 5; **4.** Large than cusp 5; **5.** Much larger than cusp 5.	 LM1l Grade 0 LM1l Grade 2
Cusp 7[1]	It is a wedge-shaped accessory cusp expressed in the lingual groove between cusps 2 (metaconid) and 4 (entoconid). Cusp 7 is never considered in determining cusp number.	**0.** Absent; **1.**Faint cusp, two weak lingual grooves; **1A.** Faint tipless displaced on the lingual surface of metaconid (cusp 2); **2.** Small; **3.** Medium-sized; **4.** Large.	 LM1l Grade 0 LM1l Grade 1 LM1r Grade 4

PERMANENT LOWER MOLARS

Trait	Description	Grades	Examples
Protostylid[1]	This trait is a cingular derivate on the buccal surface associated with the buccal groove, particularly separating cusp 1(protoconid) and cusp 3(hypoconid).	**0.** Smooth surface; **1.** Pit present; **2.** Buccal groove curve distal; **3.** Faint groove extending mesial from the bucal groove; **4.** Groove more pronounced; **5.** Groove stronger; **6.** Groove extend across the buccal surface; **7.** Free cusp.	 LM1l Grade 0 LM1l Grade 1
Anterior Fovea[1]	This trait is expressed on the mesial occlusal surface. It involves distinct essential ridges on cusp 1 (protoconid) and cusp 2 (metaconid) that meet close to the center of the trigonid, and a mesial marginal ridge that is expressed to varying degrees.	**0.** Absent; **1.**Trace, with a weak ridge connecting the mesial aspects; **2.** Essential ridges on trigonid better developed and resulting groove deeper than in grade 1; **3.** Essential ridges pronounced and marginal ridge well developed, producing a distinctive fovea on the anterior portion of the trigonid; **4.** The Mesial ridge is robust and the marginal ridge produces a well-defined fovea with a very long groove.	 LM1l Grade 0 LM1l Grade 1 LM1l Grade 4
Deflecting Wrinkle[1]	The form of manifestation of the essential medial ridge on cusp 2 (metaconid).	**0.** Absent; **1.** The essential ridge is straight and shows a midpoint constriction; **2.** The essential ridge is deflected distally. There is no contact with cusp 4 (entoconid); **3.** The essential ridge shows strong deflection at the midpoint forming an L-shaped ridge. There is contact with cusp 4 (entoconid).	 LM2r Grade 0 LM1r Grade 2 LM1r Grade 3

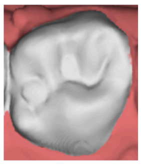
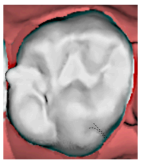
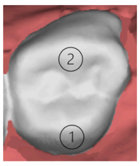
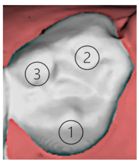
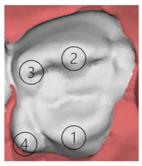
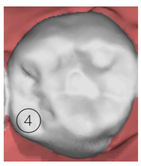
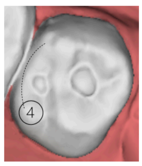
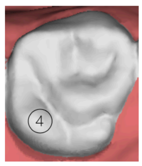
	Distal Trigonid Crest[1]	The major mesial cusps of the trigonid (cusp 1 - protoconid and cusp 2 - metaconid) express distal accessory ridges that are directly connected along the distal portion of the cusps. They can be continuous or discontinuous.	**0.** Absent; **1.** Present: distal borders are connected by a ridge.	 LM1l Grade 0  LM2l Grade 1

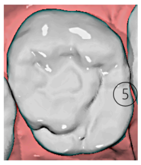
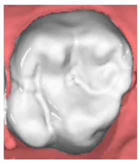
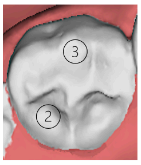
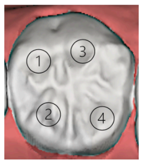
1 - ASUDAS(1991); **UM**-Permanent upper molar; **LM**-Permanent lower molar; **1**-First molar; **2**-Second molar; **(r)**-Right; **(l)**-Left.

