



Effects of local nandrolone decanoate on TGF-1 β and IGF-1 in the healing of the muscle wound

T.M. Al-Abdullah^{ID} and F.A. Al-Mashhadane^{ID}

Department of Dental Basic Sciences, College of Dentistry, University of Mosul, Mosul, Iraq

Article information

Article history:

Received March 20, 2023

Accepted June 7, 2023

Available online September 15, 2023

Keywords:

Nandrolone decanoate

Muscle

TGF-1 β

IGF-1

Correspondence:

F.A. Al-Mashhadane

faehaaazher@uomosul.edu.iq

Abstract

Identifying the appropriate therapy for the problem of exposure to muscular wounds is an essential issue in people and in animals, especially racing animals such as horses, in whom muscular function is part of life. This study investigates the hypothesis that local application of the steroid nandrolone decanoate to the masseter muscle accelerates the healing as combined with pathological repair. The rabbits were split into two equal groups at random. The first group (ten rabbits), known as the control group, had surgery and received distilled water injections. The second group (ten rabbits) had surgery and received intramuscular injections of nandrolone decanoate 10 mg/kg once daily from the first day after surgery to day of sacrifice. Five rabbits from groups A and B were sacrificed on the third and seventh days. All animals were euthanized, and then masseter muscle tissue was removed for histological analysis. Three days following the surgical wound, a microscopic inspection of the control group's muscular wounds revealed severe myositis with inflammatory exudate cells, hemorrhages, and necrotic myofibrils. Acute myositis wound site with inflammatory exudate cells, atrophy and increase in connective tissue was present after seven days. Three days following the surgical wound, a microscopic examination of the treated group's muscular wounds revealed mild myositis with inflammatory cells, vitreous degeneration, and muscle fiber atrophy. Following seven days, mild myositis with inflammatory cell infiltration, muscle fiber atrophy, and hyaline degeneration manifested at the site of wound. On the 3rd day of treatment period, the levels of serum TGF-1 β and IGF-1 in the groups of study indicated a highly significant difference, however on the seventh day; there was no difference between the groups. Local Nandrolone decanoate helps hasten the healing of muscle wounds.

DOI: [10.33899/IJVS.2023.139125.2885](https://doi.org/10.33899/IJVS.2023.139125.2885), ©Authors, 2023, College of Veterinary Medicine, University of Mosul.

This is an open access article under the CC BY 4.0 license (<http://creativecommons.org/licenses/by/4.0/>).

Introduction

Anabolic androgenic-steroids are one of synthetic testosterone derivatives that are designed to increase anabolic activity while decreasing androgenic side effects. They have become extremely well-known in the previous 50 years (1-3). AAS have a wide range of medicinal applications. It can be use in treatment the muscle wasting as well as a number of other chronic illnesses like cancer, kidney failure, cirrhosis, lung disease, and muscular

dystrophy may all benefit considerably from AAS's anabolic effects (4,5). The research in the context of protracted immobility. Preclinical investigations have demonstrated beneficial outcomes in the Period following injury of spinal cord that is characterized by loss of volumetric muscle and bone weakness (6,7). The positive impact of AASs on strength and muscular mass is becoming clearer. The anabolic effects of AASs in the muscles have recently been advocated as a way to enhance postoperative healing, including recovery from muscular injuries. However, it is

still unclear exactly what part their administration played in those processes (8). Although skeletal muscle is known to have, a considerable capacity for self-repair, more severe wounds may result in incomplete or delayed healing that is compounded by fibrosis. There is a link between testosterone and the procedures involved in muscle regeneration, according to preclinical investigations. AASs impact on muscle regeneration has only been examined in a small number of research, and the available information is inconsistent. In an intramuscular toxic injection study, Ferry *et al.* (9) investigated the nandrolone decanoate effects on the extensor soleus and longus digitorum-muscles. Researchers discovered that nandrolone decanoate increases soleus muscle mass in comparison to controls (9). Giving nandrolone decanoate will boost muscle regeneration, which is permitted depending on the quantity and shape of the muscle fibers present in such muscles, according to the findings of additional preclinical investigations (10,11). Preclinical outcomes may change depending on type of muscle injury sustained, dosage and duration of androgen treatment, and the outcome variables. The androgens' role in stimulating regeneration of muscle has not yet been studied in humans. Additional clinical research will be required to fully realize the therapeutic implications of AAS in surgery. This will be done in the clinical sectors in order to better characterize their effects on tissues and generate better therapy regimens. These studies will aid in determining how the testosterone and AAS affect regeneration of the muscle, as well as the appropriate dose and period for potential clinical advantages. In some clinical settings, such as a muscular injury, there are evidence that AASs improve the biological healing environment and speed up recovery after surgery. Despite the fact that study on this topic is ongoing, the most recent studies have not offered credible evidence in favor of or against the usage of AAS systems. (12). IGF-1 is essential for tissue restoration since it has the power to promote wound cell activity. Although liver-derived IGF-1 is released locally by wound cells and is present in high concentrations in the bloodstream, it is unknown if these substances have any impact on the healing of wounds (13). TGF is a family of growth factors that affects numerous cellular functions. The TGF-1, 2, and 3 isoforms are produced as inactive precursors that need to be activated before attaching to the TGF-1 β receptor. Each of the three isoforms is present during wound healing (14). The use of anabolic steroids to help muscle tissue repair is still debatable. This experiment tests the idea that, when used in conjunction with surgical repair, the nandrolone decanoate is injected locally. to the masseter-muscle promotes healing.

