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HISTOSTRUCTURE OF DENTAL PULP IN AN ABORTED FETUS WITH MULTIPLE CONGENITAL MALFORMATIONS AND DYSMORPHIC STIGMATA AT 21 WEEKS OF GESTATION

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ქეთევან ჯანგველაძე, რამაზ ხეცურიანი, მარინა ფაილოძე, ნანა ყიფიანი, ნინო ხვიჩია, ირმა ჯიქია, მანანა არაბული, ანზორ გოგიბერიძე

ჰესტაციის 21 კვ. ვადაზე განვითარების მრავლობითი მანკების და დისემბრიონული სტიგმების მქონე აბორტუსის ჩანასახოვანი კბილის პულპის ჰისტოსტრუქტურა

თბილისის სახელმწიფო სამედიცინო უნივერსიტეტი;
ი.ჯავახიშვილის სახ. თბილისის სახელმწიფო უნივერსიტეტი

რეზიუმე

კბილის პულპა მეზენქიმური წარმოშობის მრავალუჯრედიანი ქსოვილია, რომელიც შეიცავს სისხლძარღვებს, ნერვებს, იმუნურ უჯრედებს, უმწიფარ (მეზენქიმურ სტრომულ) უჯრედებს, შემაერთებელ ქსოვილში არსებული უჯრედული და ბოჭკოვანი ელემენტების უმეტესობას. კბილის განვითარება პირველადი პირის ღრუს ამომფენი გარსიდან - ექტოდერმიდან ხდება. მინანქარი ყალიბდება - თავის ნაწილის ექტოდერმიდან, ექტომეზოდერმიდან კი ყალიბდება - დენტინი, პულპა, ცემენტი და პერიოდონტი.

პულპის ძირითადი ფუნქცია დენტინის გამომუშავებაა. პულპა დენტინს კვებავს ოდონტობლასტური მორჩების მეშვეობით. საკვები ელემენტები ქსოვილის სითხეშია. პულპა ასევე შეიცავს ნერვებს, ამ ნერვებიდან ზოგიერთი კბილის სტრუქტურებს აძლევს მგრძნობელობას, ზოგი კი სისხლძარღვების კუნთოვან ელემენტებზე დამთავრებით თავად პულპის სისხლის მიწოდების რეგულირებას ემსახურება. პულპა კარგად არის დაცული გარეგანი გაღიზიანებისგან, თუ მას დენტინის ხელუხლებელი კედელი აკრავს. მას შეუძლია ძალიან ეფექტური რეაქციის განვითარება გაღიზიანების ზემოქმედების შემთხვევაში, იქნება ეს მექანიკური, თერმული, ქიმიური თუ ბაქტერიული ხასიათის. თავდაცვითი რეაქცია შეიძლება გამოიხატოს არარეგულარული დენტინის წარმოქმნით, თუ გაღიზიანება მსუბუქია, ან ანთებითი რეაქციით უფრო მძიმე გაღიზიანების შემთხვევაში. მიუხედავად იმისა, რომ ხისტი დენტინის კედელი პულპის დაცვად უნდა ჩაითვალოს, ის გარკვეულ პირობებში მის არსებობასაც საფრთხეს უქმნის. პულპის ანთების დროს ჰიპერემია და ექსუდატი იწვევს წნევის მატებას, რამაც სისხლძარღვების ოკლუზიის გამო შეიძლება გამოიწვიოს ნეკროზი - პულპის თვითგანადგურება.

Introduction. The development of dental pulp begins at a very early stage of embryonic life, approximately on the fifty-fifth day, in the incisor region, and later in other teeth. Mesenchymal elements are known as the dental papilla. Due to the rapid development of the epithelial elements of the tooth germ, the future pulp is well-defined by its contour. In the area of the developing pulp, fibers are fine and irregularly grouped, and significantly denser than in the surrounding tissue.

At 6-7 weeks of gestation, a new epithelial outgrowth—the dental lamina—with a smooth, flat surface forms in the labio-gingival groove, which originates from the ectomesoderm of the embryonic head region. The dental lamina, derived from the oral epithelium, penetrates into the mesoderm of the upper or lower jaw. During development, the relative number of cellular elements in the dental pulp decreases, while the extracellular matrix increases. With age, the number of fibroblasts progressively declines, accompanied by an increase in the number of fibers. In embryonic and immature pulp, cellular elements dominate, whereas in a mature tooth, fibrous components are more numerous. In a fully developed tooth, the number of cellular elements decreases towards the apical region, and fibrous elements become more abundant.

Dentin is the first to develop from the tooth germ, formed by odontoblast cells. The precursor cells of odontoblasts are preodontoblasts, from which odontoblasts capable of synthesizing dentin differentiate. Odontoblast cells are closely associated with ameloblasts, and it is hypothesized that ameloblasts provide signals to odontoblasts to promote further differentiation and dentin production.

