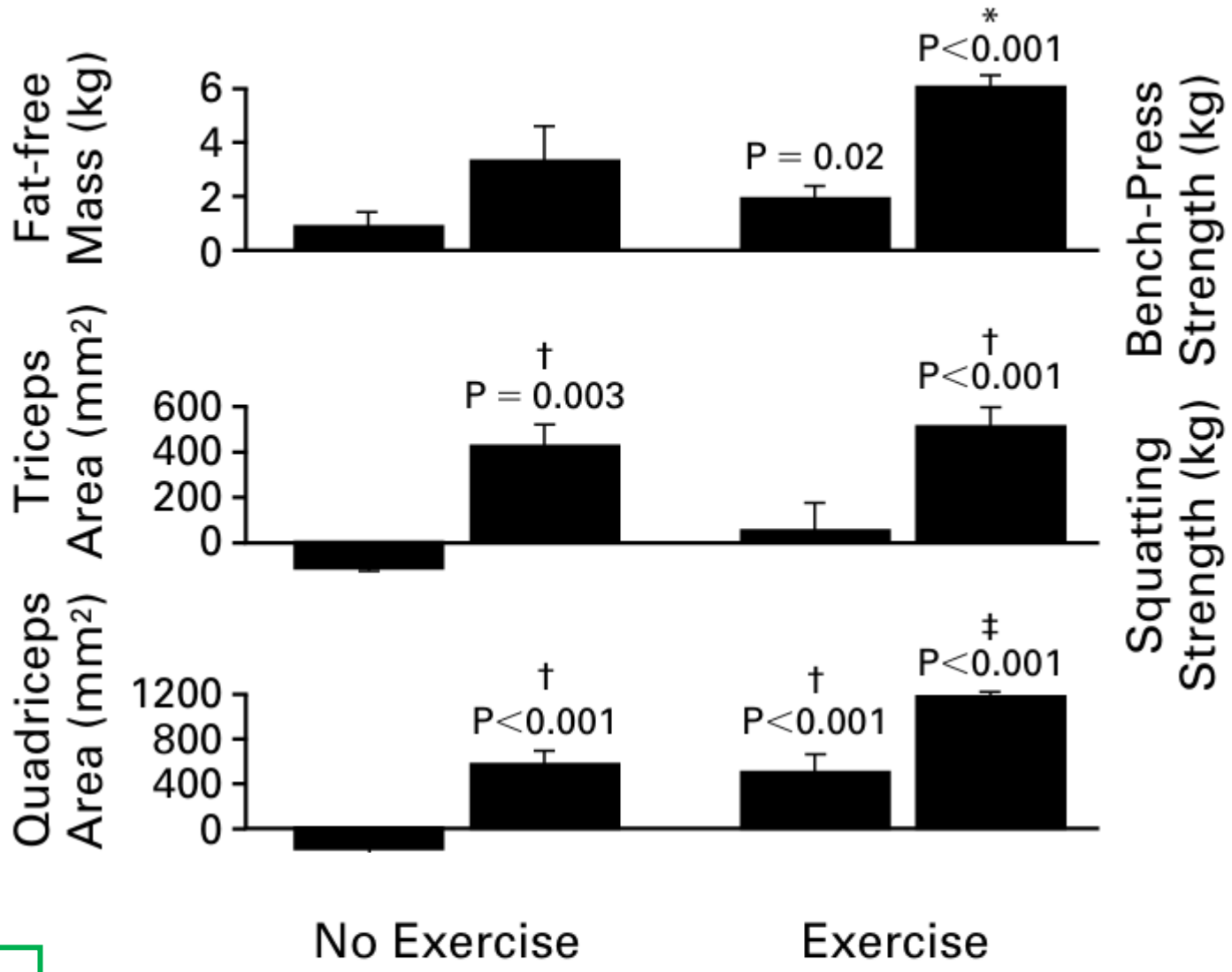
Uso abusivo de anabolizantes

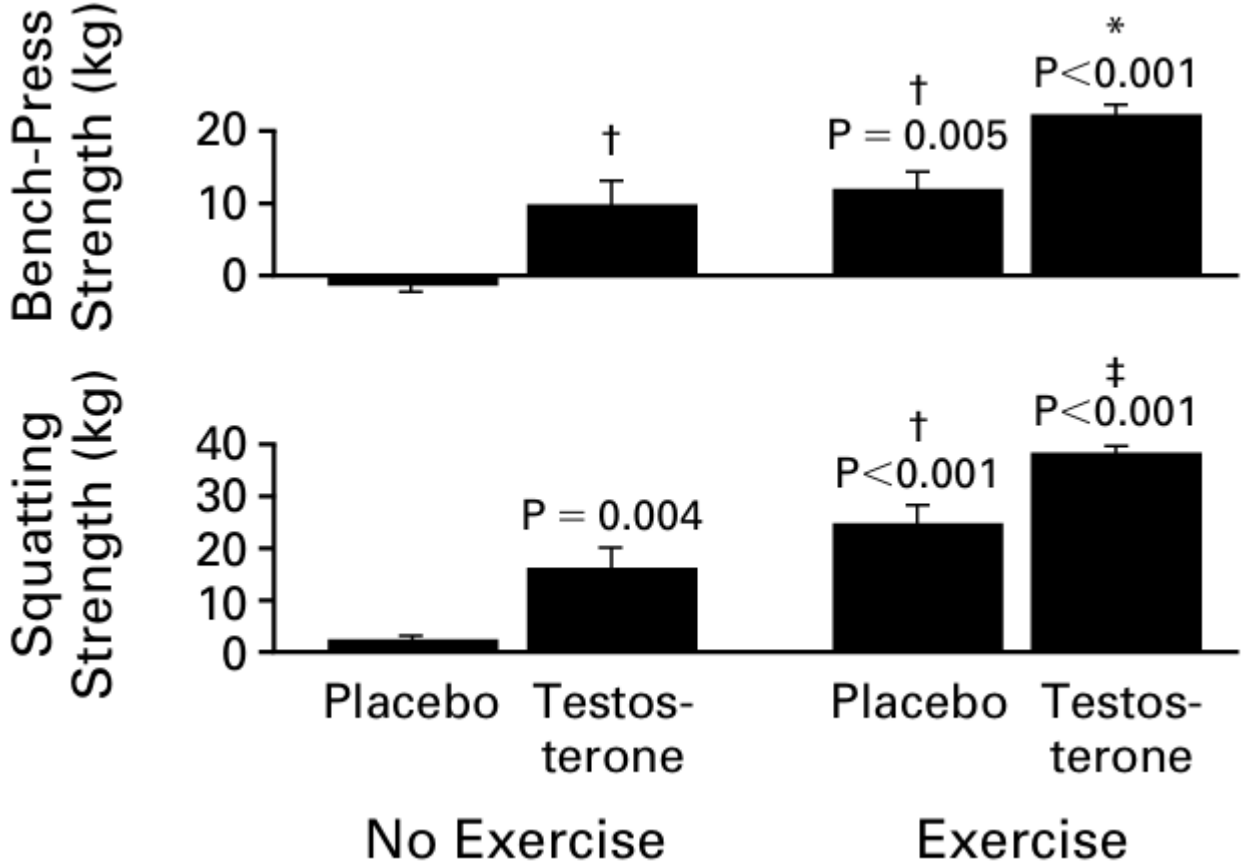
e

alterações do sistema musculoesquelético

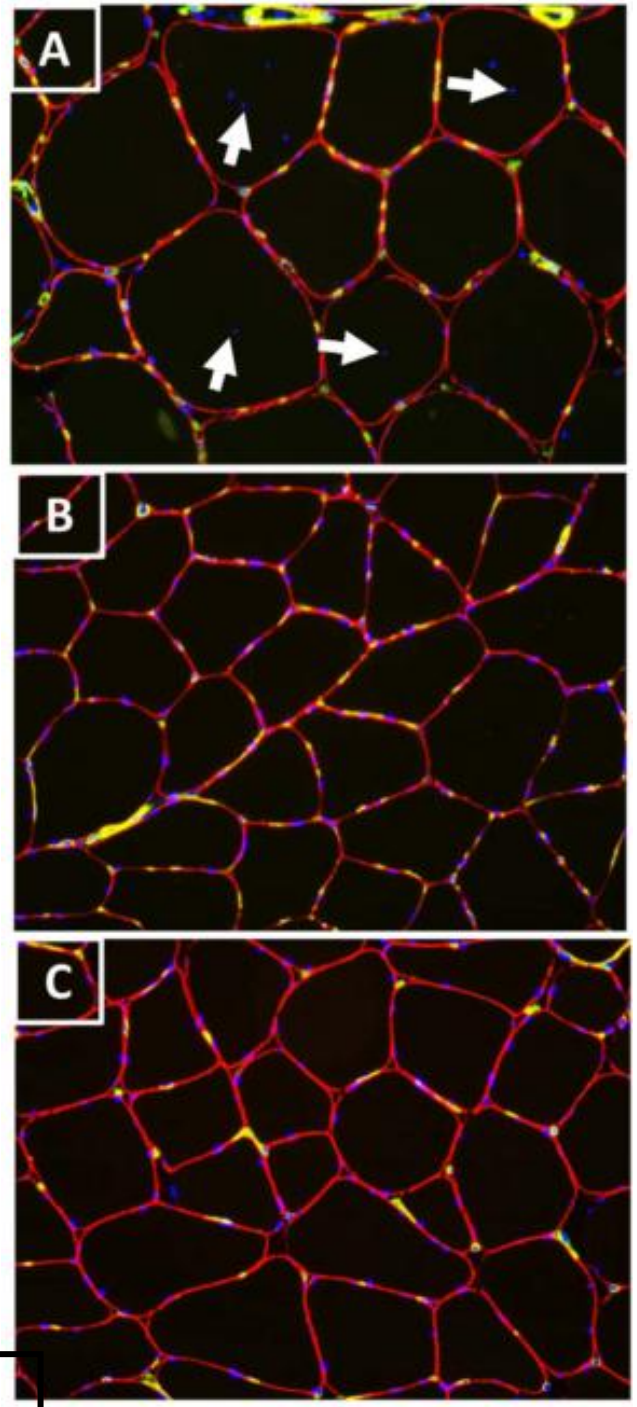
Alteração da massa e força muscular com EAA

600mg de enantato de testosterona





Bhasin S, et al. N Engl J Med. 1996;335(1):1-7.



Alta dosagem
>2500 mg/week

Baixa dosagem
<500 mg/week

Clean

OPEN ACCESS Freely available online

PLOS ONE

Effects of Long Term Supplementation of Anabolic Androgen Steroids on Human Skeletal Muscle

Ji-Guo Yu[1], Patrik Bonnerud[2], Anders Eriksson[2], Per S. Stål[4], Yelverton Tegner[2], Christer Malm[1,3]*

