

# HERTWIG'S EPITHELIAL ROOT SHEATH AND ITS PRESENCE IN HUMAN TEETH: A HISTOLOGICAL EVALUATION

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## REZUMAT

**Introducere:** Teaca radiculară Hertwig joacă un rol important în formarea, maturarea, dezvoltarea și erupția dintelui.

**Scopul:** Scopul lucrării este de a evidenția prezența/absența tecii Hertwig pe dinți umani permanenși tineri și dinți în dezvoltare.

**Material și metodă:** S-a utilizat colorația hematoxilină-eozină pentru caracterizarea arhitecturală și structurală a acestei structuri pe 4 cazuri de dinți umani în dezvoltare și pe 14 dinți permanenși tineri.

**Rezultate:** Teaca Hertwig a putut fi pusă în evidență doar la dinții în dezvoltare și numai rar la dinții permanenși tineri. Sunt descrise trei segmente ale tecii Hertwig, fiecare dintre ele prezentând aspecte morfologice particulare.

**Concluzii și discuții:** Teaca Hertwig are un caracter asimetric și este întotdeauna prezentă la dinții în dezvoltare. Persistența ei la nivelul dinților permanenși tineri este considerată o anomalie, însă rolul ei nu poate fi ignorat.

**Cuvinte cheie:** teaca radiculară Hertwig, resturile epiteliale ale lui Malassez, apexificare, creșterea și dezvoltarea dintelui, microscopie

## ABSTRACT

**Introduction:** In formation, maturation, growth and eruption, the Hertwig's epithelial root sheath is considered to play a major role.

**Aim:** The aim of our study was to evidence the presence/absence of Hertwig's root sheath in young, and in developing permanent human teeth.

**Material and methods:** The H&E morphological staining method has been used for the architectural and structural characterization of Hertwig's epithelial root sheath in 4 developing human teeth and in 14 young human teeth.

**Results:** Hertwig's epithelial root sheath has been identified in all developing teeth, but rarely in young teeth. 3 distinct segments of the Hertwig's epithelial root sheath are described along with their particular morphologic aspects.

**Discussions and conclusions:** Hertwig's root sheath has an asymmetric character and is always present in developing teeth; its persistence in young teeth is an anomaly, but its role cannot be ignored.

**Key Words:** Hertwig's epithelial root sheath (HERS), epithelial cell rests of Malassez (ERM), apexification, tooth growth and development, microscopy

## INTRODUCTION

Teeth growth and maturation are based on extremely complex morphological processes. In formation, maturation, growth and eruption, the Hertwig's epithelial root sheath (HERS), as well as its remnants, known as the epithelial cell rests of Malassez (ERM),<sup>1</sup> are considered to play a major role. The intimate bio-

logy and the real significance of these structures are still matter of controversy. More than this, their involvement in the pathology of the dental periapical region, and their reactivity at different materials used in endodontic treatment, as calcium oxide and hydroxide, are not yet well clarified.<sup>2</sup> If ERM are mentioned to be present at apical level by many authors,<sup>3</sup> the persistence of HERS in the apical region of permanent teeth is discussed, many authors being unable to identify it on histological samples.<sup>4,5</sup>

## AIM

The aim of our study was to evidence the presence/absence of HERS in young, and developing permanent human teeth, and to define its structure and particularities by using morphological staining methods. We used these methods in order to compare the

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considered normal aspects in incompletely developed teeth, with the persistence of these structures in young adult teeth.

## **MATERIAL AND METHODS**

Four incompletely developed human teeth (premolars, n=2 and third molars, n=2) and 14 young human teeth (premolars, n=10 and third molars, n=4), which were extracted from 10-to 18-years old patients for orthodontic reasons, have been used in this study. Informed consent was obtained from all patients before experiment. Under local anesthesia, the teeth were surgically extracted with the surrounding hard tissue, and immersed in 4% paraformaldehyde in 0.1 M phosphate buffer for 3 days. Following decalcification with 5% ethylenediaminetetraacetic acid (EDTA) for 3 months at 4°C, the specimens were sagittally cut with a Microslicer (Microm 615, Zeiss, Germany).

