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Original Article

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Adverse effects of consumption of anabolic steroids on heart: An Experimental Study

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Abstract

***Background & Aims*:** One of the most popular Anabolic Androgenic Steroids (AAS) among athletes and teenagers is Nandrolone Decanoate (ND), a synthetic testosterone analog. Chronic AAS consumption raises the risk of cardiovascular problems in athletes, however the mechanism causing such changes is not known. This experimental research aims to investigate the impact of nandrolone decanoate administration on heart in white male albino rats.

Materials & Methods: Twenty male Albino rats, split into two groups, were used in the study. Group A served as a control, getting peanut oil injections, while Group B received decanoate injections at a dose of 10 mg/kg body weight weekly for eight weeks. After the eighth week, the rats were sacrificed under anesthesia in accordance with the recommendations issued by the Ethical Committee. Following sacrifice, the rats were dissected and their tissues processed using normal histology procedures. Sections were stained with hematoxylin and eosin, and microscopic observations were recorded in groups. In order to properly label and analyze the photos, photographic microscopy was used.

***Results*:** After Eighth week, the control group's heart showed no obvious changes under microscopic examination, whereas the ND treated group showed intermuscular hemorrhages, congested myocardial vessels, widely separated cardiomyocytes, fragmented muscle fibers, and cardiomyocytes showing vesicular nuclei and few degenerative changes. These results suggest that ND treatment may cause particular cardiac structural changes in white male albino rats.

***Conclusion*:** The study suggests that Nandrolone abuse can lead to cardiac problems such as severe degeneration, myocardial vascular congestion, and intermuscular hemorrhages. The study emphasizes the significance of investigating the long-term effects of these medications, as well as the importance of well-designed studies and proper dosage considerations.

***Keywords*:** Albino Rats, Anabolic Steroids, Heart, Nandrolone Deconate

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Introduction

Nandrolone deconates are a group of synthetic derivative of testosterone that are used to maximize anabolic effects and minimize androgenic ones are known as anabolic androgenic steroids (1). Nandrolone decanoate has a half-life of six days, and is gradually released into the bloodstream after injection. It is injected intramuscularly and metabolized similarly to

testosterone, with 5α-reductase converting it to 3-norandrosterone (2). For humans, 0.4 mg/kg/day of nandrolone deconate is the approved therapeutic dose (3). A number of harmful side effects, both acute and chronic, can be brought on by consuming it (4). The activity of anabolic androgen steroids targets numerous organs and systems. Therefore, anabolic androgenic steroids may have negative effects on the immune system, cardiovascular, cerebrovascular, hepatic, musculoskeletal, endocrine, renal, and hematological systems (5-8). According to reports, anabolic androgenic steroids can improve the degree of protein synthesis during recovery and protect muscles from damage by increasing their capacity to withstand loading (9). This can lead to an improvement in tolerance to exercise. Anabolic androgenic steroids are being used illegally in large quantities by power sports athletes, such as bodybuilders and weightlifters, in an effort to gain more muscle mass and enhance their overall performance (10). Anabolic androgenic steroids are also abused by non-athletes. The Anabolic Steroids Control Act of 1990 has designated nandrolone decanoate injection as a Schedule III controlled substance (11). Most sporting organizations prohibit the non-medical use of anabolic androgenic steroids due to the significant health concerns involved. Additionally, the World Anti-Doping Agency (WADA) lists anabolic androgenic steroids (12). The misuse of these medications has grown to be a serious health issue (13). The Designer Steroid Control Act was passed in 2014 in an effort to plug the gaps for somewhat altered substances. These events fueled a massive demand for black-market products, facilitating the establishment of underground laboratories and the importation of pharmaceuticals made in countries with liberal anabolic androgenic steroid legislation (14). According to a poll, those who use anabolic androgen steroids usually don't tell their doctor that they use them and frequently have little faith in their expertise of these drugs (15). The global prevalence of Anabolic-Androgenic Steroid (AAS) use is believed to be between 1% and 5% (16). Male gender and/or athletic ability were found to be significant predictors of AAS misuse in a meta-analysis of 187 studies. The frequency is 1.6% in females and 6.4% in males (17). The cardiovascular risk associated with AAS comprises of the following: hypertension, life-threatening arrhythmia, myocardial dysfunction, coronary atherosclerosis (18), hypercoagulopathy, and hepatic dysfunction (19). In long-term steroid users, even after stopping AAS, concentrated left ventricular hypertrophy is frequently observed (21). This experimental research aims to investigate the impact of nandrolone decanoate administration on heart in white male albino rat models.