1 Department of Surgical and Perioperative Sciences, Sports Medicine Unit, and School of Sport Sciences, Umeå University, Umeå, Sweden, **2** Department of Health Sciences, Luleå University of Technology, Luleå, Sweden, **3** Winternet, Boden, Sweden, **4** Department of Integrative Medical Biology, Section for Anatomy, Umeå University, Umeå, Swenden

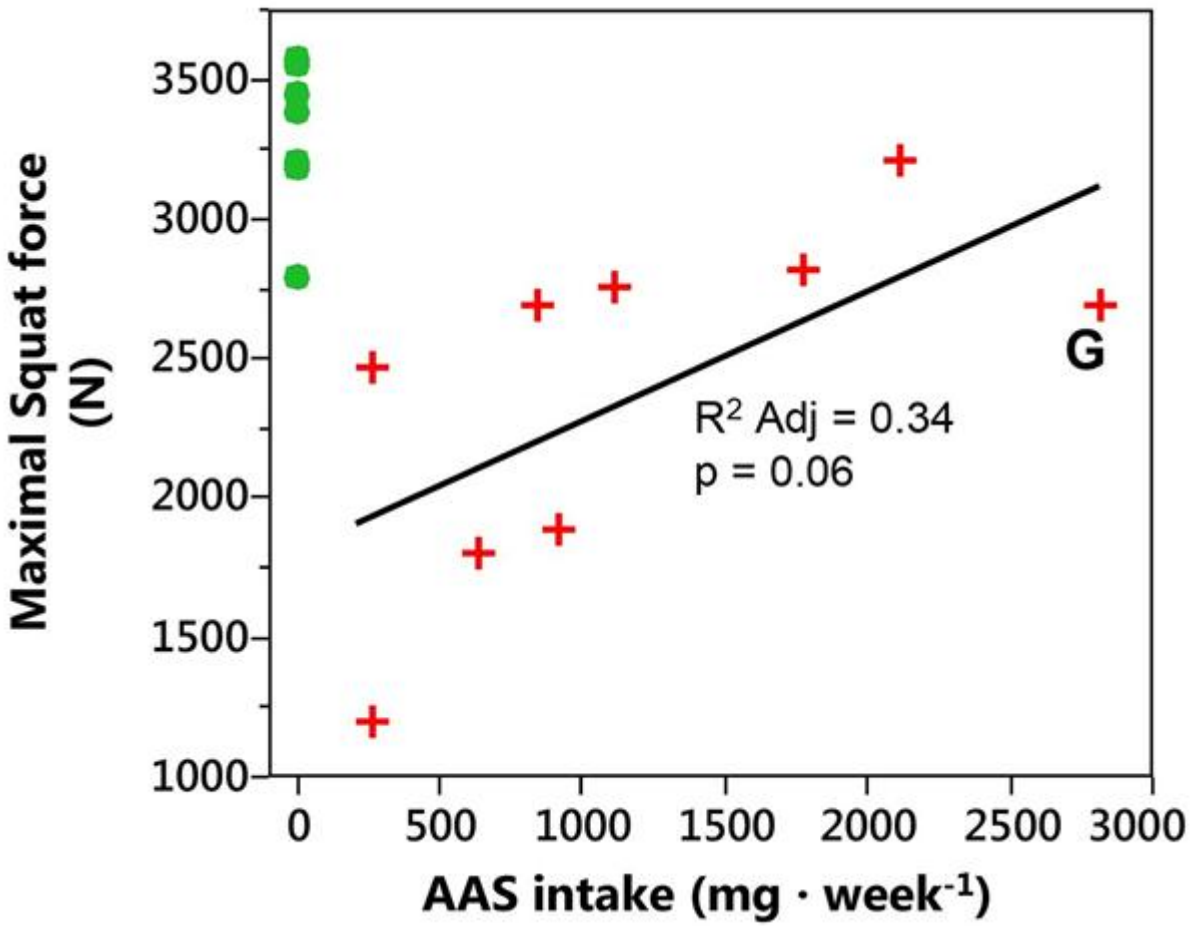
- **Massa magra**
- **Densidade capilar**
- **Densidade de mionúcleos**

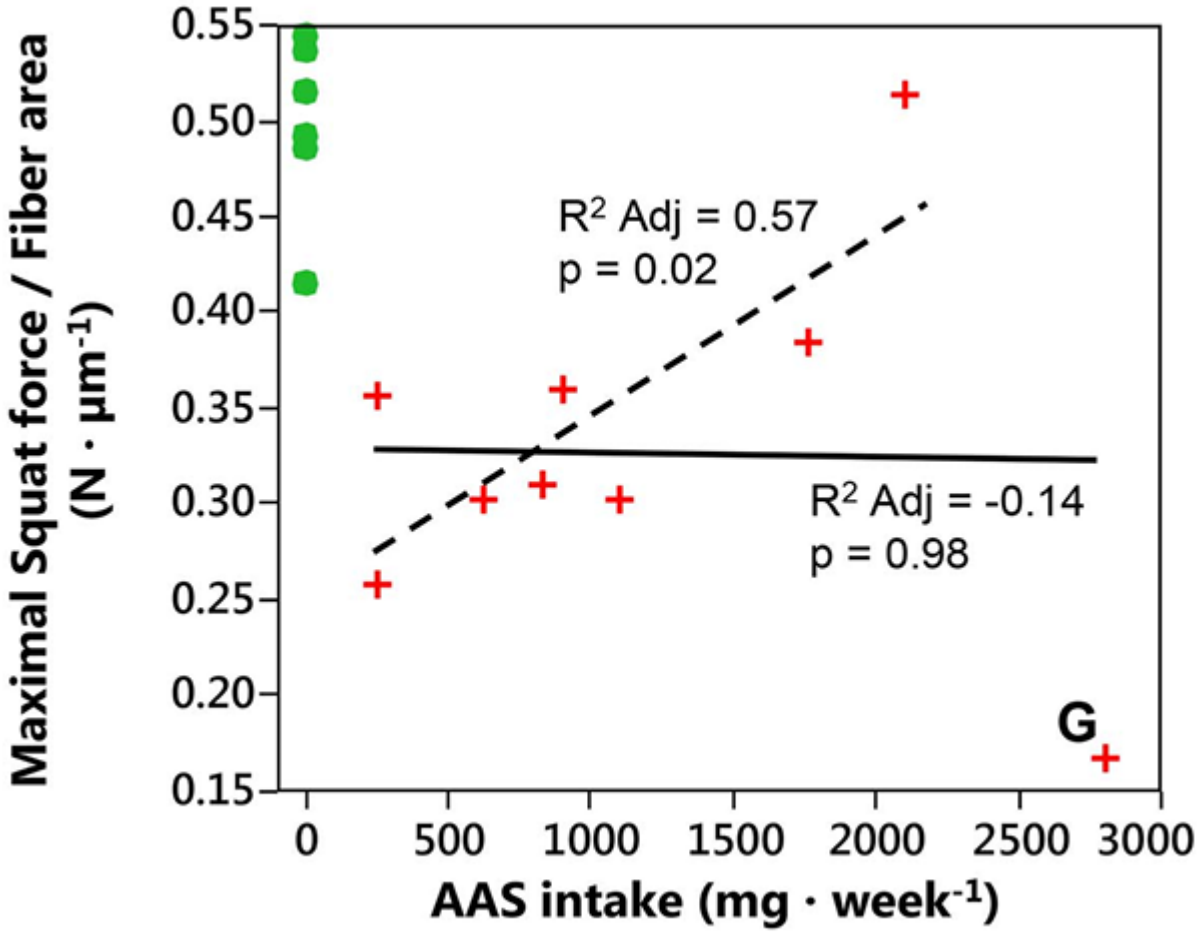
Yu JG, et al. Plos one. 2014;9:e105330.