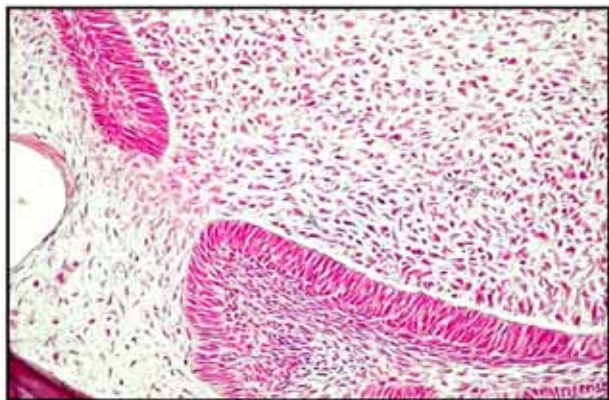
The step sections made at the apices' level (5 µm in thickness) were processed for the standard hematoxylin and eosin staining method. All microscopic examinations were made using a Nikon-Eclipse 600 Microscope, at the original magnification of ×200.

## **RESULTS**

### **Hertwig's epithelial root sheath in developing human teeth**

In developing teeth (growing teeth), Hertwig's root sheath has been identified in all 4 cases. In none of these cases the Malassez epithelial cells were identified.

Hertwig's sheath, formed from the proliferating cells of the internal and external dental epithelium, is a well defined structure, compared to the tissue of the future dental pulp, and to that of the surrounding mesenchymal tissue. (Fig. 1) The epithelial prolifera-

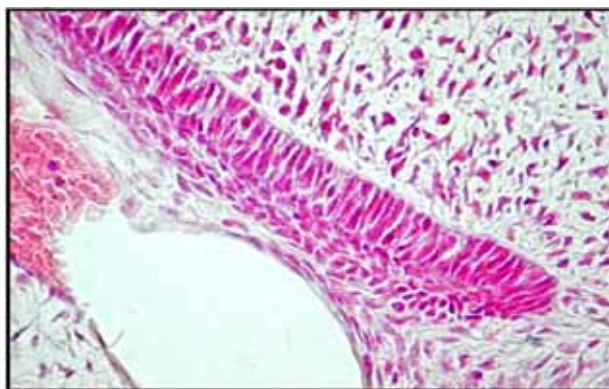


**Figure 1.** Hertwig's epithelial root sheath at the apical level of the tooth. The two terminal segments of the sheath restrict the pulpal connective tissue (right) from the mesenchymal tissue (left). H&E stain original magnification x200

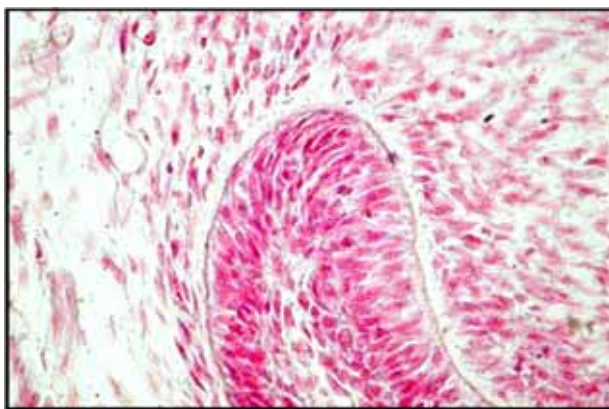
tion restricts the communicating area between the dental pulp and the connective tissue of the dental follicle. In all incompletely developed teeth, the Hertwig's sheath has an asymmetric character, its width being different for different areas of the same tooth.

The central area consists of a cell rich tissue; these cells are star-like, interconnected by cytoplasmic processes, and they are apparently disorderly arranged, creating the false impression of a connective tissue.