Materials and methods

Ethical approval

The experiment for this study was put into practice after receiving approval from the Research Ethics Committee and

the Scientific Committee at the Department Basic Dental Sciences, College of Dentistry, University of Mosul, approval No. UoM-Dent/A.82/22.

Animals

The study used twenty local male rabbits, ranging in age from 11 to 12 months and weighing 1-1.5 kg. Animals were kept individually in cages with specific circumstances temperature 25 \pm 2 $^{\circ}$ C/12:12 hr light-dark cycle, free reach to water, and a regular food (15).

Surgical procedure

Ketamine-hydrochloride in a dose of 50 mg/kg and 5 mg/kg xylazine-hydrochloride was administered intramuscularly to anesthetize the animals (16). The surgical space area was shaved, then cleaned with distal water and sterilized with povidone iodine solution. The sedated animal was then placed on its ventral side on the surgical pad. With a surgical blade no. 15 and forceps, a 1 cm is a long of incision was created in animal skin and deep within the masseter muscle (17). Later, with the primary purpose of promoting healing, the wounds were sutured with absorbable sutures. Only on the first day did the animals given antibiotics and painkillers. The rabbits were split into two equal groups at random. The first group (10 rabbits), known as the control group, had surgery and received distilled water injections as their only medical care. The second group (10 rabbits). The treatment groups. From the first day of surgery to the day of euthanasia, the rabbits received intramuscular injections of nandrolone conjugates 10 mg/kg once day using a Mantoux syringe.

In accordance with the day of euthanasia, five rabbits from group A and, group B was sacrificed on the third and seventh days. Blood was drawn from rabbits for the purpose of collecting serum for bio-chemical parameter analysis. Serum was separate by centrifugation, stored at -20 $^{\circ}$ C, pending analysis with rabbit transforming growth factor (TGF-1) ELISA kit BT LAB (Bioassay Technology Laboratory) Cat No-E0133.Rb and IGF-1 (CLIA) kit MAGL.UMI $^{\circ}$. Moreover, masseter muscle-containing tissues are surgically removed, cleaned with physiological saline, and put in 10% formalin for morphological and histological analysis. A pathologist evaluated these sections for histological alterations.

Statistical analysis

The study data statistically analyzed by one way ANOVA test and between groups were analyzed by Duncan's Multiple Range Test.

Results

Clinical observations

The veterinarian was constantly monitoring the animals. Except for local alterations in the wound region relative to

the control group, no toxicities, fatalities, atypical symptoms and signs in the activity, behavioral-pattern, or other clinical signs were noted during the period of study in any of the treated groups.

First 3 days

According to Tables 1 and 2, the IGF-1 and TGF-1 levels in all research groups. revealed a significant increase in the IGF-1 and TGF-1 levels in the treatment group compared to control groups at the 1st 3 days (Figures 1 and 2).

Table 1: Comparison of serum IGF between treated groups

	Squares Sum	df	Mean Square	F	Significant
Between-Groups	10683.989	2	5341.995	99.562	0.000**
Within Groups	643.860	12	53.655		
Total	11327.849	14			

** Highly Significant at $P \leq 0.01$.

Table 2: Comparison of TGF in serum between groups

	Squares Sum	df	Mean Square	F	Significant
Between-Groups	0.087	2	0.043	30.723	0.000**
Within Groups	0.017	12	0.001		
Total	0.104	14			

** Highly Significant at $P \leq 0.01$.

Second 7 days

TGF and IGF revealed a very substantial distinction. As indicated in tables 3 and 4. After seven days of the trial, there were significant decrease the IGF-1 and TGF-1 levels in the treatment group compared to control groups. No discernible distinction can be seen between the other groups (Figures 3 and 4).

I.G.F.

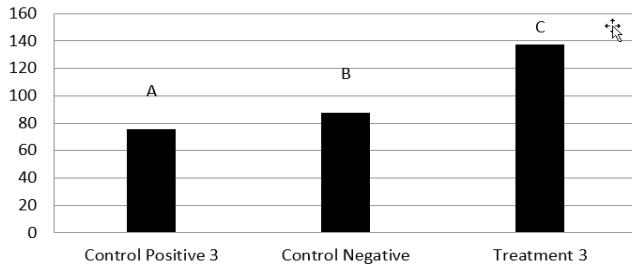


Figure 1: IGF measurements at the end of the first three days.

T.G.F.

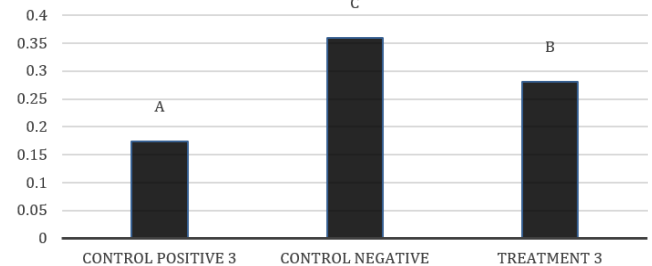


Figure 2: TGF-1β measurements at the end of the first 3days.