Table 1. Self-reported intake of banned substances in the Doped group.

Subject	Substances and dosage in recent 5 years	Substances and dosage >5 years ago
D1	Testosterone (1250 mg w^{-1}) Dianabol (8 mg d^{-1}) Insulin (10–12 IU d^{-1}) IGF I (50 μg d^{-1})	Testosterone (1250 mg w^{-1})Dianabol (8 mg day^{-1}) Trenbolone (262.5 mg w^{-1})
D2	Testosterone (2000 mg w^{-1}) Deca-durabolin (600–800 mg w^{-1}) Dianabol (50 mg d^{-1}) Insulin (12 IU d^{-1}) Ephedrine (60 mg d^{-1})	Testosterone (2500 mg w^{-1}) Insulin (18 IU day^{-1})
D3	Testosterone (1500 mg w^{-1}) Deca-durabolin (800–1600 mg w^{-1}) Boldone (500 mg w^{-1}) Ephedrine (4–6 IU d^{-1}, 6 days w^{-1})	Testosterone (1500 mg w^{-1}) Deca-durabolin (600 mg w^{-1})
D4	Testosterone 500 mg w^{-1} GH (Somatropin) (4–6 IU d^{-1}, 6 days w^{-1}) Deca-durabolin (600 mg w^{-1})	Testosterone (500 mg w^{-1}) Deca-durabolin (600 mg w^{-1})
D5	Testosterone (500 mg w^{-1}) Deca-durabolin (250 mg w^{-1}) Dianabol (175–350 mg w^{-1}) Ephedrine (10000 IU total)	Testosterone (500 mg w^{-1}) Deca-durabolin (250 mg w^{-1}) Trenbolone (75 mg w^{-1})
D6	Testosterone (500 mg w^{-1}) Deca-durabolin (200 mg w^{-1}) Dianabol (200 mg w^{-1})	Testosterone (500 mg w^{-1}) Deca-durabolin (200 mg w^{-1})
D7	Testosterone (250 mg w^{-1}) Dianabol (175 mg w^{-1})	Testosterone (250 mg w^{-1})
D8	Testosterone (250 mg w^{-1}) Deca-durabolin (200 mg w^{-1}) Dianabol (200 mg w^{-1}) Oxar (175 mg w^{-1})	Testosterone (250 mg w^{-1}) Deca-durabolin (200 mg w^{-1}) Oxar (175 mg w^{-1})
D9	Testosterone (1000 mg w^{-1}) Boldone (1000 mg w^{-1}) Dianabol (105 mg w^{-1})	Testosterone (1000 mg w^{-1}) Boldone (250 mg w^{-1})
D10	Testosterone (500 mg w^{-1}) Deca-durabolin (400 mg w^{-1}) Trenbolone (150 mg w^{-1}) Dianabol (150–200 mg w^{-1})	Testosterone (500 mg w^{-1}) Deca-durabolin (400 mg w^{-1})