Pulp is specialized loose connective tissue, composed of cells (fibroblasts) and extracellular matrix. The latter, in turn, consists of fibers and ground substance. The fibers in embryonic pulp are precollagenous, i.e., reticular or argyrophilic. Protective cells and dentin cells, odontoblasts, are part of the dental pulp. Collagenous fibers are absent in embryonic pulp, except when they follow the course of blood vessels. As the development of the tooth germ progresses, the pulp becomes increasingly vascularized, and the cells develop into stellate connective tissue cells (fibroblasts). Cells are more numerous at the periphery of the pulp. Between the epithelium and the pulp cells, there is a cell-free layer containing numerous fibers that form the basal or limiting membrane. It is also important that the development of the vascular system in the pulp begins with the formation of hemangioblasts in the embryonic yolk sac, which differentiate into hematopoietic cells and angioblasts, which are mesoderm-derived endothelial cell precursors. Vasculogenesis describes the formation of new blood vessels from precursor cells, angioblasts.

Currently, issues concerning the development of dental pulp and neurovascular structures during embryogenesis in complicated pregnancies are insufficiently studied.

Research Objective - Histopathological study of the embryonic dental pulp in a fetus aborted at 21 weeks due to medical induction, presenting with multiple developmental malformations.

Research Tasks:

- To reveal the pulp histostructure on hematoxylin and eosin-stained preparations.
- To assess the degree of fibrosis in the pulp on Masson's trichrome-stained preparations.
- To detect the following using immunohistochemical markers:
  - Vimentin (+): strong positivity for mesenchymal cells.
  - CD34 (+): vascular network and neoangiogenesis.
  - S100 (+): neural filaments and Schwann cells.
  - Ki67 (+): proliferative activity.

Research Results:

Post-mortem pathological diagnosis:

Primary: Abortus, antenatal hypoxia and death of the fetus.

Fetus: 175g, male. Early infectious embryofetopathy.

Accompanying:

Multiple congenital developmental malformations of the fetus: anencephaly.

Cardiac anomaly: heart deformed, quadrangular shape, atrial septal defect, right atrial dilation and right ventricular muscle hypertrophy, left ventricular apex hypertrophied, rough, and rounded.

Facial dysmorphic stigmata: low-set ears, antimongoloid palpebral fissures, common intestinal mesentery, bilateral talipes equinovarus.

Complication:

Universal hyperemia and stasis in internal organs.

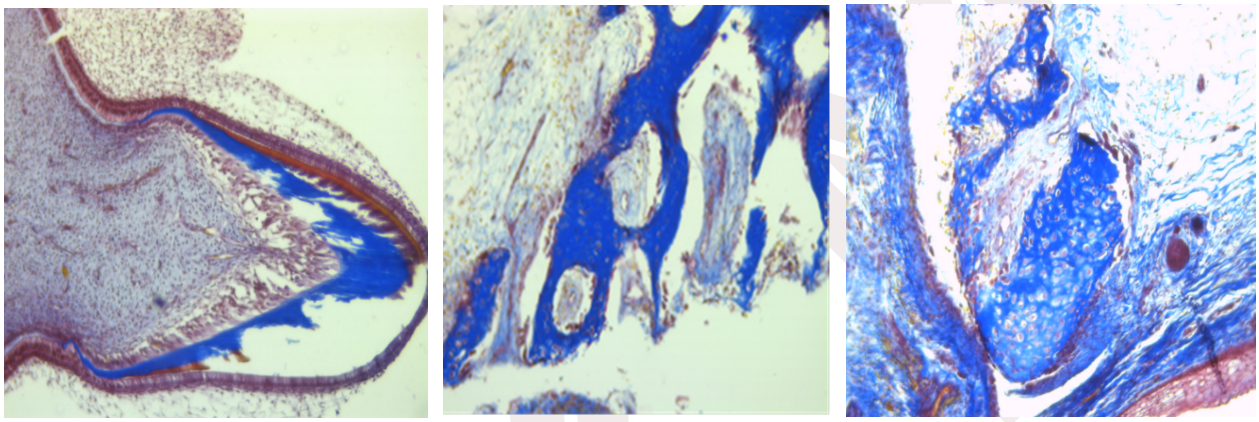
Congenital immunodeficiency state: splenic white pulp hypoplasia-delymphatization. Thymic Hassall's corpuscle agenesis with compensatory reactive proliferation of lymphocytes.

Diffuse persistence of extramedullary hematopoiesis foci in the liver.

Background:

Pathological placental immaturity - villous variant. Chorioamnionitis, umbilical cord insertion anomaly - marginal insertion.

Histomorphological Study: In hematoxylin and eosin and Masson's trichrome-stained preparations, at 21 weeks of embryonic development in the dental plate stage, fragments of superficial and dental pulp cells were observed. Adamantoblasts and enamel were moderately expressed, dental pulp showed weakly expressed angiogenesis, odontoblasts exhibited destructive changes, dentin showed fragmentation and incomplete expression (Photo 1), bone trabeculae (Photo 2), and active fibrosis (Photo 3).