Table 3: Comparison in IGF between treated groups

	Squares Sum	df	Mean Square	F	Significant
Between-Groups	2555.041	2	1277.521	6.724	0.011**
Within Groups	2279.908	12	189.992		
Total	4834.949	14			

** Highly Significant at $P \leq 0.01$.

Table 4: Comparison in TGF-1β between treated groups

	Squares Sum	df	Mean Square	F	Significant
Between-Groups	0.071	2	0.035	38.828	0.000**
Within Groups	0.011	12	0.001		
Total	0.082	14			

** Highly Significant at $P \leq 0.01$.

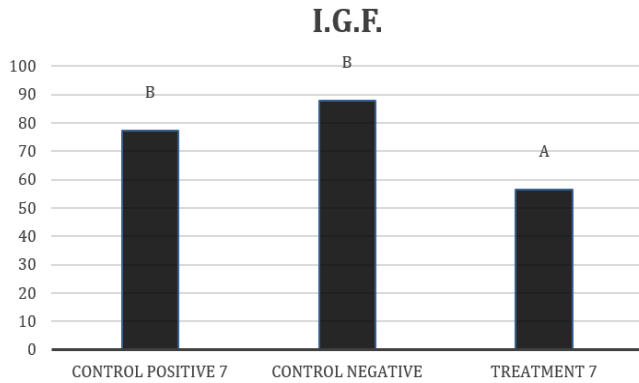


Figure 3: IGF measurements at the end of the 7 days.

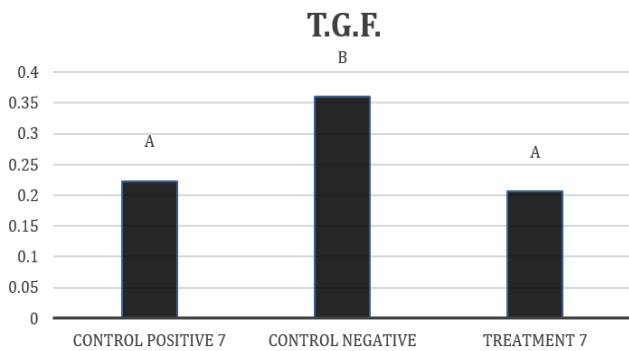


Figure 4: TGF-1β measurements at the end period of 7 days.

Histopathological findings

Microscopic analysis for muscular wounds of the control group after three days of surgery revealed severe myositis with inflammatory exudate cells, hemorrhagic myofibers, and necrotic myofibers (Figures 5-8). An acute myositis wound site with inflammatory exudate cells, atrophy, hemorrhage, and an increase in connective tissue was present after 7 days (Figure 9). Three days following the surgical wound, a microscopic examination of muscular wounds of the treated group's revealed mild myositis with inflammatory cells, hyaline degeneration, and muscle fiber atrophy (Figures 10 and 11). Following 7 days, the wound site displayed mild myositis with inflammatory cell infiltration, muscle fiber loss, and glassy degeneration (Figures 12 and 13).

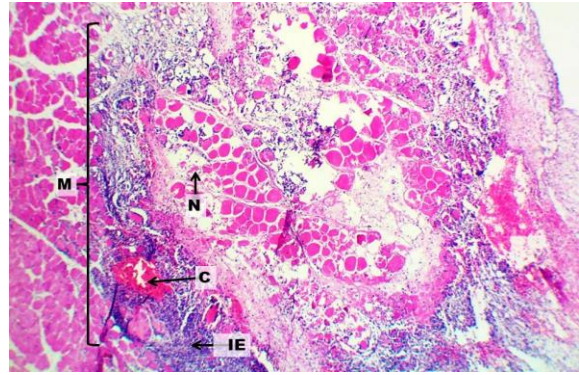


Figure 5: photomicrograph of rabbit masseter muscles of the control after 3 days showing the site of wound with severe myositis (M) composed of inflammatory exudation cells (IE), congested blood vessel (C) and necrotic muscles fibers (N). H&E stain, 40X.

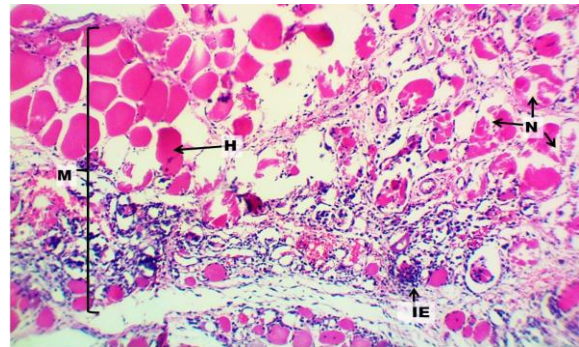


Figure 6: photomicrograph of rabbit masseter muscles of the control group after 3 days showing the site of wound with severe myositis (M) composed of inflammatory exudation cells (IE), hyaline degeneration (H) and necrotic muscles fibers (N). H&E stain, 100X.

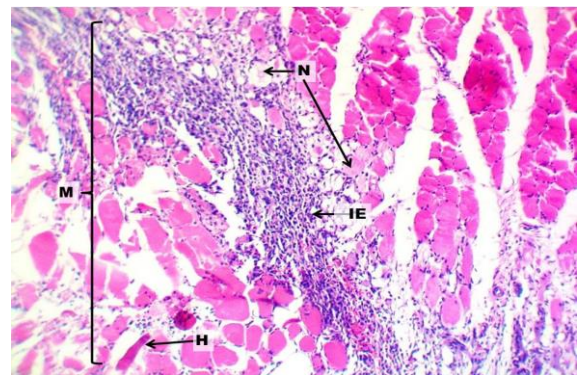


Figure 7: photomicrograph of rabbit skeletal muscles of the D2 group (surgical wound with D.W) after 3 days showing the site of wound with severe myositis (M) composed of inflammatory exudation cells (IE), hyaline degeneration (H) and necrotic muscles fibers (N). H&E stain, 100X.

