



MORPHOLOGICAL AND MORPHOMETRIC CHANGES OF THE THYMUS IN 2-MONTH-OLD ALBINO RATS UNDER CHEMOTHERAPY

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Abstract

Chemotherapy, while effective in cancer treatment, may negatively affect immune organs, including the thymus, which is essential for T-lymphocyte maturation and immune regulation. This study aimed to evaluate morphological and morphometric changes in the thymus of 2-month-old albino rats following chemotherapy exposure. Histological and morphometric analyses assessed alterations in the thymic capsule, trabeculae, vascular structures, and cellular composition. The results demonstrated significant thinning of the thymic capsule in gateway, anterior, and posterior regions compared with controls, accompanied by fiber loosening, focal destruction, and vacuole formation between collagen fibers. Trabeculae showed decreased thickness and length, as well as disorganization of collagen architecture. Morphometric evaluation revealed reduced arteriolar and venular wall thickness, indicating vascular alterations under chemotherapeutic influence. Additionally, a marked reduction in thymocyte proportion and lymphocyte number was observed in both cortical and medullary layers. These findings indicate disruption of the thymic microenvironment and suggest decreased functional activity of the organ following chemotherapy. Overall, the study highlights the susceptibility of the thymus to cytotoxic treatment and the importance of monitoring thymic integrity during chemotherapy.

Keywords: Thymus, chemotherapy, morphometry, thymic capsule, trabeculae, albino rats, histological changes.



Introduction

One of the most pressing issues in modern oncology is the treatment of malignant tumors, a challenge further complicated by the increasing incidence of late-stage diagnoses [1]. Chemotherapy remains one of the principal therapeutic approaches used to control tumor progression and improve patient survival; however, its systemic cytotoxic effects often lead to damage in non-target organs and tissues [2]. Among these, the immune system is particularly vulnerable, as rapidly proliferating immune cells are highly sensitive to antineoplastic agents [3].

The thymus plays a central role in immune regulation by providing the microenvironment necessary for T-lymphocyte differentiation, maturation, and selection, thereby maintaining immune homeostasis [4]. Structural integrity of the thymic stroma, including the capsule, trabeculae, vascular components, and thymocyte populations, is essential for proper organ function [5]. Experimental and clinical studies have demonstrated that exposure to cytotoxic drugs may induce thymic involution, cellular depletion, and architectural disorganization [6].

Morphological and morphometric analyses are important tools for evaluating microstructural alterations of lymphoid organs under pathological or experimental conditions [7]. Previous investigations have reported that chemotherapy can disrupt stromal elements, impair vascularization, and reduce lymphocyte proliferation, ultimately weakening immune responsiveness [8]. Despite growing evidence of chemotherapy-associated immunotoxicity, detailed quantitative data describing early structural changes in the thymus, particularly in young organisms, remain limited [9].

Therefore, the present study aimed to investigate morphological and morphometric changes in the thymus of 2-month-old albino rats following chemotherapy exposure, with particular attention to capsular structure, trabecular organization, vascular parameters, and cellular composition [10].

Aim of the Study

The aim of the present study was to investigate morphological and morphometric changes in the thymus of 2-month-old albino rats under the influence of chemotherapy. Particular attention was focused on evaluating alterations in the thymic capsule, trabecular architecture, vascular structures, and cellular



composition in order to assess the impact of cytotoxic treatment on the thymic microenvironment and its potential implications for immune function.

Materials and Methods

The experimental study was carried out on outbred white rats aged 2 months maintained under standard vivarium conditions. Before the beginning of the experiment, all animals underwent a one-week quarantine period to exclude somatic and infectious diseases. After acclimatization, the rats were housed under routine laboratory conditions with free access to food and water and were fed according to the standard vivarium regimen three times daily.