Materials & Methods

In this experimental study, injection of nandrolone decanoate for the procedure was procured from the market under the brand name Protadec^{R} 25 injection, Peanut oil.

The Wistar Albino rats served as experimental animals. The present study was conducted on a total of 20 adult male Albino rats of Wistar strain weighing 180-200 grams. The rats were procured from the Central Animal House of Government Medical College, Srinagar. Necessary clearance for the use of animals was obtained from Animal Institutional Ethical Committee constituted for this purpose.

Experimental Design:

A total of 20 male Albino rats were divided into 2 groups. **Group A**: Five rats served as Control group received an injection of 90% peanut oil. **Group B:** Fifteen rats received intramuscular decanoate at 10mg/kg body weight per week for 8 weeks. The animals were sacrificed and dissected after 8th week.

The animals were anesthetized by chloroform inhalation, as per the guidelines laid down by the "Committee for Purpose of Control and Supervision of Experiment on Animals". After sacrificing, the rats were dissected.

Histological techniques:

These tissues were processed manually for block making using standard Histological techniques. Sections measuring 5-7 micrometers will be cut and fixed on glass slides. These sections were stained with Hematoxylin and Eosin. The Microscopic observations

were recorded group wise using Light Microscope. Appropriate photographs were taken using Photographic Microscopy, labeled properly.

Results

Experimental groups were medicated with intramuscular injection of 10mg/kg body weight of nandrolone decanoate once a week, for 8 weeks respectively while Group A (Control) received injection of 90% peanut oil. The rats were sacrificed from each group at the end of the 8th week.

The animals were anesthetized by chloroform inhalation as per the guidelines laid down by the Committee. The dissection of rats was done under controlled conditions in the Animal House of GMC Srinagar with the help of the esteemed staff. A room set aside for the dissection of experimental animals was available at the Animal House, and all the equipment necessary for dissection was provided.

Gross examination of the rats was done, weight, activity, feeding, condition of the skin and presence of any external parasites were noted. All orifices were examined for the presence of discharges and any lesions either palpable or visible on the surface of the body were recorded accordingly. The Heart was identified, dissected out, cleaned, and put in containers containing formaldehyde. The gross morphology was noted and processed manually for block-making using standard histological techniques. Sections measuring 5-7 micrometers were cut and fixed on glass slides. These sections were stained with hematoxylin and eosin. The microscopic observations were recorded group-wise using a light microscope. Appropriate photographs were taken using photographic microscopy and labeled properly.

Results After the 8th week, on general examination, the animals were apparently healthy, alert, feeding well, and with no hair loss; however; their size and total body weight were increased.

Control Group [Group A]:

Microscopic features: On microscopic examination the basic architecture of the Heart was found to be preserved. No significant histological changes were seen in these animals as shown in (Figure 1)

Nandrolone Decanoate [Group B]: (10mg/kg body weight per week)

Microscopic features: Microscopic examination revealed **intermuscular hemorrhages** as shown in (Figures 2 and 3), **congested myocardial vessels** as shown in (Figure 4), **widely separated cardiomyocytes and fragmented muscle fibers** (Figure 5) and **cardiomyocytes showing vesicular nuclei and few degenerative changes** (Figure 6).