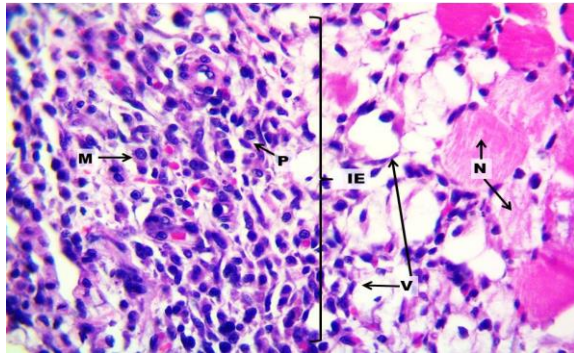


Figure 8: photomicrograph of rabbit masseter muscles of the control after 7 days showing the site of wound with severe myositis with inflammatory exudation cells (IE) composed of polymorph (P) and mono nuclear (M) inflammatory cells, increased vascularization (V) and necrotic muscles fibers (N). H&E stain, 400X.

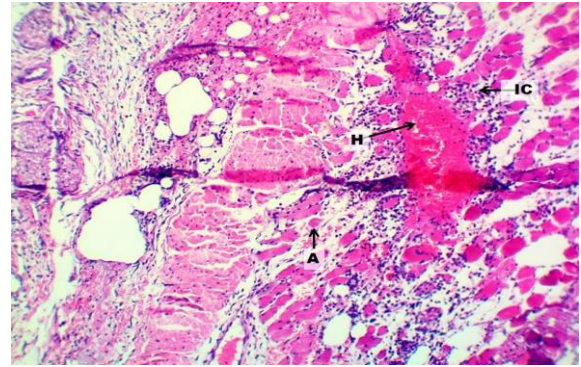


Figure 11: photomicrograph of rabbit masseter muscles of the treatment group) after 3 days showing mild myositis with mild inflammatory cells infiltration (IE), atrophy of muscles fibers (A) and hemorrhage between it (H). H&E stain, 100X.

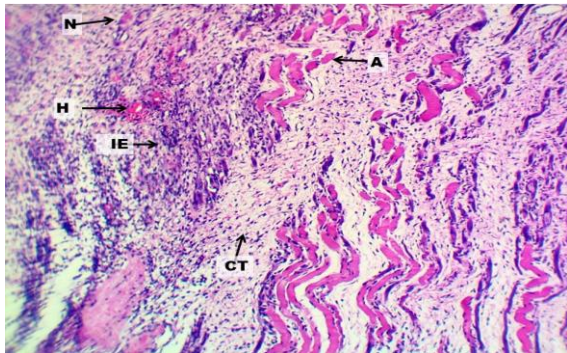


Figure 9: photomicrograph of rabbit masseter muscles of the control group after 7 days showing the site of wound with severe myositis (M) composed of inflammatory exudation cells (IE), necrotic muscles fibers (N) with atrophy (A), hemorrhage (H) and increased connective tissue (CT). H&E stain, 100X.



Figure 12: photomicrograph of rabbit masseter muscles of the treatment group (surgical wound with treatment) after 7 days showing moderate myositis (M) with inflammatory cells infiltration (IC), atrophy (A) and hyaline degeneration (HD) of the muscles fibers (A). H&E stain.

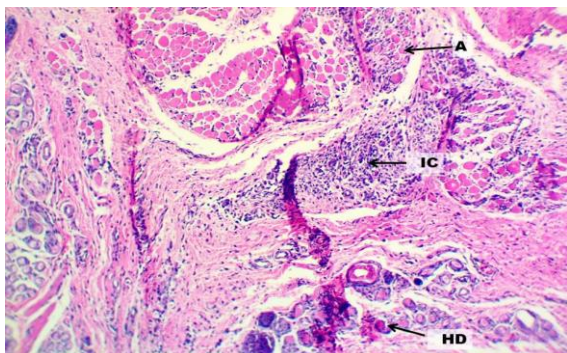


Figure 10: photomicrograph of rabbit masseter muscles of the treatment group after 3 days showing mild myositis with inflammatory cells (IC), hyaline degeneration (HD) and atrophy (A) of the muscle's fibers. H&E stain, 100X.

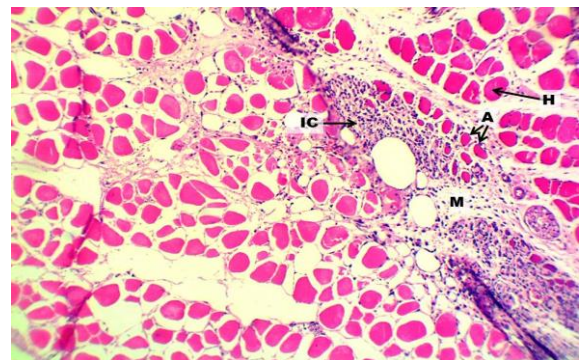


Figure 13: photomicrograph of rabbit masseter muscles of the treatment group (surgical wound with treatment) after 7 days showing moderate myositis (M) with inflammatory cells infiltration (IC), atrophy (A) and hyaline degeneration (HD) of the muscles fibers (A). H&E stain, 100X.