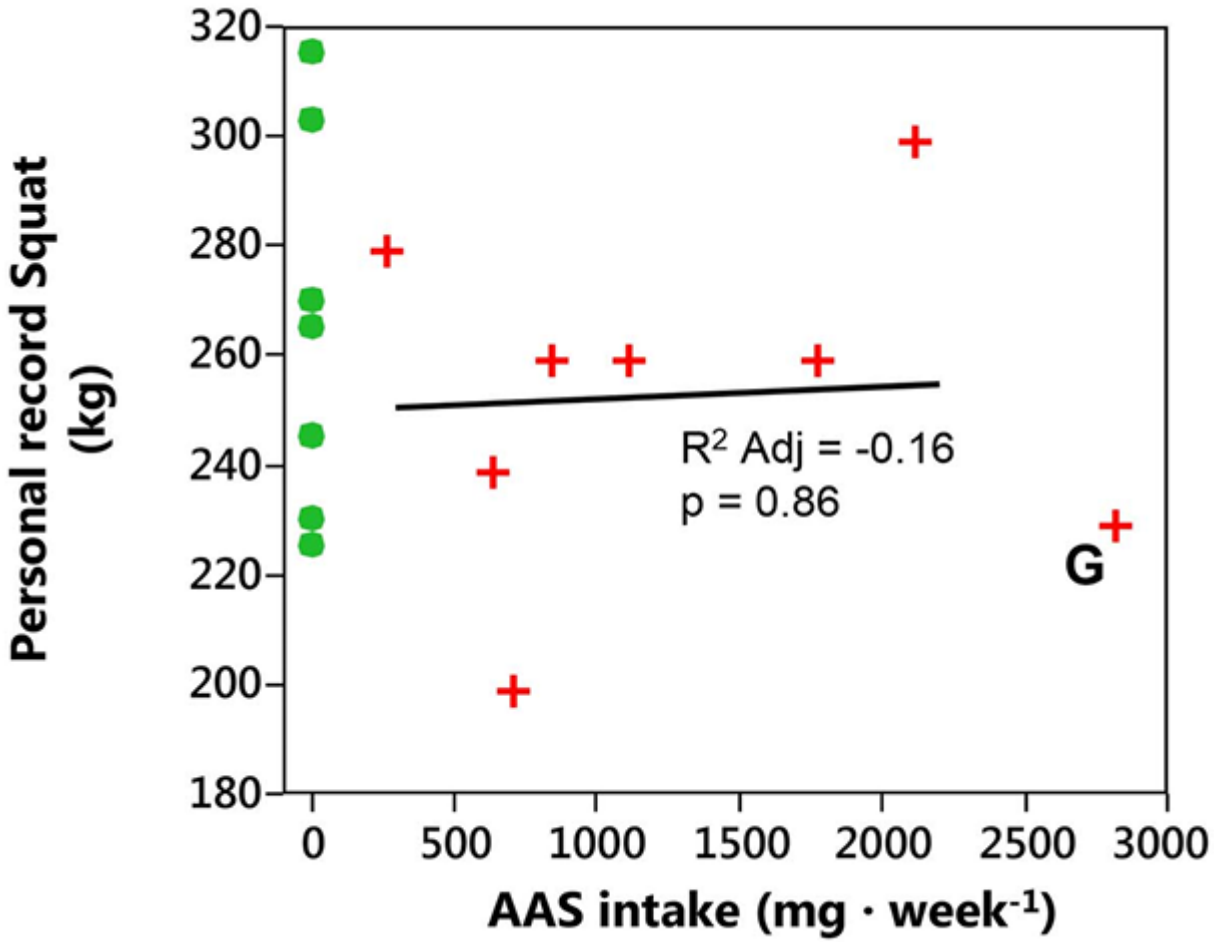
Efeito sobre a força muscular

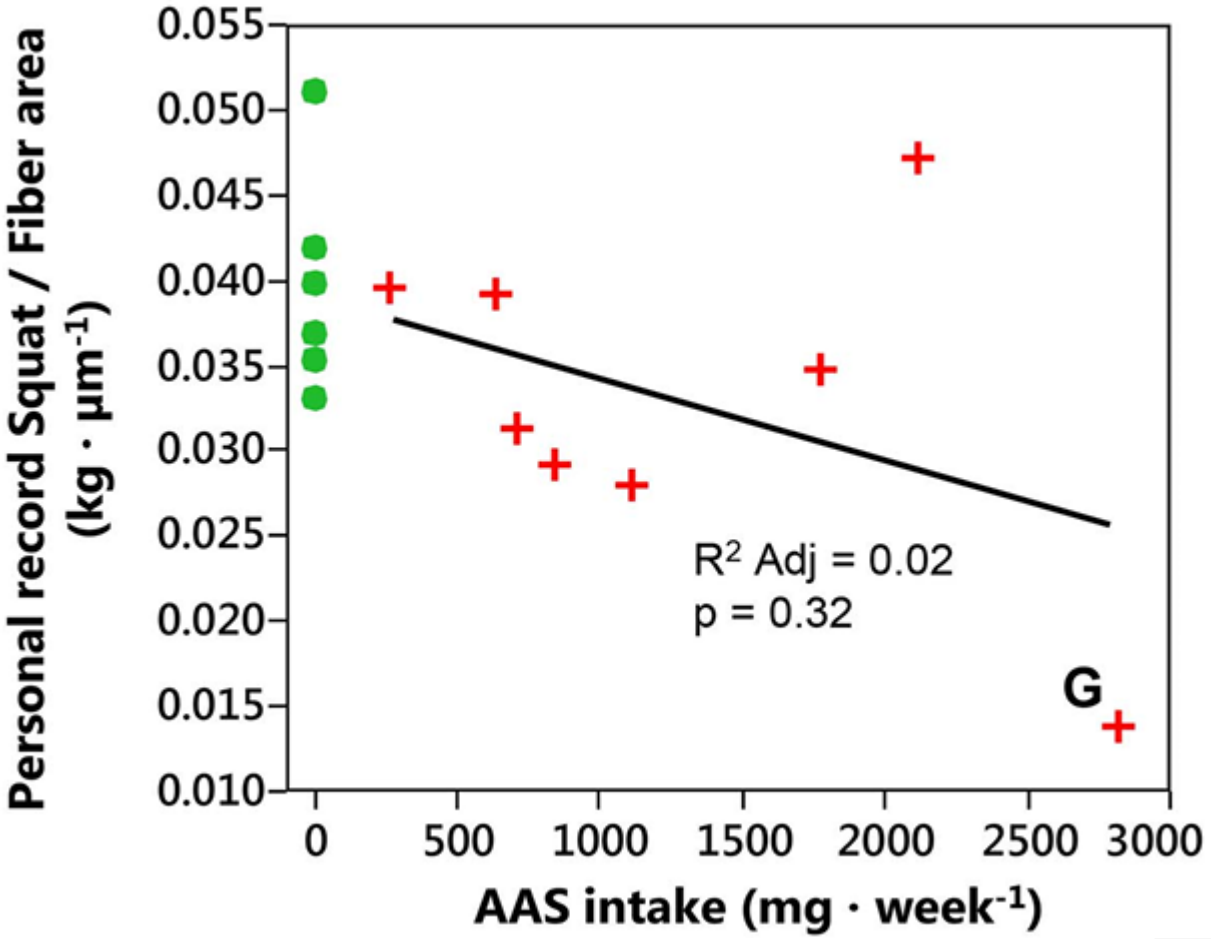




Yu JG, et al. Plos one. 2014;9:e105330.

Efeito sobre a força muscular





Yu JG, et al. Plos one. 2014;9:e105330.

Efeito sobre a força muscular

Variable	*All subjects (N = 10)*		*Excluding subject G (N = 9)*	
	r	**p**	**r**	**p**
Performance				
Maximal Squat force (N)	0.65	0.06	0.75	0.03
Maximal Squat force/Lean body mass ($N \cdot g^{-1}$)	0.51	0.17	0.83	0.01
Maximal Squat force/Lean leg mass ($N \cdot g^{-1}$)	0.55	0.13	0.88	0.004
Maximal Squat force/Mean fiber area ($N \cdot \mu m^{-2)}$	−0.01	0.98	0.76	0.01
Maximal Squat force/Type I fiber area ($N \cdot \mu m^{-2}$)	−0.01	0.98	0.80	0.02
Maximal Squat force/Type IIa fiber Area ($N \cdot \mu m^{-2}$)	−0.08	0.85	0.60	0.12

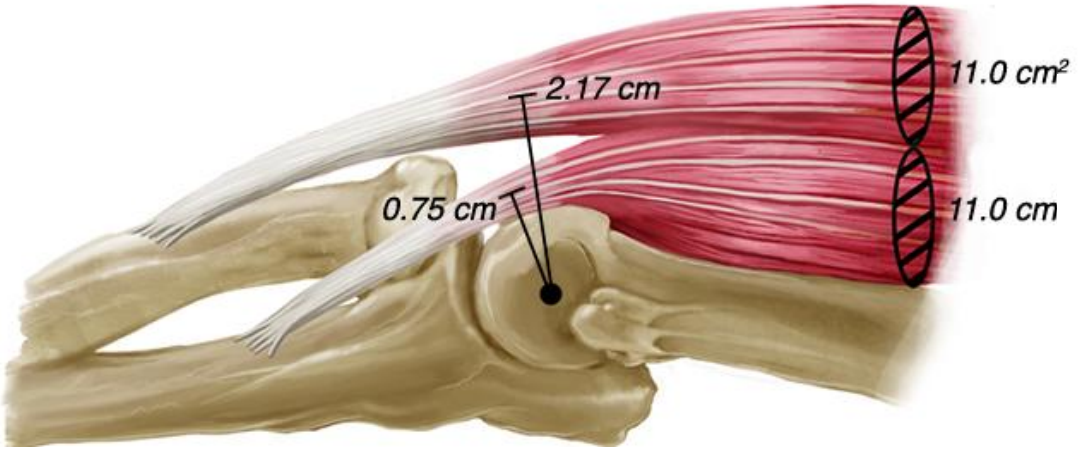
Discussion

The main findings of the study were that the doped athletes had higher lean mass, capillary density and myonuclei density, but lower maximal squat force relative to muscle mass and to fiber area, compared to the clean athletes. The Doped group also had a

Yu JG, et al. Plos one. 2014;9:e105330.

Produção de força e hipertrofia

Aumento exacerbada da área de secção transversal (CSA) do músculo pode prejudicar potência muscular.



athletes did not show similar fiber type specificity. Finally, if subject G, with extremely high AAS dose, was taken into calculation of correlation between AAS intake and maximal squat force relative to muscle fiber area, there seem to be an upper limit for AAS intake, beyond which further increase in AAS intake will suppress muscular adaptation and performance.

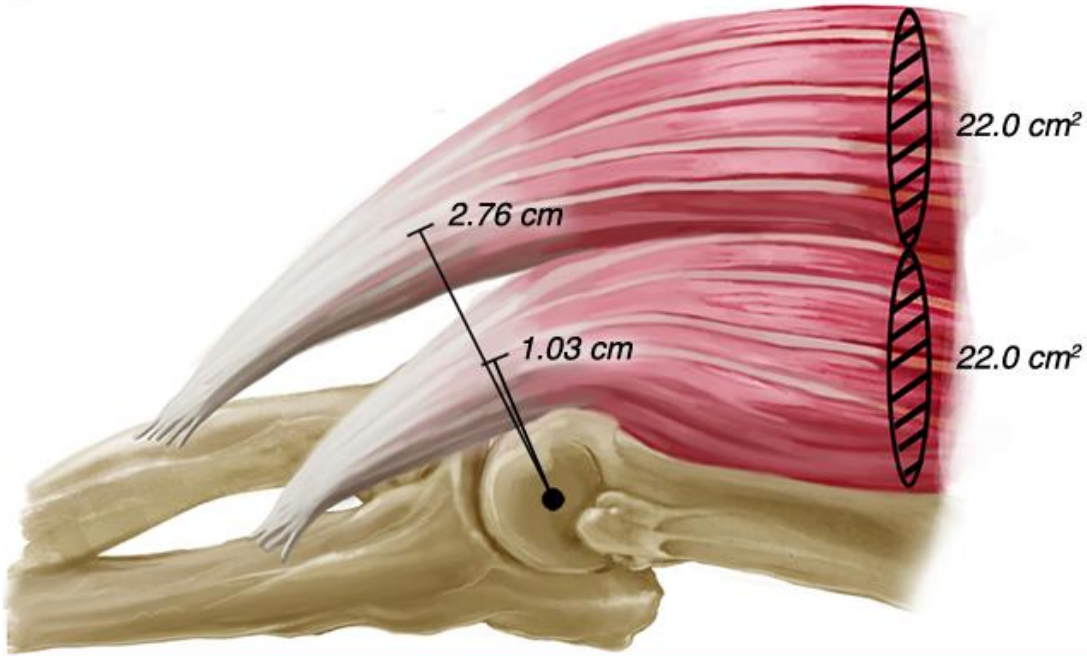


Figure 3 Illustration of the changes in biceps brachii and brachialis moment arm lengths with increases in anatomical cross-sectional area. By doubling the anatomical cross-sectional area of the biceps brachii and brachialis, the moment arms of each increase by 27.2% and 37.3%, respectively.

Vigotsky AD, et al. Peer J. 2015. 3:e1462.