The terminal, deepest part of Hertwig's root sheath is elongated or rounded, and represents the front of proliferation and differentiation. (Fig. 2a, and 2b) The column cells located on the internal side of the epithelium are orderly arranged.



**Figure 2a.** The deepest part of the sheath. The internal epithelium is elongate, and well delimited from the dental pulp. H&E stain, original magnification x 200

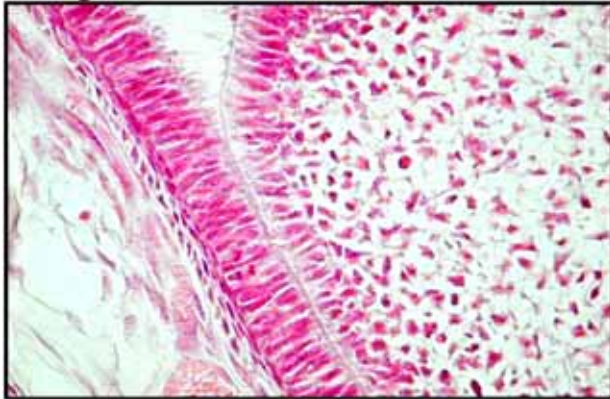


**Figure 2b.** Internal epithelial cells are column-like, external sides are smaller, and polygonal in shape. H&E stain, original magnification x 200

The external part of the epithelium contains cells smaller in size, cuboids or polygonal in shape, less orderly. The limit between the dental pulp and the internal epithelium cells is well marked by a highly chromophobic area with usual staining methods. The limit between the external epithelium and the connective tissue is less evident, and usually they couldn't be differentiated by usual staining methods.

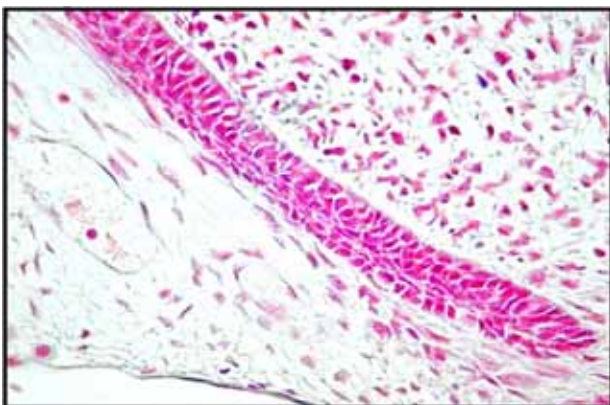
Hertwig's root sheath formation precedes odontoblasts differentiation, which confirms the

inductive effect of the internal dental epithelium on pulpal tissue differentiation. This is supported by the results obtained on step sections performed from cervical till the apical level of the tooth. In the superficial part, epithelial and odontoblast cells without an interposing structure, can be observed. (Fig. 3a)



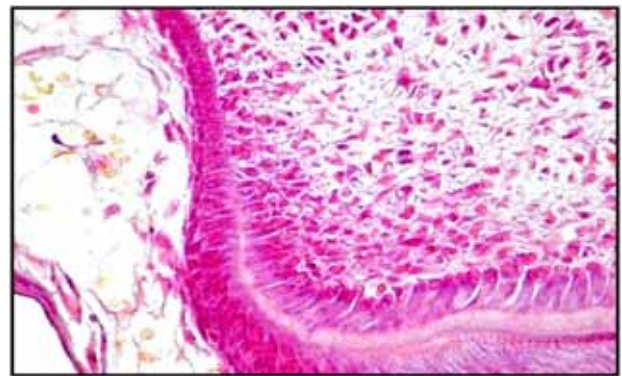
**Figure 3a.** The superficial area of Hertwig's sheath, with epithelial cells on the left side and odontoblasts on the right one. H&E stain original magnification x 200