Discussion

Although anabolic steroid use has been shown to affect skeletal muscle, little is known about how much faster muscle will regenerate after an injury. The aim of this research was to ascertain whether nandrolone decanoate topical injection enhances muscle regeneration and repair following a surgical incision. Exogenous stimulants have been studied in animal models to stimulate muscle regeneration following various muscle injuries. Nandrolone decanoate was externally administered to non-castrated rats in a prior study, and the results demonstrated its positive effects on calf muscle regeneration following a crush injury. Anabolic steroid use after muscle damage caused by snake venom in healthy rats also promotes the growth of soleus muscle mass (18-21). Further research is required on the modification of exogenous nandrolone decanoate for muscle regeneration. Moreover, nandrolone decanoate had an interest in mice that successfully recovered from muscle graft surgery (22,23). Although anabolic steroids' ability to regulate muscle regeneration following injury has been thoroughly studied (24,25), their impact on these regenerative mechanisms has not yet been fully appreciated.

The first events of skeletal muscle regeneration following damage resemble those of healing and typically call for the simultaneous control of inflammation, extracellular matrix remodeling, and myofiber development (26,27). Moreover, anabolic steroids have improved control over the activity of immune cells, fibroblasts, and myogenic precursors, all of which are essential for any tissue regeneration (28-32). The idea was that administering nandrolone decanoate would promote the development of tiny muscle fibers and IGF-1 signaling during the first 14 days of regeneration, supporting and promoting improved muscle growth 42 days after injury. Different skeletal muscles' sensitivity to levels of circulating androgen had been noted (33).

In a study, anabolic steroids were used to see how well they would help skeletal muscle regenerate after being injured by bupivacaine. After 5, 14, and 42 days after starting treatment, nandrolone decanoate injection alone boosted the expression of muscle proteins. At 14 days of healing, nandrolone decanoate enhanced protein expression in damaged muscle by three times over the control level. When injured muscles were given nandrolone decanoate, protein expression was dramatically increased compared to control muscles. The synergistic effects of damage and nandrolone decanoate on muscle growth and regeneration suggest that injured muscles treated with nandrolone decanoate will be more responsive to androgens. Accelerating the formation of muscle mass by nandrolone decanoate during injury healing may depend on androgen receptor stimulation of the target gene's transcription.

The findings of the present investigation showed that nandrolone decanoate has a faster effect on muscular injury recovery within a few days. There is proof that nandrolone

decanoate -induced myofiber development in injured muscles starts at an early stage of the recovery process. Increased fiber is the main cause of the faster nandrolone-induced muscle growth after recovery. Within a few days of healing, nandrolone decanoate-treated injured muscles showed a considerable elevation of the gene expression of skeletal actin, an important sarcomere protein. This important extrapolation suggests that the muscle fibers stimulated by regeneration, and anabolic-steroid treatment are in an active state of recovery, where they are growing. The most recent results build on earlier trials to show that anabolic steroid therapy can quicken the repair of injured muscles by accelerating an early muscular response. Two main processes can help steroid-induced healing. The first is that the nandrolone decanoate group experienced an increase in IGF-1; the second is that there may be a potential increase in muscle development as a result of the administration of nandrolone decanoate. The substantial rise in microfibrils observed with damage and nandrolone decanoate is evidence that the two components combined can promote fibril production (34).

TGF-1 levels increase over the course of the investigation; the third day of the trial saw the greatest increase. Platelets emit substantial levels of TGF-1 shortly after infection (34). Neutrophils, macrophages, and fibroblasts are drawn to the initial rise in active TGF-1 produced by platelets, and as a result, these cell types raise TGF-1 level in another cell. Also, to the active-forms, latent TGF-1 is also produced and locked away in the wound matrix, where it is released over time by proteolysis enzymes. TGF-1 is always present during the wound healing process thanks to this combination of cellular sources and buffering (35). Our findings are in line with those of Rorison and colleagues, who discovered that in case with successful healing of burn in the first two-weeks following damage, plasma TGF-1 rapidly surged to much higher level and then swiftly declined.

IGF-1 levels varied during the time of the current investigation. The concentration increased on the third day and fell to virtually normal level at the end of the study, which is consistent with the fact that IGF-1 concentrations changed during therapy. Due to the elevated IGF-1 observed in the Nandrolone decanoate group infection, we used the IGF-1 and TGF-1 to measure the effect of nandrolone decanoate (36). IGF-1 also regulates cell proliferation, differentiation, and survival, which is essential for growth and development during adolescence and for maintaining homeostasis in adult tissues (37). The key growth- factor involved in every step of the healing is TGF-1. It contributes to cutaneous fibrosis in patients who have undergone profound trauma, surgery, or injury (38).

Along with being simple to acquire and measure in vitro, TGF-1 has been found to be effect on a number of wound healing processes, such as the inflammation, the angiogenesis, the fibroblast proliferation, and the collagen

synthesis (39,40). This research has several restrictions. Short study length and small sample size. Yet we think that topical anabolic steroid use has certainly positive effects on masseter muscle rehabilitation. To verify these findings, additional research is required.

Conclusion

The direction of recovery might be changed by administering nandrolone locally to the wounded rabbit muscle. Complementary pharmacological treatments may help the facial muscles repair and recover after surgical wounds.

Conflicted interest

None.

Acknowledgment

All thanks for College of Dentistry in University of Mosul for all supports.