Redução da força muscular com destreinamento

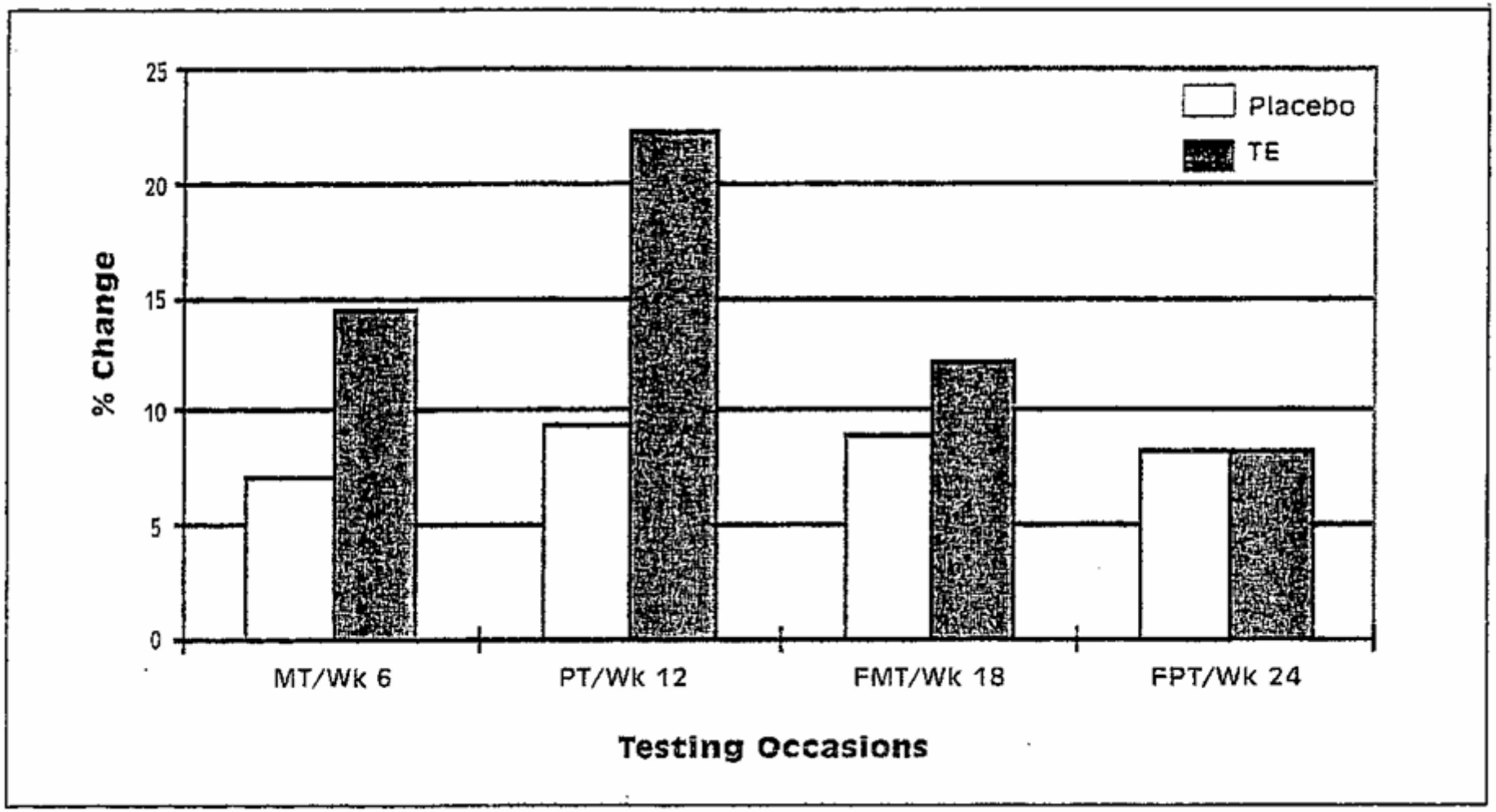
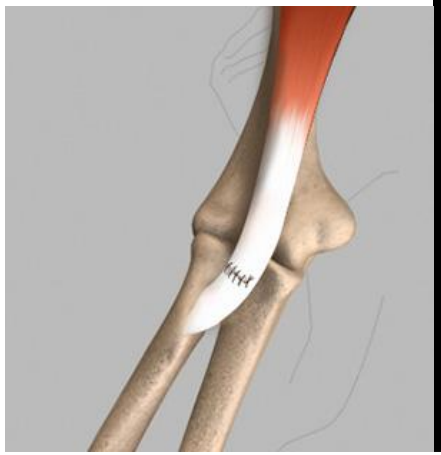


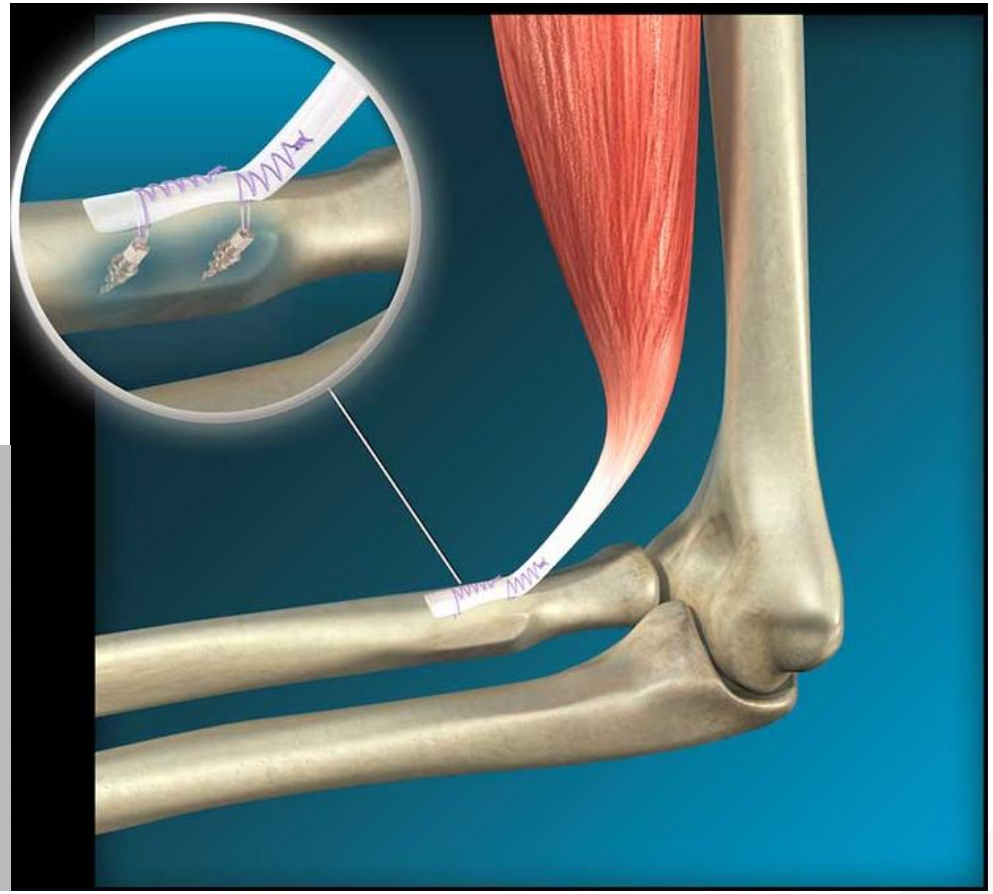
Figure 1: Percentage change in bench press performance recorded at each testing occasion.

Giorgi A, et al. J Sci Med Sport.1999;2(4):341-55.

Principais lesões osteomioarticulares

- ✓ Tendinite
- ✓ Distensão
- ✓ Luxação
- ✓ Bursite
- ✓ Avulsão
- ✓ Ruptura
- ✓ Fratura



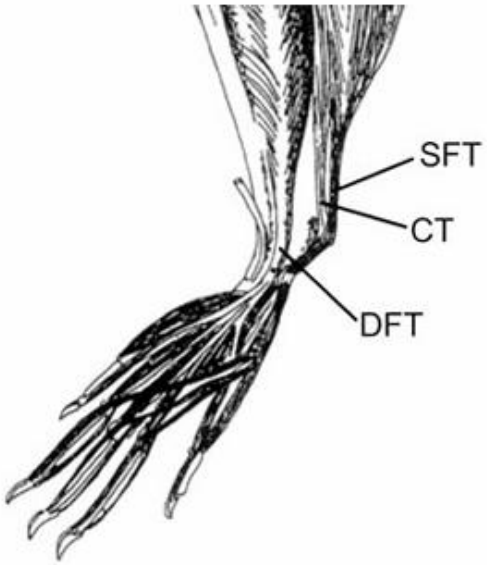


Marqueti RC, et al. Scan J Med Sci Sports.2011;21(6):e91-9.