Photos 1, 2, 3. 21-week aborted fetus. Embryonic dental pulp. Masson's trichrome. Leica 1000 LED. MC 170 HD, x0.25.

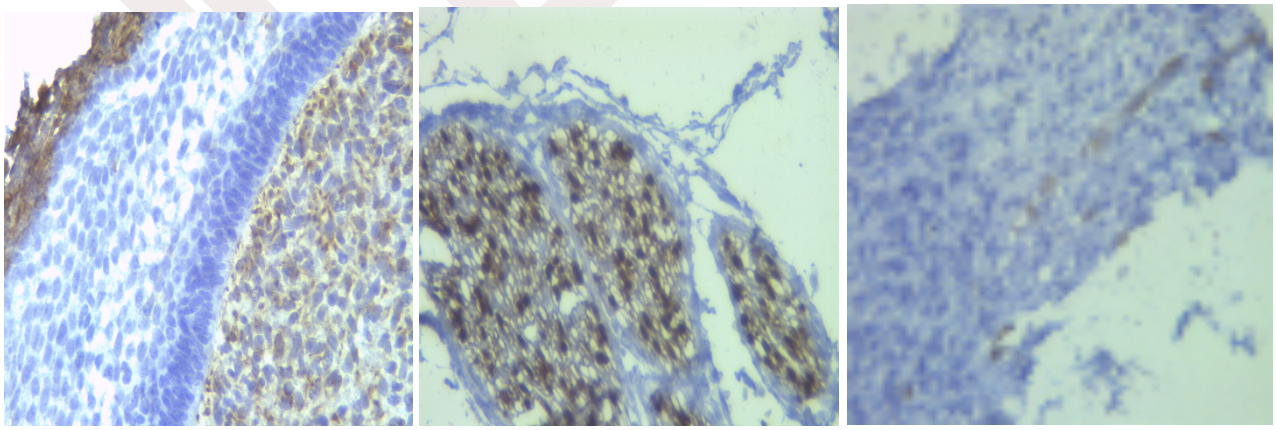
Immunohistochemical Study Revealed:

Vimentin (+): mild to moderate positivity, indicating a relatively low degree of mesenchymal cell proliferation.

CD34: insignificant focal expression, suggesting low potential for vascular network and neoangiogenesis.

S100 (+): pronounced positivity, indicating active formation of nervous tissue.

Ki67 (-): negative, indicating inhibited proliferative activity.



Photos 4, 5, 6. Immunohistochemistry. Vimentin, CD34, S100. Leica 1000 LED. MC 170 HD, x0.65.

Conclusions:

Research into the embryonic dental pulp in an aborted fetus at 21 weeks gestation, diagnosed with multiple developmental malformations following medical induction, revealed:

Disturbances in pulp development and the formation of neurovascular structures, tending towards hypoplasia. This includes a relatively low degree of mesenchymal cell proliferation, low potential for the vascular network and neoangiogenesis, inhibited proliferative activity, and a high degree of fibrosis with collagenization. Only focal activity in the formation of neural elements was observed.

Existing studies on this topic present vague and fragmented information. Consequently, experimental studies are mandatory to identify the formation and differentiation of the component elements of embryonic dental pulp during embryogenesis.

The obtained results will be significant in dental practice for all age groups, from early childhood, in terms of expected complications and for explaining various pathological processes identified, as well as for assessing diseases and developing new approaches.

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SUMMARY

Dental pulp, a multicellular tissue of mesenchymal origin, is known to contain blood vessels, nerves, immune cells, immature (mesenchymal stromal) cells, and most cellular and fibrous elements found in connective tissue. Tooth development originates from the ectoderm, the lining of the primary oral cavity. Enamel forms from the ectoderm of the head region, while dentin, pulp, cementum, and periodontium develop from the ectomesoderm.

The primary function of the pulp is dentin production. The pulp nourishes the dentin through odontoblastic processes, with nutritional elements present in the tissue fluid. The pulp also contains nerves; some of these provide sensation to tooth structures, while others terminate in the muscular elements of blood vessels, regulating the pulp's blood supply. The pulp is well-protected from external irritation when surrounded by an intact dentin wall. It can develop a highly effective response to irritation, whether mechanical, thermal, chemical, or bacterial in nature. A defensive reaction may manifest as the formation of irregular dentin if the irritation is mild, or an inflammatory reaction in cases of more severe irritation. Although the rigid dentin wall should be considered a protective barrier for the pulp, under certain conditions, it also poses a threat to its existence. During pulp inflammation, hyperemia and exudate lead to an increase in pressure, which can cause necrosis—pulp self-destruction—due to vascular occlusion.

Keywords: Histostructure, Dental Pulp, Aborted Fetus, Congenital Malformations