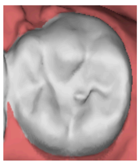
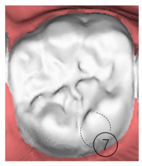
HANIHARA, K. Criteria for Classification of Crown Characters of the Human Deciduous Dentition. **Journal Of The Anthropological Society Of Nippon**, v. 69, p. 27-45, 1961.

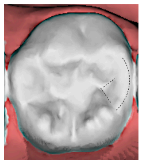
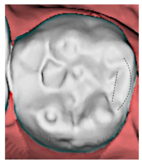
TURNER II, C. G.; NIICHOL, C. R.; SCOTT, R. Scoring procedures for key morphological traits of the permanent dentition: the arizona state university dental anthropology system. **Advances in Dental Anthropology**. New York:Wiley-Liss, 1991.

SCIULLI, P.W. Evolution of the dentition in prehistoric Ohio Valley Native Americans: ii. morphology of the deciduous dentition. **American Journal Of Physical Anthropology**, v. 106, n. 2, p. 189-205, 1998.

	TRAIT	FEATURES	GRADE	EXAMPLES
PRIMARY UPPER MOLARS	**Carabelli's trait**[3]	It occurs on the lingual surface of the protocone (cusp 1/mesiolingual cusp) and is expressed from complete absence, groove or pit to a large cusp.	**0**.Smooth mesiolingual surface; **1**.Pit, groove; **2**.Two grooves are roughly parallel; **3**.The area between grooves raised, apex not free; **4**.The expression is similar to type 3 but there is a free apex.	 um2r Grade 0  um2r Grade 2  um2r Grade 4
	Crown Pattern 1st molar[2]	The pattern is based on the development of the crown cusps of the upper 1st deciduous molars.	**2**.Only two cusps are presents: protocone(cusp 1) and paracone (cusp 2); **3M**.Protocone(cusp 1), paracone (cusp 2) and metacone(cusp 3) are present; **3H**.Protocone(cusp 1), paracone (cusp 2) and hypocone (cusp 4) are present. There is no metacone (cusp 3); **4–**.All four cusps present but hypocone(cusp 4) reduced; **4**.All four cusps present but hypocone (cusp 4) not reduced.	 um1r Grade 2  um1r Grade 3M  um1r Grade 4
	Crown Pattern 2nd molar[2]	The pattern is based on the development of the crown cusps of the upper 2nd deciduous molars.	**3**.Protocone (cusp 1), paracone (cusp 2), metacone(cusp 3), and a small distally placed hypocone (cusp 4). It is possible the distal marginal ridge connecting the hypocone with the metacone be interrupted by a groove; **4–**.Protocone (cusp 1), paracone (cusp 2) and metacone (cusp 3) attached to small hypocone (cusp4). The distal marginal ridge follows its course to the tip of the metacone (cusp3) without interruption;	 um2r Grade 3  um2r Grade 4–  um2r Grade 4

PRIMARY UPPER MOLARS			**4**.Protocone (cusp 1), paracone (cusp 2), metacone (cusp 3), and large hypocone (cusp 4).	
	Metaconule[3]	A 5th cusp on the distal border between the metacone(cusp 3) e hypocone(cusp 4). The cusp should show two parallel vertical grooves.	**0**. Absent; **P**. Present.	 um2l Grade 0  um2l Grade P
	Parastyle[1]	It is most common expressed on the paracone (cusp 2 /mesiobuccal cusp). In some instances, it occurs on the metacone (cusp 3).	**0**. Smooth buccal surface; **1**. A small pit near the buccal groove between cusps 2 and 3; **2**. Small cusp without free apex; **3**. Medium cusp with free apex; **4**. Large cusp with free apex; **5**. Very large cusp that may extend onto the surfaces of both cusps 2 and 3; **6**. Peg-shaped crown attached to root of second or third molar.	 um2r Grade 0
PRIMARY LOWER MOLARS	**Groove pattern**[1]	Lower molars can have 5 cusps: cusp 1 - protoconid, cusp 2 - metaconid, cusp 3 - hypoconid, cusp 4-entoconid and cusp 5- hypoconulid. The cusps can make contacts by creating patterns.	**Y**. Cusps 2 and 3 are in contact; **+**. Cusps 1–4 are in contact; **X**. Cusps 1 and 4 are in contact.	 lm2r Grade Y  lm2r Grade X  lm2r Grade +