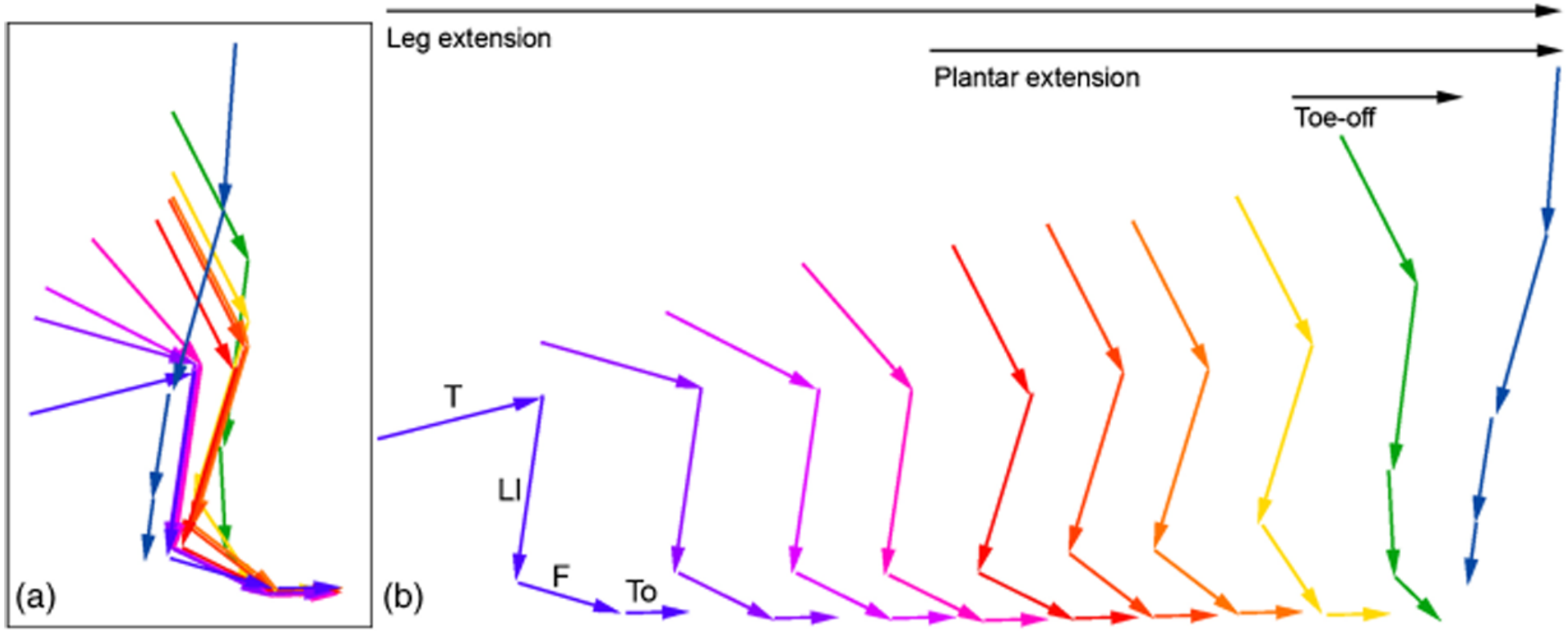
Scand J Med Sci Sports. 2011 Dec;21(6):e91-9. doi: 10.1111/j.1600-0838.2010.01162.x.
Epub 2010 Jul 29.

Biomechanical responses of different rat tendons to nandrolone decanoate and load exercise

R C Marqueti [1], J Prestes, C C Wang, O H P Ramos, S E A Perez, W R Nakagaki, H F Carvalho, H S Selistre-de-Araujo



Tendão calcâneo, flexor superficial e profundo



› Scand J Med Sci Sports. 2011 Dec;21(6):e91-9. doi: 10.1111/j.1600-0838.2010.01162.x.
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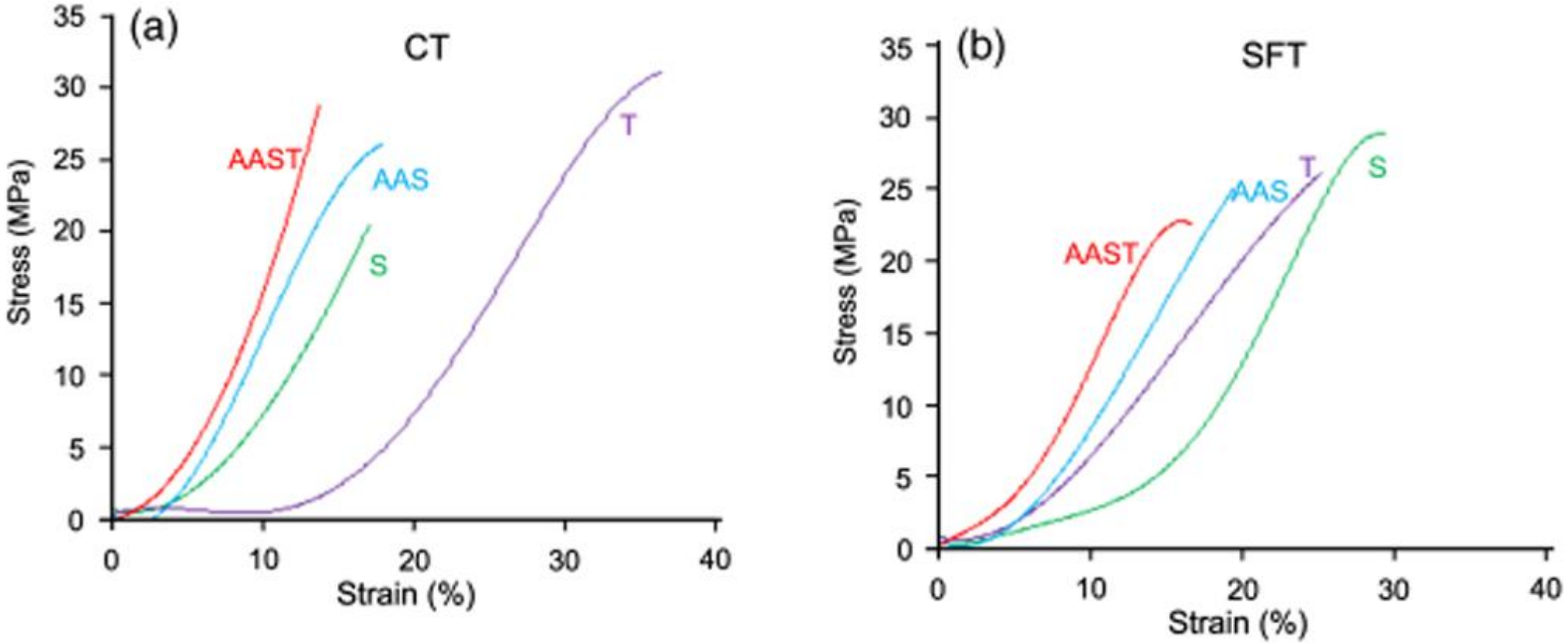
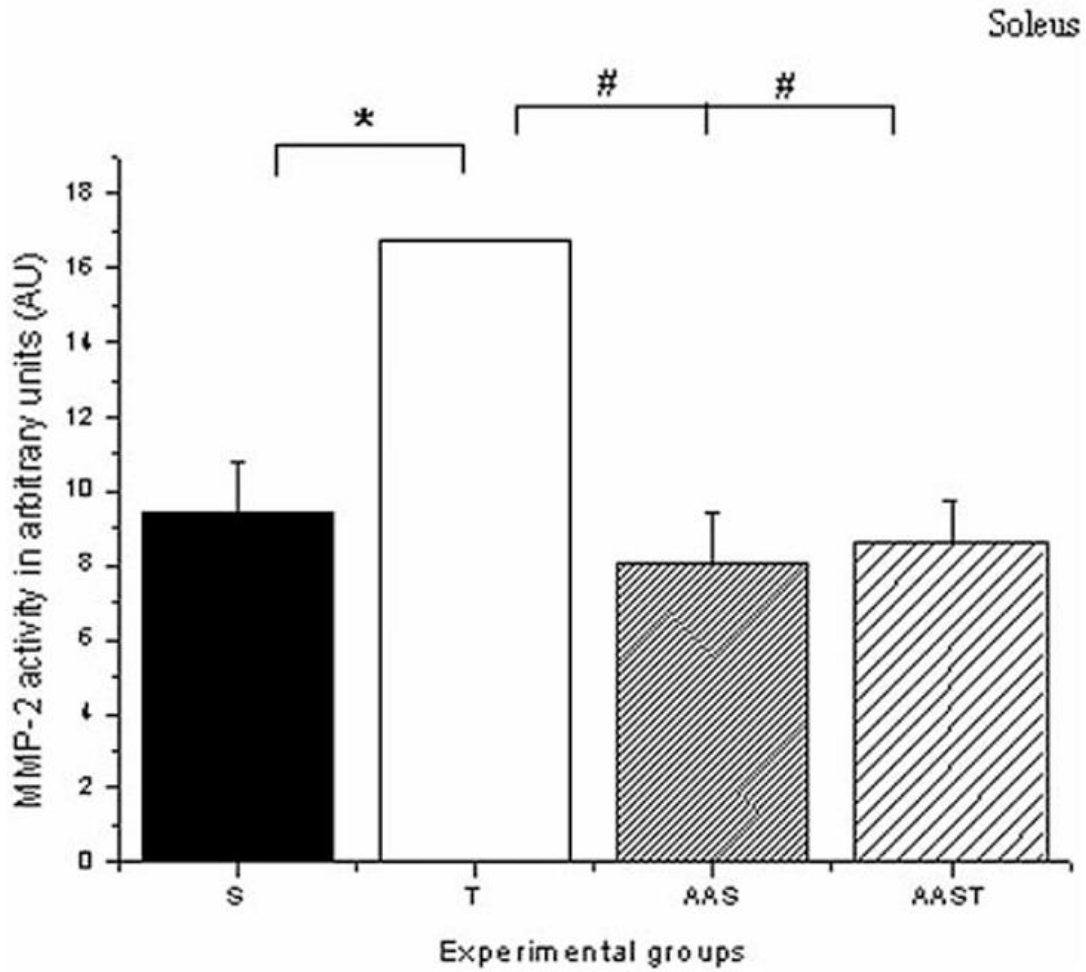