References

- Haupt HA, Rovere GD. Anabolic steroids: A review of the literature. *Am J Sports Med.* 1984;12:469-484. DOI: [10.1177/036354658401200613](https://doi.org/10.1177/036354658401200613)
- Siperstein G, Romano N, Iskenderoglu G, Roman A, Fowler Jr FJ, Drascher M. The American public's perception of illegal steroid use: A national survey, 2013, Boston: University of Massachusetts, 2013.
- McDuff D, Stull T, Castaldelli-Maia JM, Hitchcock ME, Hainline B, Reardon CL. Recreational and ergogenic substance use and substance use disorders in elite athletes: A narrative review. *Br J Sports Med.* 2019;53:754-760. DOI: [10.1136/bjsports-2019-100669](https://doi.org/10.1136/bjsports-2019-100669)
- Basaria S, Wahlstrom JT, Dobs AS. Anabolic-androgenic steroid therapy in the treatment of chronic diseases. *J Clin Endocrinol Metab.* 2001;86:5108-5117. DOI: [10.1210/jcem.86.11.7983](https://doi.org/10.1210/jcem.86.11.7983)
- Wischmeyer PE, Suman OE, Kozar R, Wolf SE, Molinger J, Pastva AM. Role of anabolic testosterone agents and structured exercise to promote recovery in ICU survivors. *Curr Opin Crit Care.* 2020;26:508-515. DOI: [10.1097/MCC.0000000000000757](https://doi.org/10.1097/MCC.0000000000000757)
- Giangregorio L, McCartney N. Bone loss and muscle atrophy in spinal cord injury: Epidemiology, fracture prediction, and rehabilitation strategies. *J Spinal Cord Med.* 2006;29:489-500. DOI: [10.1080/10790268.2006.11753898](https://doi.org/10.1080/10790268.2006.11753898)
- Gorgey AS, Khalil RE, Gill R, O'Brien LC, Lavis T, Castillo T, Cifu DX, Savas J, Khan R, Cardozo C, Lesniewsky EJ. Effects of testosterone and evoked resistance exercise after spinal cord injury (TEREX-SCI): Study protocol for a randomised controlled trial. *BMJ Open.* 2017;7:e014125. DOI: [10.1136/bmjopen-2016-014125](https://doi.org/10.1136/bmjopen-2016-014125)
- Weber AE, Gallo MC, Bolia IK, Cleary EJ, Schroeder TE, Hatch III GF. Anabolic androgenic steroids in orthopaedic surgery: Current concepts and clinical applications. *J Am Acad Orthop Surg Glob Res Rev.* 2022;6(1):e21.00156. DOI: [10.5435/JAAOSGlobal-D-21-00156](https://doi.org/10.5435/JAAOSGlobal-D-21-00156)
- Ferry A, Noirez P, Page CL, Salah IB, Daegelen D, Rieu M. Effects of anabolic/androgenic steroids on regenerating skeletal muscles in the rat. *Acta Physiol Scand.* 1999;166:105-110. DOI: [10.1046/j.1365-201x.1999.00549.x](https://doi.org/10.1046/j.1365-201x.1999.00549.x)
- Beiner JM, Jokl P, Cholewicki J, Panjabi MM. The effect of anabolic steroids and corticosteroids on healing of muscle contusion injury. *Am J Sports Med.* 1999;27:2-9. DOI: [10.1177/03635465990270011101](https://doi.org/10.1177/03635465990270011101)
- White JP, Baltgalvis KA, Sato S, Wilson LB, Carson JA. Effect of nandrolone decanoate administration on recovery from bupivacaine-induced muscle injury. *J Appl Physiol.* 2009;107:1420-1430. DOI: [10.1152/jappphysiol.00668.2009](https://doi.org/10.1152/jappphysiol.00668.2009)
- Serra C, Tangherlini F, Rudy S, Lee D, Toraldo G, Sandor NL, Zhang A, Jasuja R, Bhasin S. Testosterone improves the regeneration of old and young mouse skeletal muscle. *J Gerontol A Biol Sci Med Sci.* 2013;68:17-26. DOI: [10.1093/gerona/gls083](https://doi.org/10.1093/gerona/gls083)
- Ferry A, Vignaud A, Noirez P, Bertucci W. Respective effects of anabolic/androgenic steroids and physical exercise on isometric contractile properties of regenerating skeletal muscles in the rat. *Arch Physiol Biochem.* 2000;108:257-261. DOI: [10.1076/1381-3455\(200007\)108:3:1-Z:FT257](https://doi.org/10.1076/1381-3455(200007)108:3:1-Z:FT257)
- Grounds MD. Phagocytosis of necrotic muscle in muscle isografts is influenced by the strain, age, and sex of host mice. *J Pathol.* 1987;153:71-82. DOI: [10.1002/path.1711530110](https://doi.org/10.1002/path.1711530110)
- Axell AM, MacLean HE, Plant DR, Harcourt LJ, Davis JA, Jimenez M, Handelsman DJ, Lynch GS, Zajac JD. Continuous testosterone administration prevents skeletal muscle atrophy and enhances resistance to fatigue in orchidectomized male mice. *Am J Physiol Endocrinol Metab.* 2006;291:E506-E516. DOI: [10.1152/ajpendo.00058.2006](https://doi.org/10.1152/ajpendo.00058.2006)
- Yan Z, Choi S, Liu X, Zhang M, Schageman JJ, Lee SY, Hart R, Lin L, Thurmond FA, Williams RS. Highly coordinated gene regulation in mouse skeletal muscle regeneration. *J Biol Chem.* 2003;278:8826-8833. DOI: [10.1074/jbc.M209879200](https://doi.org/10.1074/jbc.M209879200)
- Saeed MG, Al-Hamdany EK, Ismail HK. Pathological and histomorphometric study of comparative gastric ulcer induced by indomethacin, aspirin, and ethanol in rats. *Iraqi J Vet Sci.* 2023;1:37(2):339-346. DOI: [10.33899/ijvs.2022.134659.2389](https://doi.org/10.33899/ijvs.2022.134659.2389)
- Ambrosio F, Kadi F, Lexell J, Fitzgerald GK, Boninger ML, Huard J. The effect of muscle loading on skeletal muscle regenerative potential: An update of current research findings relating to aging and neuromuscular pathology. *Am J Phys Med Rehabil.* 2009;88:145-155. DOI: [10.1097/PHM.0b013e3181951fc5](https://doi.org/10.1097/PHM.0b013e3181951fc5)
- Huard J, Li Y, Fu FH. Muscle injuries and repair: Current trends in research. *J Bone Joint Surg Am.* 2002;84:822-832. DOI: [10.2106/00004623-200205000-00022](https://doi.org/10.2106/00004623-200205000-00022)
- Mahendra MY, Purba RA, Dadi TB, Pertiwi H. Estragole: A review of its pharmacology, effect on animal health and performance, toxicology, and market regulatory issues. *Iraqi J Vet Sci.* 2022;37(2):537-546. DOI: [10.33899/ijvs.2022.135092.2445](https://doi.org/10.33899/ijvs.2022.135092.2445)
- Alabdaly YZ. Effect of diclofenac on the pharmacokinetics of ciprofloxacin in quail. *Iraqi J Vet Sci.* 2021;35(4):777-81. DOI: [10.33899/ijvs.2021.128440.1576](https://doi.org/10.33899/ijvs.2021.128440.1576)
- Friedl R, Brunner M, Moeslinger T, Spieckermann PG. Testosterone inhibits expression of inducible nitric oxide synthase in murine macrophages. *Life Sci.* 2000;68:417-429. DOI: [10.1016/S0024-3205\(00\)00953-X](https://doi.org/10.1016/S0024-3205(00)00953-X)
- Grounds MD. Phagocytosis of necrotic muscle in muscle isografts is influenced by the strain, age, and sex of host mice. *J Pathol.* 1987;153:71-82. DOI: [10.1002/path.1711530110](https://doi.org/10.1002/path.1711530110)
- Horiguchi T, Shibata MA, Ito Y, Eid NA, Abe M, Otsuki Y. Macrophage apoptosis in rat skeletal muscle treated with bupivacaine hydrochloride: Possible role of MCP-1. *Muscle Nerve.* 2002;26:79-88. DOI: [10.1002/mus.10162](https://doi.org/10.1002/mus.10162)
- Schneider CP, Schwacha MG, Samy TS, Bland KI, Chaudry IH. Androgen-mediated modulation of macrophage function after traumahemorrhage: Central role of 5 alpha-dihydrotestosterone. *J Appl Physiol.* 2003;95:104-112. DOI: [10.1152/jappphysiol.00182.2003](https://doi.org/10.1152/jappphysiol.00182.2003)
- Zhang J, Pugh TD, Stebler B, Ershler WB, Keller ET. Orchiectomy increases bone marrow interleukin-6 levels in mice. *Calcif Tissue Int.* 1998;62:219-226. DOI: [10.1007/s002239900421](https://doi.org/10.1007/s002239900421)
- Antonio J, Wilson JD, George FW. Effects of castration and androgen treatment on androgen-receptor levels in rat skeletal muscles. *J Appl Physiol.* 1999;87:2016-2019. DOI: [10.1152/jappl.1999.87.6.2016](https://doi.org/10.1152/jappl.1999.87.6.2016)