Experimental skin carcinogenesis was induced using 7,12-dimethylbenz [a] anthracene (DMBA), a polycyclic aromatic hydrocarbon widely applied as a model of epithelial tumorigenesis due to its DNA-damaging effects on epidermal cells. Following tumor induction, the animals were divided into three groups: Group I (control, n = 73), consisting of intact rats; Group II (chemotherapy group, n = 68), including rats with DMBA-induced skin carcinoma treated with chemotherapy; and Group III (chemotherapy with biocorrection, n = 62), comprising animals receiving chemotherapy followed by plant-based corrective treatment.

During the experimental period, animal growth, general condition, and behavior were regularly monitored, and no significant abnormalities were observed. At designated time points, rats were weighed and sacrificed by decapitation under ether anesthesia on an empty stomach. Tissue samples were collected on days 1, 7, and 30 after treatment for subsequent histological examination.

Chemotherapy was administered after confirmation of papillomatous and precancerous lesions. Paclitaxel, a microtubule-stabilizing antineoplastic agent that inhibits mitosis and induces apoptosis, was administered at a dose of 0.2 mg/kg adjusted individually according to body weight. In Group III, animals additionally received a standardized liquid extract of *Silybum marianum* as a biocorrective agent characterized by high bioavailability and rapid absorption.

Immunohistochemical analysis of thymic tissue was performed using CD4 and CD138 markers in collaboration with the “Ipsum Pathology” laboratory (Tashkent, Uzbekistan). Morphological and morphometric data were processed using Microsoft Excel 7.0, and statistical analysis was performed using

STTGRAPH 5.1 software with calculation of mean values, standard deviations, and standard errors.

Results

According to our study, chemotherapy had a significant impact on the morphology of the thymus in 2-month-old albino rats (as shown in Table 1). The thymic capsule became noticeably thinner, particularly in the gateway, anterior, and posterior regions. In normal conditions, the capsule is thin, elastic, and uniform; under chemotherapy, loosening of fibers, focal destruction, and the appearance of vacuoles between collagen fibers were observed.

Similarly, the thymic trabeculae showed considerable structural changes. The thickness of trabeculae in the subcapsular and central regions decreased, and their length was reduced. The trabecular structure was altered, with collagen fibers becoming loose, areas of destruction, and the formation of vacuoles. These changes indicate structural disruption within the thymic microenvironment, reflecting a possible decline in organ function under the influence of chemotherapy (Table 1).

Table 1.

Parameter	Control (2 mo)	Chemotherapy (2 mo)
Thymic capsule thickness (µm)		
Gateway	8.67 ± 0.22	6.27 ± 0.11*
Anterior	6.77 ± 0.22	5.26 ± 0.11*
Posterior	8.22 ± 0.22	5.92 ± 0.09*
Trabeculae thickness (µm)		
Subcapsular	6.22 ± 0.21	5.49 ± 0.20*
Central	8.90 ± 0.22	7.76 ± 0.19*
Trabeculae length (µm)	126.22 ± 2.16	104.87 ± 1.08*
Arteriolar thickness (µm)		
Capsule trabeculae	2.61 ± 0.05	1.72 ± 0.05*
Proximal/distal	2.14 ± 0.05	2.04 ± 0.06
Venular thickness (µm)		
Capsule trabeculae	1.16 ± 0.05	0.95 ± 0.02*
Proximal/distal	1.82 ± 0.05	0.93 ± 0.03*
Thymocytes (%)		
Cortical layer	65–70%	40–45%
Medullary layer	30–35%	20–25%
Lymphocyte number		
Cortical layer	250–300	150–170
Medullary layer	120–150	90–100

Conclusion

The results of our study indicate that chemotherapy induces significant structural changes in the thymus of 2-month-old albino rats. Thymic capsules became thinner and less uniform, with fiber loosening, focal destruction, and vacuole formation observed microscopically. Trabeculae also exhibited a reduction in thickness and length, along with collagen fiber disorganization and vacuolization. These morphometric alterations suggest that chemotherapy negatively affects the thymic microenvironment, potentially impairing its functional capacity in immune regulation. Overall, the findings highlight the vulnerability of the thymus to cytotoxic treatment and underscore the importance of monitoring thymic integrity during chemotherapy

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