PRIMARY LOWER MOLARS	**Hypoconulid**[3]	The cusp 5. It occurs on the distal occlusal surface and it associated with cusp 3 (hypoconid).	**0**. Absent; **P**. Present.	 lm1l Grade 0  lm2l Grade P
	Cusp 6[1]	This cusp is expressed on the distal portion, but it is associated with the cusp 4 (entoconid). It is important to note that cusp 5 (hypoconulid) has to be present.	**0**. Absent; **1**. Much smaller than cusp 5; **2**. Smaller than cusp 5; **3**. Equal in size to cusp 5; **4**. Large than cusp 5; **5**. Much larger than cusp 5.	 lm2l Grade 0  lm2l Grade 5
	Cusp 7[2]	It is a wedge-shaped accessory cusp expressed in the lingual groove between cusps 2 (metaconid) and 4 (entoconid). Cusp 7 is never considered in determining cusp number.	**0**.Absent; **1**.Only a very weak short groove extends downward from the lingual ridge of cusp 3 (metacone). There is no cusp; **2**.There are two grooves on the lingual surface and a small cusp is present; **3**.The cusp is well developed.	 lm2l Grade 0  lm2l Grade 2

PRIMARY LOWER MOLARS	**Protostylid**[1]	This trait is a cingular derivate on the buccal surface associated with the buccal groove, particularly separating cusp 1(protoconid) and cusp 3(hypoconid).	**0**. Smooth surface; **1**. Pit present; **2**. Buccal groove curve distal; **3**. Faint groove extending mesial from the bucal groove; **4**. Groove more pronounced; **5**. Groove stronger; **6**. Groove extend across the buccal surface; **7**. Free cusp.	 Im2l Grade 0  Im2l Grade 1
	Anterior Fovea[1]	This trait is expressed on the mesial occlusal surface. It involves distinct essential ridges on cusp 1 (protoconid) and cusp 2 (metaconid) that meet close to the center of the trigonid, and a mesial marginal ridge that is expressed to varying degrees.	**0**. Absent; **1**.Trace, with a weak ridge connecting the mesial aspects; **2**.Essential ridges on trigonid better developed and resulting groove deeper than in grade 1; **3**.Essential ridges pronounced and marginal ridge well developed, producing a distinctive fovea on the anterior portion of the trigonid; **4**. The Mesial ridge is robust and the marginal ridge produces a well-defined fovea with a very long groove.	 Im2l Grade 1  Im2l Grade 2  Im2l Grade 4
	Central Ridge of the Metaconid[2]	The form of manifestation of the essential medial ridge on cusp 2 (metaconid). This trait is the same as Deflecting Wrinkle on permanent dentition.	**1**. The essential ridge of the cusp 2 (metaconid) is expressed similar in size and prominence as that of the other cusps; **2**. The essential ridge is very well developed in its thickness on cusp 2 (metaconid) and also expands its width in the trigonid basin. The ridge sometimes seems to curve distally at its inner end.	 Im2l Grade 1  Im2l Grade 2

	Distal Trigonid Crest[2]	The major mesial cusps of the trigonid (cusp 1 - protoconid and cusp 2 - metaconid) express distal accessory ridges that are directly connected along the distal portion of the cusps. They can be continuous or discontinuous.	**0**. Absent; **1**. Present: distal borders are connected by a ridge.	 Im2r Grade 0  Im2r Grade 1

1 - ASUDAS(1991); **2** - Hanihara (1961); **3** - Sciulli (1998); **um**-Primary upper molar; **lm**-Primary lower molar; **1**-First molar; **2**-Second molar; **(r)**-Right; **(l)**-Left.

HANIHARA, K. Criteria for Classification of Crown Characters of the Human Deciduous Dentition. **Journal Of The Anthropological Society Of Nippon**, v. 69, p. 27-45, 1961.

TURNER II, C. G.; NIICHOL, C. R.; SCOTT, R. Scoring procedures for key morphological traits of the permanent dentition: the arizona state university dental anthropology system. **Advances in Dental Anthropology**. New York:Wiley-Liss, 1991.

SCIULLI, P.W. Evolution of the dentition in prehistoric Ohio Valley Native Americans: ii. morphology of the deciduous dentition. **American Journal Of Physical Anthropology**, v. 106, n. 2, p. 189-205, 1998.