28. Alessi DR, James SR, Downes CP, Holmes AB, Gaffney PR, Reese CB, Cohen P. Characterization of a 3-phosphoinositide-dependent protein kinase which phosphorylates and activates protein kinase Balpha. *Curr Biol.* 1997;7:261-269. DOI: [10.1016/S0960-9822\(06\)00122-9](https://doi.org/10.1016/S0960-9822(06)00122-9)
29. Currie RA, Walker KS, Gray A, Deak M, Casamayor A, Downes CP, Cohen P, Alessi DR, Lucocq J. Role of phosphatidylinositol 3,4,5-trisphosphate in regulating the activity and localization of 3-phosphoinositide-dependent protein kinase-1. *Biochem J.* 1999;1;337(3):575-83. DOI: [10.1042/bj3370575](https://doi.org/10.1042/bj3370575)
30. Roberts RE, Cavalcante-Silva J, Kineman RD, Koh TJ. Liver is a primary source of insulin-like growth factor-1 in skin wound healing. *J Endocrinol.* 2022;252(1):59-70. DOI: [10.1530/JOE-21-0298](https://doi.org/10.1530/JOE-21-0298)
31. Penn JW, Grobbelaar AO, Rolfe KJ. The role of the TGF-1 β family in wound healing, burns and scarring: A review. *Int J Burns Trauma.* 2012;2(1):18-28. [[available at](#)]
32. Assoian RK, Komoriya A, Meyers CA, Miller DM, Sporn MB. Transforming growth factor-beta in human platelets. Identification of a major storage site, purification, and characterization. *J Biol Chem.* 1983;258(11):7155-7160. DOI: [10.1016/S0021-9258\(18\)32345-7](https://doi.org/10.1016/S0021-9258(18)32345-7)
33. Robert MB, Sporn MB. Transforming growth factor-. In: Clark RF, editor. *The molecular and cellular biology of wound repair.* New York: Plenum; 1996. 275-308 p. DOI: [10.1007/978-1-4899-0185-9_8](https://doi.org/10.1007/978-1-4899-0185-9_8)
34. Rorison P, Thomlinson A, Hassan Z, Roberts SA, Ferguson MW, Shah M. Longitudinal changes in plasma transforming growth factor beta-1 and post-burn scarring in children. *Burns.* 2010;36(1):89-96. DOI: [10.1016/j.burns.2009.03.008](https://doi.org/10.1016/j.burns.2009.03.008)
35. Vitale G, Pellegrino G, Vallery M, Hofland LJ. Role of IGF-1 system in the modulation of longevity: Controversies and new insights from a centenarians' perspective. *Front Endocrinol.* 2019;27. DOI: [10.3389/fendo.2019.00027](https://doi.org/10.3389/fendo.2019.00027)
36. Goldstein RH, Poliks CF, Pilch PF, Smith BD, Fine A. Stimulation of collagen formation by insulin and insulin-like growth factor I in cultures of human lung fibroblasts. *Endocrinol.* 1989;124(2):964-970. DOI: [10.1210/endo-124-2-964](https://doi.org/10.1210/endo-124-2-964)
37. Nall AV, Brownlee RE, Colvin CP, Schultz G, Fein D, Cassisi NJ, Nguyen T, Kalra A. Transforming growth factor β 1 improves wound healing and random flap survival in normal and irradiated rats. *Arch Otolaryngol Head Neck Surg.* 1996;122(2):171-177. DOI: [10.1001/archotol.1996.01890140057011](https://doi.org/10.1001/archotol.1996.01890140057011)
38. Alabsy EH, Alabdaly YZ. Therapeutic effect of taurine on sodium fluoride toxicity in chicks. *Iraqi J V Sci.* 2022;36(1):223-38. DOI: [10.33899/ijvs.2021.129854.1692](https://doi.org/10.33899/ijvs.2021.129854.1692)
39. Hormozi M, Assaei R, Boroujeni MB. The effect of aloe vera on the expression of wound healing factors (TGF β 1 and bFGF) in mouse embryonic fibroblast cell: In vitro study. *Biomed Pharmacother.* 2017;88:610-6. DOI: [10.1016/j.biopha.2017.01.095](https://doi.org/10.1016/j.biopha.2017.01.095)
40. Porte J, Jenkins G, Tatler AL. Myofibroblast TGF- β activation measurement in vitro. In: Hinz B, Lagares D, editors. *Myofibroblasts: Methods and protocols.* New York: Springer; 2021. 99-108 p.