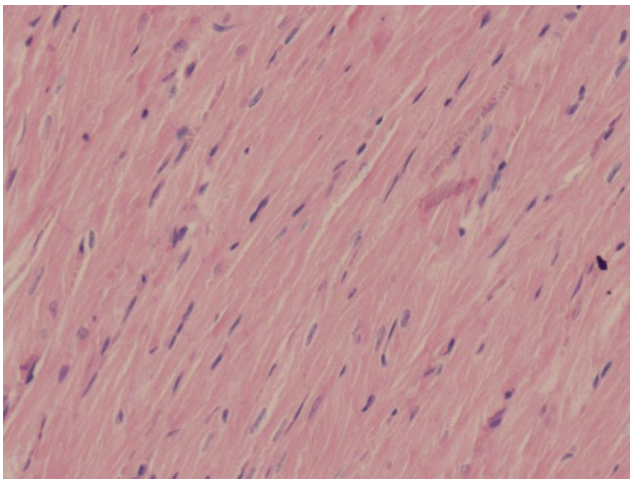

Fig. 1. Photomicrograph of cardiac tissue of the rats from group B showing normal features at the end of the 8th week

Stain: H & E **Magnification: 20x**

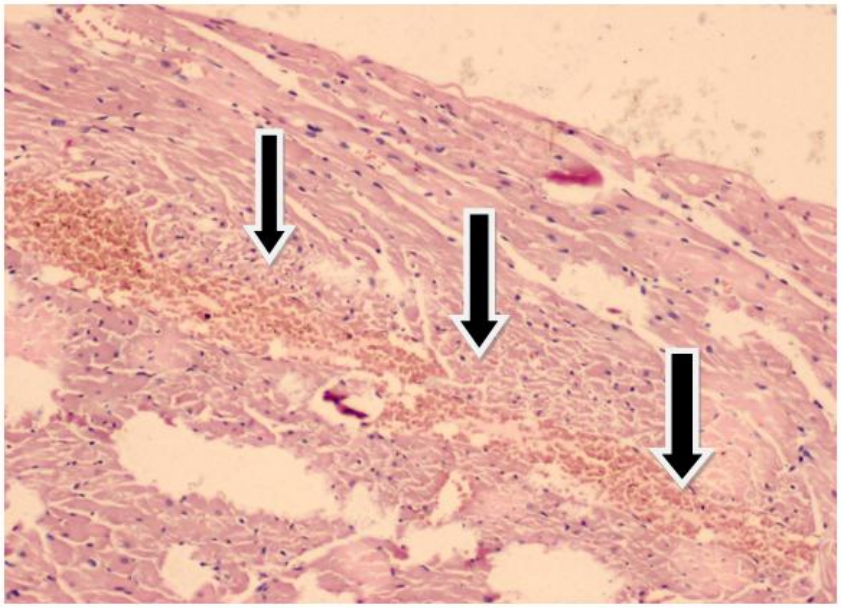

Fig. 2. Photomicrograph of heart from group B showing intermuscular hemorrhage (black arrows) at the end of the 8th week.

Stain: H & E **Magnification: 10x**

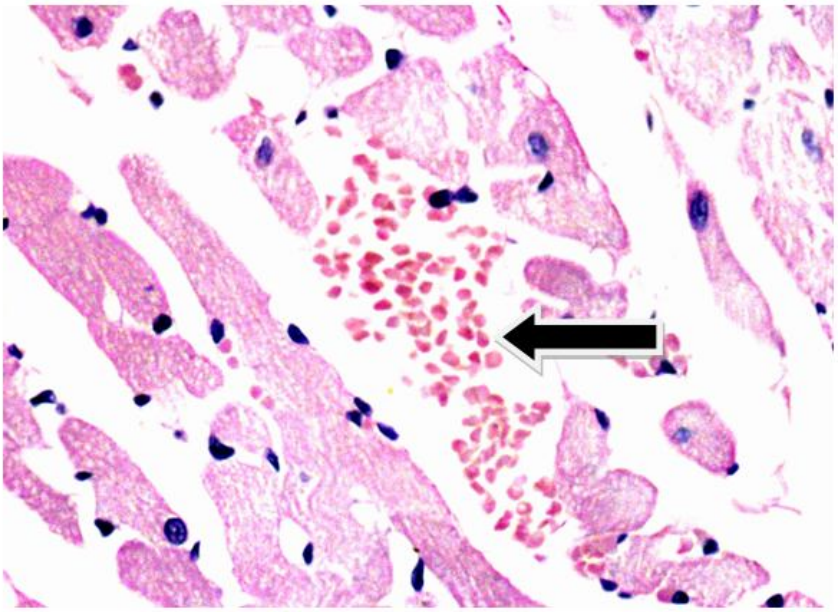

Fig. 3. Photomicrograph of heart from group B showing intermuscular hemorrhage (Black Arrow) at the end of 8th week.