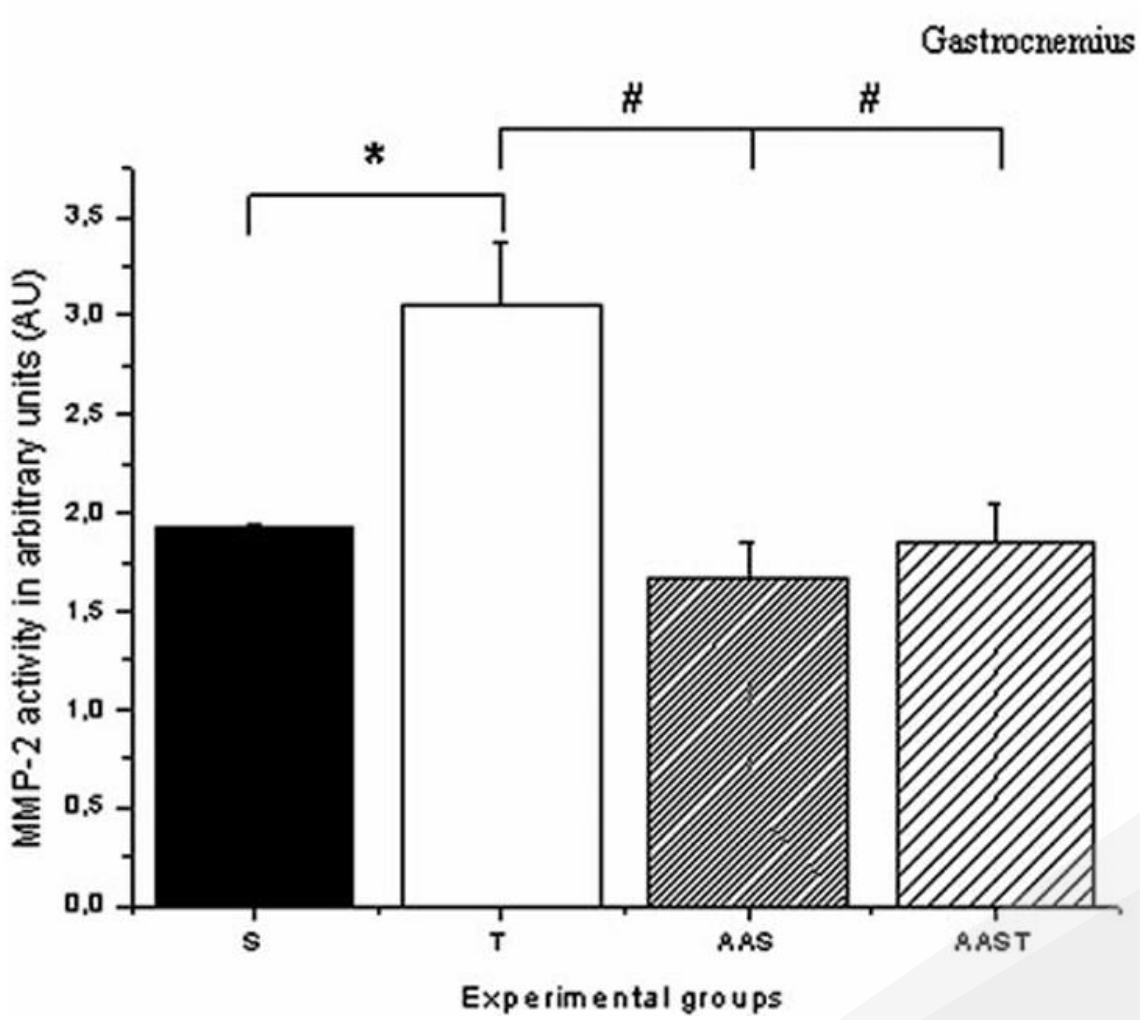
Tendão calcâneo e flexor superficial

Marqueti RC, et al. Scan J Med Sci Sports.2011;21(6):e91-9.

Redução de MMP-2 / Tecido conjuntivo

Matrix metallopeptidase 2





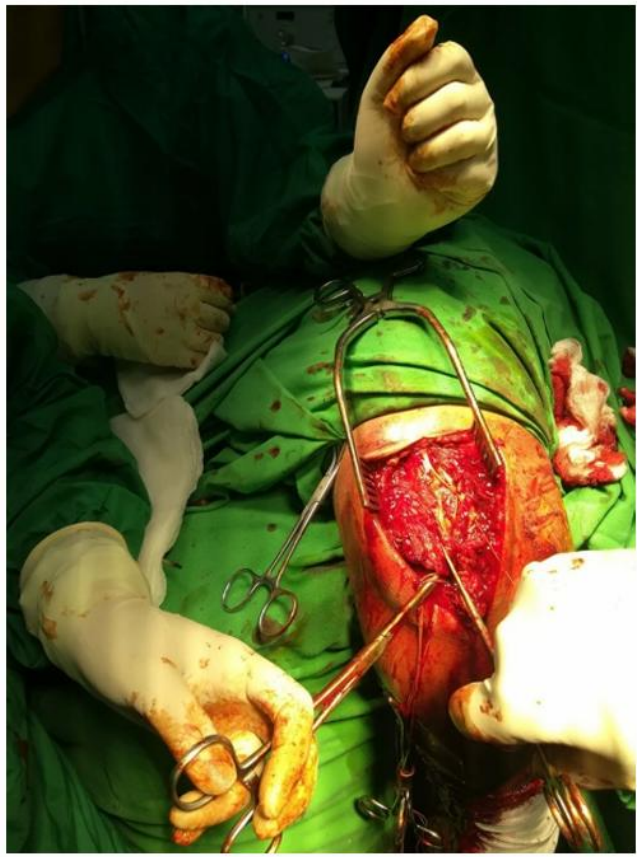
Marqueti RC, et al. Eur J Appl Physiol.2008;104(6):1087-93. / Marqueti RC, et al. Int J Sports Med. 2008; 29(7):559-63.

Case Reports > J Orthop Case Rep. 2023 Jul;13(7):70-76. doi: 10.13107/jocr.2023.v13.i07.3758.

Nontraumatic Triceps Tendon Rupture in a Young Bodybuilder Athlete: A Case Report and Review of the Literature of a Known Injury in an Unknown Setting

Dimitrios Ntourantonis [1], Vasileios Mousafeiris [2], Ioanna Lianou [2]

Incidência <1%



- Ruptura completa de tríceps braquial
- IAM prévio – Angioplastia
- Uso regular de Boldenona, Testosterona, Metenolona (primobolan), Trembolone, mestetolona (Proviron) e Stanozolol na última década.

Case Reports > J Orthop Case Rep. 2023 Jul;13(7):70-76. doi: 10.13107/jocr.2023.v13.i07.3758.