In the deepest part, epithelial cells are less differentiated and have a short column-like form. On the pulpal side of the sheath only mesenchymal tissue can be observed, and no odontoblasts. The mesenchymal tissue is highly cellular and has a homogeneous aspect near and at distance from the epithelium. (Fig. 3b)



**Figure 3b.** The deepest area of the sheath is finger-shaped, with less differentiated epithelial cells. Odontoblasts are absent, dental pulp being homogenous. H&E stain original magnification x 200

With only one exception, similar aspects were noticed for mono- and multiradicular teeth. In multiradicular teeth, the intermediate zone between the superficial and the deepest portion of the sheath is significantly shorter. A thin layer of dentin can be identified close to the area of differentiated odontoblasts. As the epithelial cells of the outer side become flat, the outer layer of the dental pulp differentiates into odontoblasts. (Fig. 4)

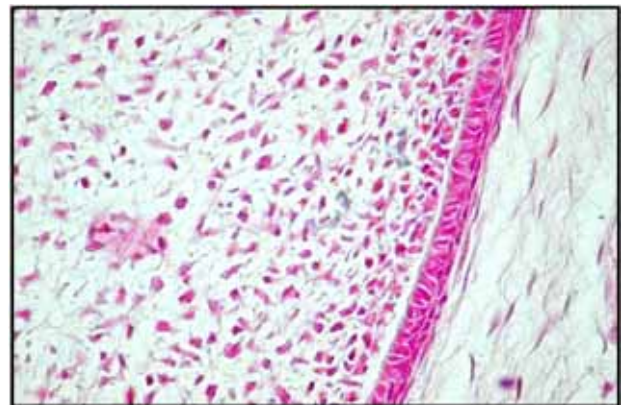


**Figure 4.** Multiradicular developing tooth. Hertwig's sheath is short because of a less represented intermediate segment. Differentiation of odontoblasts is almost synchronous with dentin deposition. H&E stain original magnification x 200

### Hertwig's epithelial root sheath in young human teeth

In young teeth, Hertwig's epithelial root sheath was observed as a continuous band of epithelial cells in only one case (from 14 cases). (Fig. 5) Epithelial cells in this only case are compact disposed and do not have a column-like shape. Consecutively, on the pulpal side of the sheath only a minimum differentiation of the odontoblasts was noticed.

In 9 of these 14 studied cases, the epithelial cell rests of Malassez were identified in the periapical region, between the conjunctive fibers of the periodontal ligament.



**Figure 5.** Monoradicular young tooth with persistence of HERS. H&E stain, original magnification x 200

## DISCUSSION AND CONCLUSIONS

Hertwig's epithelial root sheath is considered to play an important role in the development of an apical barrier by some authors.<sup>6</sup> The role of the remnants of Hertwig's root sheath cannot be ignored because of their presence in the periodontal ligament as the cell rests of Malassez and their potential for cellular activity.<sup>7</sup>

However, England and Best<sup>4</sup> found no evidence

of Hertwig's sheath in a study on animal teeth, although apical closure has occurred. Ohara and Torabinejad reported a case which demonstrated the formation of a hard tissue barrier, without involvement of Hertwig's epithelial root sheath.<sup>5</sup>

In contrast to that, in the present study, Hertwig's root sheath was found in all developing human teeth. It has an asymmetric character, and it is composed of 3 individualized parts, with particular morphology: the apical, the intermediate and the superficial part. There is a relation between the epithelial cells and odontoblasts differentiation and maturation.

The persistence of Hertwig's root sheath in young teeth (only in one from 14 cases) is an anomaly of the internal epithelium cells maturation and of external epithelium cells involution. We considered this case as representing an exception, and not the rule. That's why our results suggested an abnormal rather than a normal aspect.

More studies directed towards the role of HERS

and ERM in the apexification process induced by calcium hydroxide pastes, and their involvement in the repair of the periapical region after using different endodontic materials, need to be performed.

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