Stain: H & E **Magnifcation: 40x**

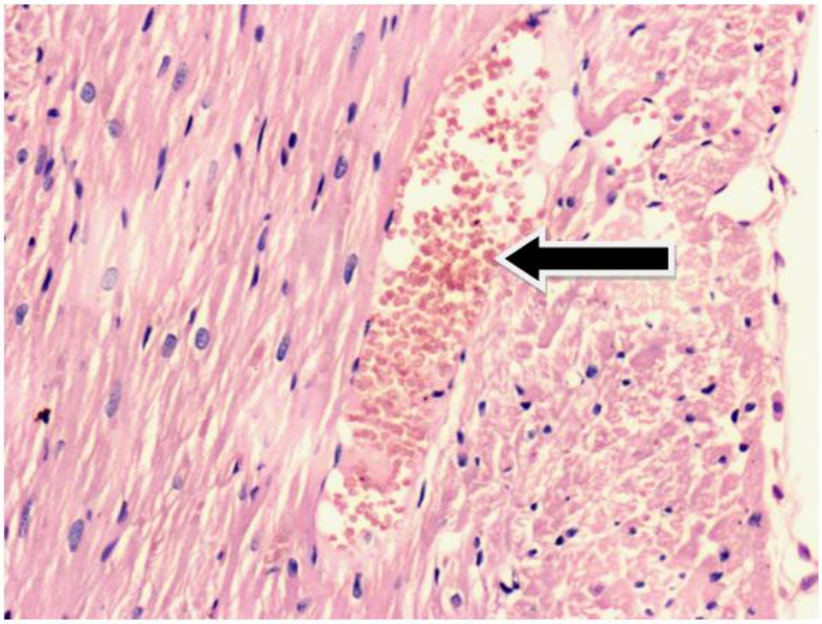

Fig. 4. Photomicrograph of heart from group B showing congested blood vessel (Black arrow) in myocardium at the end of 8th week.

Stain: H & E **Magnification: 20x**

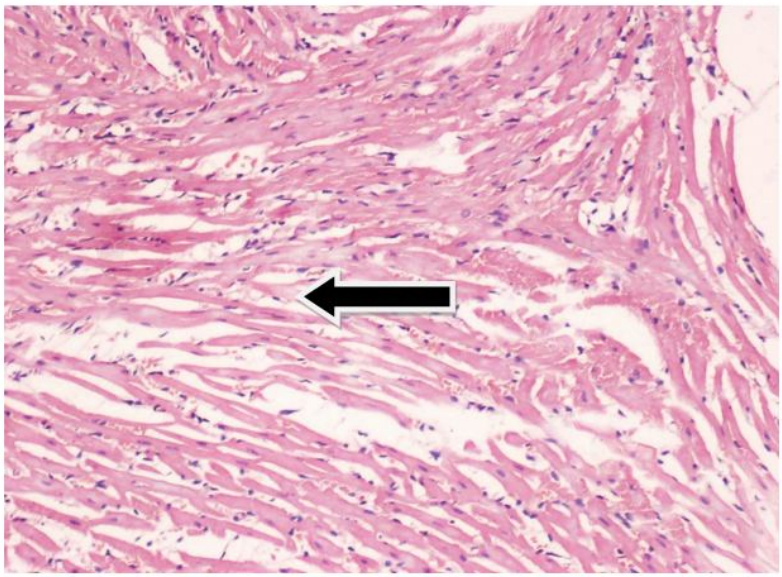

Fig. 5. Photomicrograph of heart from group B showing widely **separated cardiac myocytes and fragmented muscle fibers** (Black arrow) at the end of the 8th week of study.