ANEXOS

Anexo A. Carta de aprovação do Comitê de Ética na Universidade de Regensburg.

Universität Regensburg

Ethikkommission
an der Universität Regensburg

Ethikkommission · Universität Regensburg · 93040 Regensburg

Universitätsklinikum Regensburg
Poliklinik für Kieferorthopädie
Dr. med. dent. Christian Kirschneck
Franz-Josef-Strauß-Allee 11
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Prof. Edward K. Geissler, PhD, Vorsitzender

Ass. jur. Jan von Hassel, Geschäftsführer

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http://ethikkommission.uni-regensburg.de

13.11.2019

Unser Zeichen: **19-1549-101**

Beratung nach § 15 Abs. 1 Berufsordnung für die Ärzte Bayerns
für das Forschungsvorhaben:

Studientitel:	**AUFDECKUNG MÖGLICHER ÄTIOLOGISCHER ZUSAMMENHÄNGE ZWISCHEN BIOLOGISCHEN FAKTOREN BZW. GENETISCHEN POLYMORPHISMEN UND DENTOFAZIALEN SOWIE KIEFEROR-THOPÄDISCHEN PHÄNOTYPEN**
Antragssteller:	Dr. med. dent. Christian Kirschneck

Die Ethikkommission der Universität Regensburg hat in Ihrer Sitzung am 13.11.2019 über das o.g. Forschungsvorhaben auf Grundlage der im Anhang aufgeführten Unterlagen beraten. Es ergeben sich daraus keine berufsethischen oder rechtlichen Bedenken gegen das vorgelegte Forschungsvorhaben.

Es wird auf folgendes grundsätzlich hingewiesen:

1. Unabhängig vom Beratungsergebnis verbleibt die ärztliche und juristische Verantwortung beim Forscher und seinen Mitarbeitern. Eine Nichtbeachtung des Beratungsergebnisses kann berufs- und haftungsrechtliche Folgen nach sich ziehen.

2. Die Auflagen der Deklaration von Helsinki des Weltärztebundes in ihrer aktuellen Fassung hinsichtlich ethischen und rechtlichen Aspekten biomedizinischer Forschung am Menschen sind strikt zu beachten.

3. Die Ethikkommission erwartet bei Interventionsstudien, dass ihr alle schwerwiegenden oder unerwarteten unerwünschten Ereignisse (u.a. Todesfälle), die während der Studie auftreten und die Sicherheit der Studienteilnehmer oder die Durchführung der Studie beeinträchtigen können, unverzüglich schriftlich mitgeteilt werden. Dieses sollte in Verbindung mit einer Stellungnahme des Antragsstellers geschehen, ob aus seiner Sicht die Nutzen-Risiko-Relation des Vorhabens verändert ist.

4. Die Ethikkommission bittet darum, dass ihr der Abbruch oder Abschluss einer Studie mitgeteilt werden.

5. Dieses Schreiben ist mit den Studienunterlagen jederzeit sorgfältig aufzubewahren. Duplikate oder Abschriften dieses Schreibens können im Nachhinein nicht erstellt werden.
   Auf die Rechtspflichten zum Umgang mit dienstlichem Schriftgut bzw. Urkunden wird verwiesen.

6. Auf Grundlage dieser rein berufsrechtlichen Beratung können Sie nachträgliche Änderungen am Protokoll dieses Forschungsvorhabens vornehmen, ohne dafür eine erneute Beratung (umgangssprachlich 'Amendmentvotum') durch die Ethikkommission beantragen zu müssen. Zur Begrenzung rechtlicher Risiken wird eine solche Beratung aber gleichwohl dringend empfohlen.

   Sobald Sie jedoch ein neues Forschungsvorhaben durchführen wollen, müssen Sie dieses einer eigenständigen Beratung durch die Ethikkommission zuführen. Hierfür gilt gemäß Grundsatzbeschluss unserer Ethikkommission vom 02.08.2016:

   In der Regel handelt es sich noch um ein und dasselbe Forschungsvorhaben ohne eine erneute Beratungspflicht, wenn sich lediglich ergänzende Fragestellungen im Rahmen der selben Hypothese, methodische Erweiterungen oder Beschränkungen oder Erweiterungen oder Beschränkungen in der Studienpopulation nachträglich ergeben. Um ein neues Forschungsvorhaben handelt es sich aber in der Regel, wenn die Formulierung einer neuen Hypothese, wesentliche Änderungen am Studiengegenstand bzw. der Entität sowie wesentliche Änderungen an der wissenschaftlichen oder technischen Vorgehensweise vorgenommen werden sollen, was dann eine Pflicht zur neuerlichen Beratung durch die Ethikkommission begründet. Gesetzliche Vorschriften bleiben unberührt.