آثار ديكانوات الناندرولون الموضعي على عامل نمو التحول بيتا والعامل شبيه الأنسولين الأول في الشفاء من جرح العضلة

تمارة مازن العبدالله و فيحاء ازهر المشهداني

فرع علوم طب الأسنان الأساسية، كلية طب الأسنان، جامعة الموصل، الموصل، العراق

الخلاصة

إن تحديد العلاج المناسب لمشكلة التعرض للجروح العضلية هو أمر أساسي عند الإنسان والحيوان، وخاصة حيوانات السباق مثل الخيول، حيث تكون الوظيفة العضلية جزء من حياتها. تبحث هذه الدراسة في الفرضية القائلة بأن التطبيق المحلي لمركب الناندرولون ديكانوات الستيرويد على العضلة الماضعة يسرع من عملية الشفاء عندما يقترن بالإصلاح الجراحي. تم تقسيم الأرناب إلى مجموعتين متساويتين بشكل عشوائي. المجموعة الأولى (عشرة أرناب)، والمعروفة باسم مجموعة السيطرة، خضعت لعملية جراحية وحُققت بالماء المقطر. خضعت المجموعة الثانية (عشرة أرناب) لعملية جراحية وحُققت عضليا ناندرولون ديكانوات 10 ملغم / كغم مرة واحدة يوميا منذ اليوم الأول بعد الجراحة. تم تخدير خمسة أرناب من كل من المجموعة أ و ب في اليوم الثالث والسابع. تم قتل جميع الحيوانات بطريقة القتل الرحيم، وتمت إزالة أنسجة العضلة الماضعة لغرض إجراء التحليل النسيجي. بعد ثلاثة أيام من الجرح الجراحي، كشف الفحص المجهرى للجروح العضلية لمجموعة السيطرة عن التهاب عضلي حاد مع خلايا إفرازات التهابية ونزيف عضلي ونخر كما أن موضع الجرح كان فيه التهاب عضلي حاد مع وجود الخلايا الالتهابية وضمورا ونزيفا وزيادة في النسيج الضام بعد سبعة أيام من المعاملة. أما في المجموعة المعاملة بعد ثلاثة أيام من إجراء الجرح الجراحي، فقد كشف الفحص المجهرى للجروح العضلية للمجموعة المعالجة عن التهاب عضلي خفيف مع خلايا التهابية، وتنكس زجاجي، وضمور الألياف العضلية. بعد 7 أيام، ظهر التهاب خفيف في العضلة مصحوبا بارتشاح الخلايا الالتهابية، وضمور الألياف العضلية، وتنكس زجاجي في موقع الجرح. خلصت الدراسة انه في اليوم الثالث من فترة المعاملة، أشارت مستويات عامل نمو التحول بيتا والعامل شبيه الأنسولين الأول في المصل في مجاميع الدراسة إلى وجود اختلاف مهم جدا، بينما لم يكن هناك فرق في اليوم السابع من المعاملة. يساعد الناندرولون ديكانوات المحلي على تسريع التئام جروح العضلات.