Stain: H & E **Magnification: 10x**

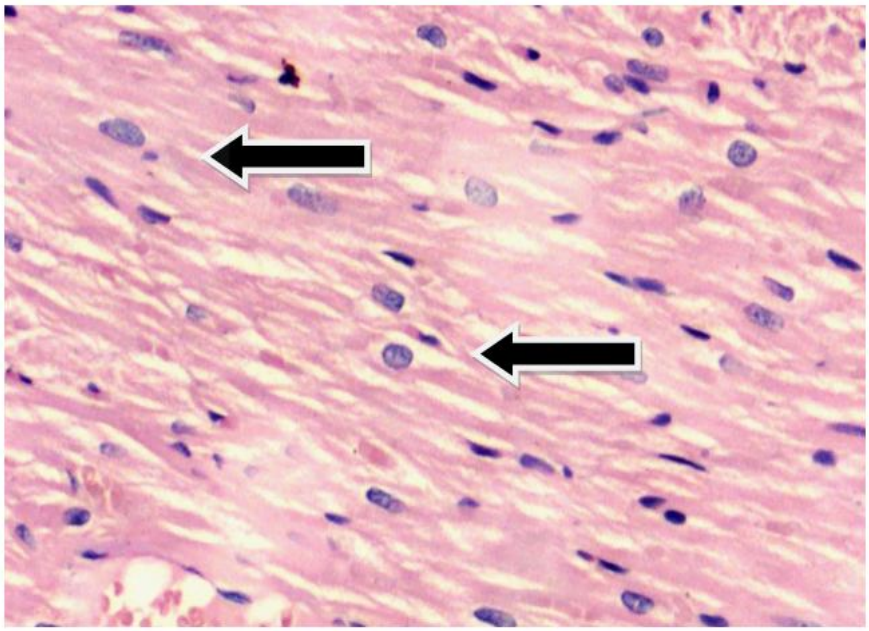

Fig. 6. Photomicrograph of heart from group B showing cardiomyocytes showing **vesicular nuclei and few degenerative changes** (Black arrow) in myocardium at the end of the 8th week.

Stain: H & E **Magnification: 20x**

Discussion

In the present study, no apparent gross abnormality was noted. Light microscopy of cardiac tissue revealed normal histology of the heart in Group A (Control). Group B (ND) at the end of the 8thweek, shows intermuscular hemorrhages, congestion of myocardial vessels, separated cardiacmyocytes and fragmented muscle fibers, vesicular nuclei and severe degenerative changes.

Ren (22) showed that steroids alone can induce cardiomyocyte hypertrophy a dose much higher than that used in our study (15%) increase with nandrolone alone. The divergence may be the result of different study design (e.g., their study was performed in cell culture conditions); therefore, the doses of the hormones may not be comparable.

Abdelhafez (23) showed highly degenerated muscle fibers with areas of hemorrhage and widened endomysium. Also, she demonstrated a numerous pyknotic and karyolytic nuclei.

The same findings were obtained by Soliman (24) who found that nandrolone administration causes a 10-fold increase in heart collagen.

Parssinen (21) added that this effect tended to be dose-dependent. These short-term changes in collagen metabolism may be explained by increased anabolic effects in muscle. The same results were obtained by Soliman (24).

Also, Elgendy (25) reported hypertrophy and degeneration of both cardiac and skeletal muscles and explained this by its effect on the androgen receptors that are widely distributed in different types of muscles.

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Conclusion

According to this study, using nandrolone can cause cardiac abnormalities like severe degenerative changes, myocardial vascular congestion, and intermuscular hemorrhages. These findings are consistent with earlier research, which has suggested increased collagen and muscle fiber degeneration. As the main limitation of the current study was low study population, the study's findings highlight and recommended the significance of future research into the long-term effects of these medications and effects of toxic doses of nandrolone, as well as careful consideration of study design and dose.

Acknowledgments

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Ethical statement

This study was conducted after approval by the ethics committee of Government Medical College, Srinagar with code of ethics MC-421 (GMCS-2020).

Data availability

The raw data supporting the conclusions of this article are available from the authors upon reasonable request.

Author contributions

All the authors contributed equally from study design, methodology, procurement of drug used, processing of tissues, results, discussion to final submission.

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None.

Conflict of interest

The authors have no conflict of interest in this study.

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