7. Die Ethikkommission bestätigt die Bearbeitung gemäß der GCP/ICH-Richtlinien.

8. Die Ethikkommission empfiehlt im Einklang mit der Deklaration von Helsinki nachdrücklich die Registrierung der Studie vor Studienbeginn in einem öffentlich zugänglichen Register, das die von der WHO geforderten Voraussetzungen erfüllt.

9. Falls kein gesetzlicher Kostenbefreiungstatbestand greift, wird ein gesonderter Kostenbescheid für die Gebühren und Auslagen der Ethikkommission ergehen.

10. **Die Übermittlung personenbezogener Daten einschließlich DNA-tragender Biomaterialien in datenschutzrechtlich unsichere Drittstaaten, wie etwa die USA, bedarf einer gesonderten datenschutzrechtlichen Beurteilung und Risikoaufklärung.**

11. **Datenschutzrecht wird durch die Ethikkommission grundsätzlich nur kursorisch geprüft. Dieses Votum ersetzt mithin nicht die Konsultation des zuständigen Datenschutzbeauftragten.**

Prof. Edward K. Geissler, PhD
Vorsitzender der Ethikkommission

Liste der eingereichten Unterlagen:

Anlageelement	Datei-Name	Eingangs-datum
Prüfplan	01 Protokoll.pdf	23.09.2019
Gegenstand des Forschungsvorhabens	02 Gegenstand des Forschungsvorhabens.pdf	23.09.2019
Angaben zum Nutzen für die Heilkunde/ wissenschaftl. Erkenntniswert	03 Angaben zum Nutzen für die Heilkunde bzw. wissenschaftlicher Erkenntniswert.pdf	23.09.2019
Nutzen-Risiko-Bewertung	04 Informationen zu Abwägung zwischen Risiko und Nutzen für den Patienten bzw. Probanden.pdf	23.09.2019
Angaben zu Anzahl, Alter und Geschlecht	05 Angaben zu Anzahl, Alter und Geschlecht der Versuchspersonen.pdf	23.09.2019
Angaben zur ethischen Problematik	06 Angaben zur ethischen Problematik.pdf	23.09.2019
Vereinbarungen zur Vergütung	07 Angaben zum Honorar für Versuchspersonen.pdf	23.09.2019
Patienteninformation	08 Aufklärungsdokument.pdf	23.09.2019
Patienteninformation	08 Aufklärungsdokument_Kinder.pdf	23.09.2019
Patienteneinwilligung	09 Einwilligungsdokument.pdf	23.09.2019
Vorgesehene Untersuchungsmethoden/ Abweichung von der üblichen Praxis	10 Beschreibung der vorgesehenen Untersuchungsmethoden und eventuelle Abweichungen von den in der medizinischen Praxis üblichen Untersuchungen.pdf	23.09.2019
Literaturverzeichnis	11 Literaturverzeichnis.pdf	23.09.2019
Angaben zur Methodik der Erfassung/ Verarbeitung personenbezogener Daten	12 Angaben zur Methodik der Erfassung und Verarbeitung personenbezogener oder personenbeziehbarer Daten.pdf	23.09.2019
Kurzbeschreibung	Kurzbeschreibung.pdf	23.09.2019

An dieser Entscheidung der Ethikkommission in Ihrer Sitzung vom 13.11.2019 haben mitgewirkt:

Prof. Dr. Karin Pfister
Prof. Dr. Karl Peter Ittner
RiAG Dr. Wolfhard Meindl
Prof. Dr. Michael Melter
Prof. Dr. Stefan Wüst
Dr. Sophie Schlosser
RAR Werner Stelzl
PD Dr. Anja-Kathrin Wege
PD Dr. Anika Bundscherer
Michael Ertl

Anexo B. Tradução para a língua inglesa da Carta de aprovação do Comitê de Ética na Universidade de Regensburg.

