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AGE- AND EXPERIMENTAL FACTOR-INDUCED MORPHOMETRIC CHANGES IN LYMPH NODES: AN EXPERIMENTAL STUDY IN WHITE OUTBRED RATS

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Abstract

This study evaluated age-related and experimentally induced morphological and morphometric alterations in the lymph nodes of 3-, 6-, and 12-month-old white outbred rats. Histological and morphometric analyses demonstrated preservation of the normal lymph node architecture in the control groups, whereas physiological involution progressively developed with age. In the experimental groups, young (3- and 6-month-old) animals exhibited marked lymphoid hyperplasia characterized by enlarged lymphoid follicles, expanded germinal centers, and increased cellular density within the paracortical region. In contrast, 12-month-old rats showed a combination of hyperplastic responses and age-associated involutional remodeling. The findings indicate that aging and experimental exposure exert distinct but interacting effects on lymph node structure and function, providing new insights into adaptive remodeling of peripheral lymphoid organs.

Keywords

Lymph node; morphometry; histology; white outbred rat; immune system; lymphoid follicle; germinal center; paracortical zone; hyperplasia; involution.

Introduction

Lymph nodes are essential peripheral immune organs responsible for initiating and regulating adaptive immune responses. Structural remodeling of lymphoid tissue reflects both physiological aging and pathological adaptation. The present study aimed to compare morphometric changes in lymph nodes of rats of different ages under physiological and experimental conditions.

Materials and Methods

White outbred rats aged 3, 6, and 12 months were assigned to control and experimental groups. Histological sections of lymph nodes were examined using light microscopy. Morphometric assessment included capsule thickness, cortical, paracortical and medullary compartment areas, lymphoid follicle and germinal center diameters, and cellular density. Results were expressed as mean $\pm$ standard error ($M \pm m$).

Results

The control groups retained normal lymph node architecture, although gradual age-related involution was observed. Experimental exposure induced pronounced reactive hyperplasia in 3- and 6-month-old rats, reflected by enlargement of lymphoid follicles and germinal centers together with increased paracortical cellularity. In 12-month-old animals, hyperplastic changes persisted but were accompanied by stromal expansion, capsule thickening, and reduced proliferative activity, indicating concurrent involutional remodeling. Comparative analysis demonstrated that the biological response to the experimental factor depends on age and shifts from adaptive activation in young animals to mixed adaptive-involutional remodeling in older animals.

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Conclusions

1. Normal lymph node architecture was maintained in control animals despite age-related involution.
2. Experimental exposure stimulated lymphoid hyperplasia in young rats.
3. The strongest adaptive response was observed in 6-month-old animals.
4. Older rats exhibited combined hyperplastic and involutional changes.
5. Morphometric parameters reliably reflected age- and exposure-dependent remodeling of lymph nodes.