Universität Regensburg

Ethics Committee
at the University of Regensburg

Ethics Committee University of Regensburg 93040 Regensburg

University Hospital Regensburg
Polyclinic for Orthodontics
Dr. med. dent. Christian Kirschneck
Franz-Josef-Strauß-Allee 11
93053 Regensburg

Prof. Edward K. Geissler. PhD, Vorsitzender
Ass. jur. Jan von Hassel, Geschäftsführer
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ETHICS COMMITTEE
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1 3.1 1.2019

Unser Zeichen. 19-1549-101

Consultation according to § 1 5 Abs. 1 Professional code for the doctors of Bavaria for the research project:

Study title: **IDENTIFICATION OF POSSIBLE ETIOLOGICAL CORRELATIONS BETWEEN BIOLOGICAL FACTORS OR GENETIC POLYMORPHISMS AND DENTOFACIAL AND ORTHODONTIC PHENOTYPES**

Applicant: Dr. med. dent. Christian Kirschneck

The Ethics Committee of the University of Regensburg discussed the above-mentioned research project at its meeting on 13.11.2019 on the basis of the documents listed in the appendix. There are no ethical or legal objections to the submitted research project.

The following is generally pointed out:

1 Regardless of the outcome of the consultation, the medical and legal responsibilityremains with the researcher and his/her collaborators. Non-observance of the result of the consultation can result in professional and liability law consequences.

2 The requirements of the Declaration of Helsinki of the World Medical Association in its current version regarding ethical and legal aspects of biomedical research involving human subjects are to be strictly observed.

3 In the case of intervention studies, the ethics committee expects to be informed immediately in writing of any serious or unexpected adverse events (including deaths) that occur during the study and may affect the safety of the study participants or the conduct of the study. This should be done in conjunction with a statement from the applicant as to whether, in his or her view, the benefit-risk ratio of the project has changed.

4 The Ethics Committee requests to be informed of the termination or completion of a study.

5 This letter must be carefully kept with the study documents at all times. Duplicates or copies of this letter cannot be made subsequently.
Reference is made to the legal obligations regarding the handling of official documents.

6 On the basis of this purely professional advice, you can make subsequent changes to the protocol of this research project without having to apply for a new consultation (colloquially known as an 'amendment vote') by the ethics committee. However, in order to limit legal risks, such advice is strongly recommended.

However, as soon as you want to carry out a new research project, you must submit it to an independent consultation with the ethics committee. This applies in accordance with the basic decision of our Ethics Committee of 02.08.2016:

As a rule, it is still one and the same research project without a renewed obligation to consult if only supplementary questions within the framework of the same hypothesis, methodological extensions or limitations, or extensions or limitations in the study population subsequently arise. However, a new research project is usually involved if the formulation of a new hypothesis, substantial changes to the object of study or the entity, as well as substantial changes to the scientific or technical procedure are to be undertaken, which then justifies an obligation for renewed consultation by the ethics committee. Statutory regulations remain unaffected.

7. The ethics committee confirms the processing according to the GCP/ICH guidelines.

8. In accordance with the Declaration of Helsinki, the Ethics Committee strongly recommends the registration of the study prior to study initiation in a publicly accessible registry that meets the requirements demanded by the WHO.

9. If no statutory exemption from costs applies, a separate cost order will be issued for the fees and expenses of the ethics committee.

10. The transfer of personal data, including DNA-bearing biomaterials, to third countries that are insecure in terms of data protection law, such as the USA, requires a separate data protection assessment and risk clarification.

11. Data protection law is only examined by the ethics committee in a cursory manner. This vote therefore does not replace consultation with the responsible data protection officer.

Prof. Edward K. Geissler, PhD
Vorsitzender der Ethikkommission

List of documents received:

Investment element	File-Name	Received date
Test plan	01 Protocol.pdf	23.09.2019
Subject of the research project	02 Subject of the research project.pdf	23.09.2019
Information on the benefit for medical science / scientific knowledge value	03 Information on the benefit for medical science or scientific investigative value.pdf	23.09.2019
Benefit-Risk Assessment	04 Information on weighing up the risk and benefit for the patient or test person.pdf	23.09.2019
Information on number, age and gender	05 Information on the number, age and sex of the test subjects.pdf	23.09.20s 9
Information on the ethical problem	06 Information on the ethical problem.pdf	23.09.2019
Remuneration agreements	07 Details of the fee for test subjects.pdf	23.09.2019
Patient information	08 Reconnaissance document.pdf	23.09.2019
Patient information	08 Reconnaissance document children.pdf	23.09.2019
Patient Informed Consent	09 Informed consent document.pdf	23.09.2019
Intended examination methods/ deviation from usual Practice	1 0 Description of the intended examination methods and any deviations from the usual examinations in medical practice.pdf	23.09.20J 9
References	11 References.pdf	23.09.2019
Information on the methodology of collection/processing of personal Data	12 Information on the methodology of collection and processing of personal or personal-related data.pdf	23.09.2019
Brief description	Brief description.pdf	23.09.2019

The following participated in this decision of the Ethics Committee in your meeting of 13.11.2019.

Prof. Dr. Karin Pfister

Prof. Dr. Karl Peter Ittner

RiAG Dr. Wolfhard Meindl

Prof. Dr. Michael Melter

Prof. Dr. Stefan Wüst

Dr. Sophie Schlosser

RAR Werner Stelzl

PD Dr. Anja-Kathrin *Wege*

PD Dr. Anika Bundscherer

Michael Ertl

Anexo C: Normas para publicação no periódico Annals of anatomy.

Guide for Authors

Introduction

The journal is open to original papers covering a link between anatomy and areas such as molecular biology, cell biology, reproductive biology, immunobiology, developmental biology, neurobiology, embryology as well as neuroanatomy, neuroimmunology, clinical anatomy, comparative anatomy, modern imaging techniques, evolution, and especially also aging. Moreover, manuscripts dealing with all forms of anatomical teaching and new forms of curricula will be considered for publication. Priority will be given to experimental studies; merely descriptive studies will only be published if the Editors consider that they are of functional significance. Annals of Anatomy publish original articles as well as brief review articles.

This journal has no page charges.

Submission checklist

You can use this list to carry out a final check of your submission before you send it to the journal for review. Please check the relevant section in this Guide for Authors for more details.

Ensure that the following items are present:

One author has been designated as the corresponding author with contact details:

• E-mail address

• Full postal address

All necessary files have been uploaded:

Manuscript:

• Include keywords

• All figures (include relevant captions)

• All tables (including titles, description, footnotes)

• Ensure all figure and table citations in the text match the files provided

• Indicate clearly if color should be used for any figures in print Graphical Abstracts / Highlights files (where applicable) Supplemental files (where applicable) Further considerations

• Manuscript has been 'spell checked' and 'grammar checked'

• All references mentioned in the Reference List are cited in the text, and vice versa

• Permission has been obtained for use of copyrighted material from other sources (including the Internet)

• A competing interests statement is provided, even if the authors have no competing interests to declare

• Journal policies detailed in this guide have been reviewed

• Referee suggestions and contact details provided, based on journal requirements

Anexo D: Comprovante de submissão do artigo no periódico Annals of anatomy.

Confirm co-authorship of submission to Annals of Anatomy

Annals of Anatomy <em@editorialmanager.com>
Ter, 14/02/2023 18:02
Para: Ariane Beatriz Blancato <ariane_bblancato@hotmail.com>

ELSEVIER

This is an automated message.

Journal: Annals of Anatomy
Title: Assessing the frequency and variability of non-metric crown traits of primary and permanent molars in a German group
Corresponding Author: Prof. Dr. Erika Calvano Küchler
Co-Authors: Ariane Beatriz Blancato; Eva Paddenberg; Peter Proff; Maria Angélica Hueb de Menezes-Oliveira; Flares Baratto-Filho; Carsten Lippold; Christian Kirschneck; César Penazzo Lepri
Manuscript Number: AANAT5202

Dear Ariane Beatriz Blancato,

The corresponding author Prof. Dr. Erika Calvano Küchler has listed you as a contributing author of the following submission via Elsevier's online submission system for Annals of Anatomy.

Submission Title: Assessing the frequency and variability of non-metric crown traits of primary and permanent molars in a German group

Elsevier asks all authors to verify their co-authorship by confirming agreement to publish this article if it is accepted for publication.

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If you did not co-author this submission, please contact the corresponding author directly at erikacalvano@gmail.com.

Thank you,
Annals of Anatomy