Nontraumatic Triceps Tendon Rupture in a Young Bodybuilder Athlete: A Case Report and Review of the Literature of a Known Injury in an Unknown Setting

Dimitrios Ntourantonis [1], Vasileios Mousafeiris [2], Ioanna Lianou [2]

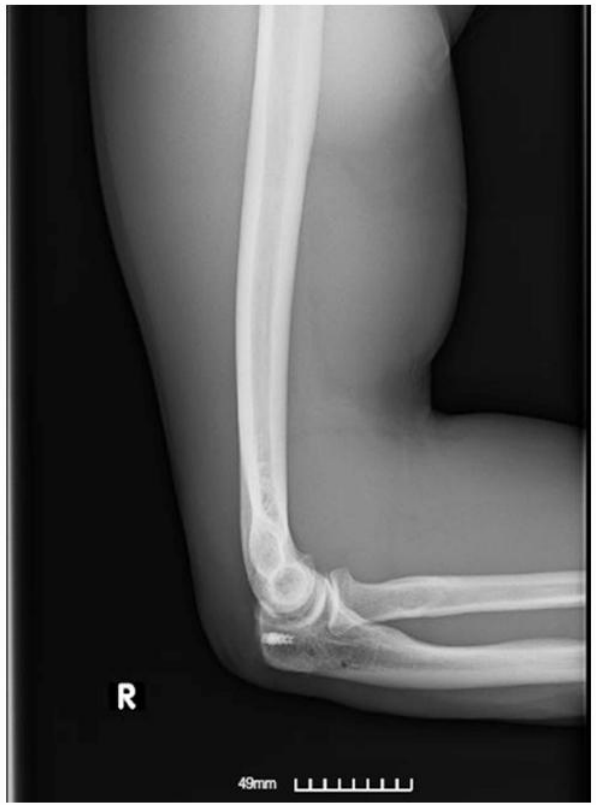


Figure 6: One year postoperative (a) full range of motion was documented on flexion and (b) on extension with no residual pain with patient reporting that triceps strength had returned to the pre-injury levels.

Author/year	Type of study	Purpose	Results
Bach et al. [16], 1987	Case report	Reporting an interesting case of a wrestler and weightlifter at competitive level with triceps rupture of the musculotendinous region.	AAS weightlifter had triceps rupture while snatching 325 pounds. Large doses of ASA (both oral and injectable) were used prior to and after the rupture. The relationship between the amount of AAS used, and the strength of tendon and ligament is not well established.
Stannard and Bucknell [18], 1993	Case report	Reporting a case of a 35 years-old active-duty soldier and a trainer AAS user who sustain a TTR and had received six injections of corticosteroids for olecranon bursitis on the injured elbow.	Potential relationship of the TTR with AAS abuse. Highlights the risk of using steroids, local injected, in order to treat tissues with inflammation in cases of strength athletes.
Sollender et al. [19], 1998	Case series	Reporting 4 cases of avulsion of the tendon (triceps) in athletes training in weightlifting under AAS, three of them with chronic pain, two of them received local steroid injections (these with tendinopathy), one of them with re-rupture in 6 weeks.	TTR are uncommon injuries without predisposing factors. Local and systemic steroid use and tendinopathy as predisposing factors. Not clear whether tendinopathy itself or the combination with local steroid injection leads to TTR.
Hameed et al. [17], 2016	Case report	Reporting an interesting case of a 25-years-old male with rupture of the triceps tendon and overuse of AAS, B12, insulin, lyothyronine, and protein supplements	The TTR seems to be associated with the excessive use of AAS, as this use can progressively stiffen the tendon, especially in cases of weightlifting.

AAS: Androgenic anabolic steroid, TTR: Triceps tendon rupture

Author/year	Type of study	Purpose	Results
Inhofe et al. [14], 1995	Biomechanical	Achilles tendons of 48 rats (male), which were separated into four groups, were evaluated with biomechanical, biochemical and ultrastructural tests. These groups included: control group, group with the use of AAS, group with exercise every day, and one with combination of both (AAS and exercise).	A 6-week course of AAS makes the tendon stiffer and vulnerable to failure with less energy and/or elongation
			Ultimate force before failure not affected by the use of AAS or exercise.
Yeh et al. [5], 2010	Review article	To review the existed literature about the anatomy, predisposing factors (including AAS), presentation and physical examination of TTR, diagnostic imaging, management, chronic, revision or difficult tears management, postoperative care, results and complications following TTR management.	Acute ruptures are uncommon and mainly occur among athletes, especially weightlifters. Clinical diagnosis, aided by MRI. Surgical repair offers predictable functional outcome, with anatomic footprint repair to be the favorable.
Tsitsilonis et al. [13], 2014	Experimental	To study the impact of AAS on specific characteristics of Achilles tendon (biomechanical and histological).	AAS influence tendons (reverse the beneficial impact of exercise) and can cause a worse result by reducing stress values.
Kanayama et al. [15], 2015	Cross sectional cohort	To evaluate TTR by comparing a large cohort of patients using AAS with those not using.	When AAS excessive users were compared with similar bodybuilders, an increase in the risk tendon ruptures was noted, especially these of upper-body.
Dunn et al. [4], 2017	Systematic review	Classification of differential signs, rerupture rates, predisposing and rerupture rates of all cases of TTR surgically treated.	The most common predisposing factor is renal disease (10%), while use of AAS is the second most common (7%).
AAS: Androgenic anabolic steroid, TTR: Triceps tendon rupture			

Foot Ankle Surg. 2014 Jun;20(2):94-9. doi: 10.1016/j.fas.2013.12.001. Epub 2013 Dec 14.

Anabolic androgenic steroids reverse the beneficial effect of exercise on tendon biomechanics: an experimental study

Serafim Tsitsilonis [1], Panayiotis E Chatzistergos, Athanasios S Mitousoudis, Stavros K Kourkoulis, Ioannis S Vlachos, George Agrogiannis, Konstantinos Fasseas, Despina N Perrea, Aristides B Zoubos

Table 1
The values of fracture forces, cross-sectional area of the tendons and fracture stress among the four different groups. There were statistical significant differences in the fracture stress between the control group (C) and the exercise group (E) and between the exercise group (E) and the exercise and anabolics group (AE).

Parameter	Controls (C)	Exercise (E)	Anabolics (A)	Anabolics and exercise (AE)	Significant differences
Fracture force (N)	41.7 ± 7.1	46.6 ± 10.9	45.3 ± 10.1	53.4 ± 14.5	None
Area (μm^2)	$23{,}000 \pm 8750$	$17{,}800 \pm 1600$	$21{,}000 \pm 7600$	$26{,}000 \pm 5700$	None
Fracture stress (MPa)	15.7 ± 2.6	26.1 ± 7.2	19.1 ± 2.5	15.0 ± 3.4	C-E[a], E-AE[b]

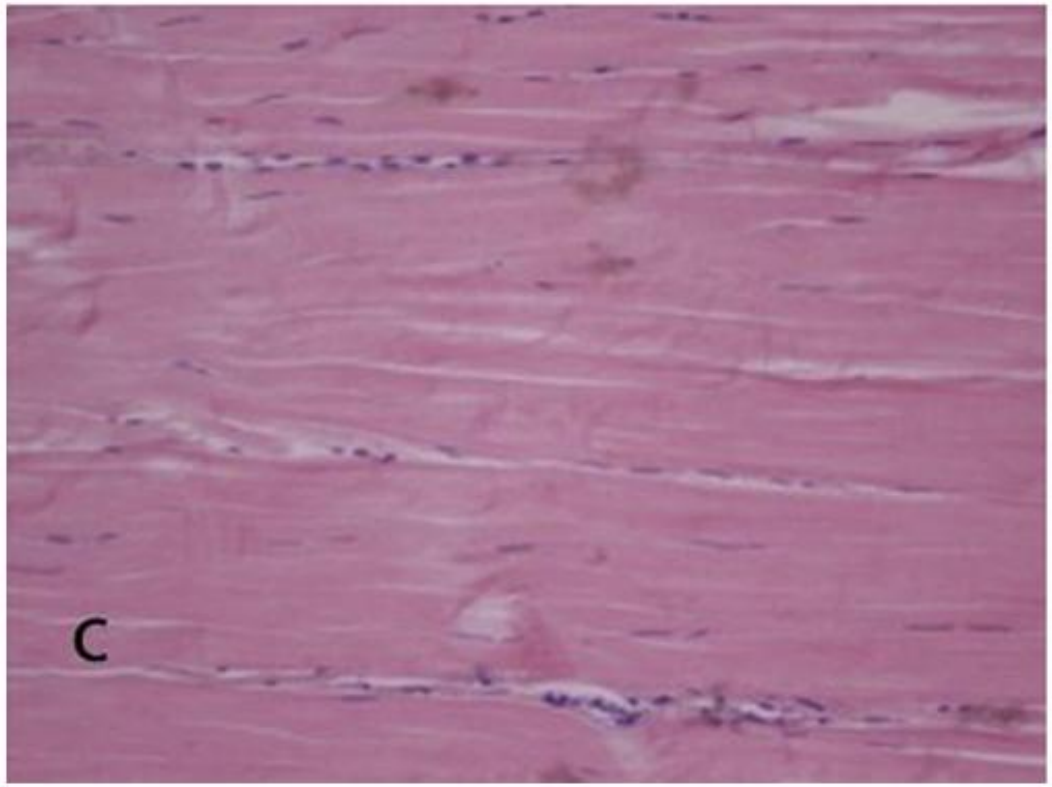
[a] $p < 0.01$.
[b] $p < 0.001$.

Uso de EAA prejudica a adaptação do tendão ao exercício, provocando enrijecimento e capacidade diminuída de estiramento.

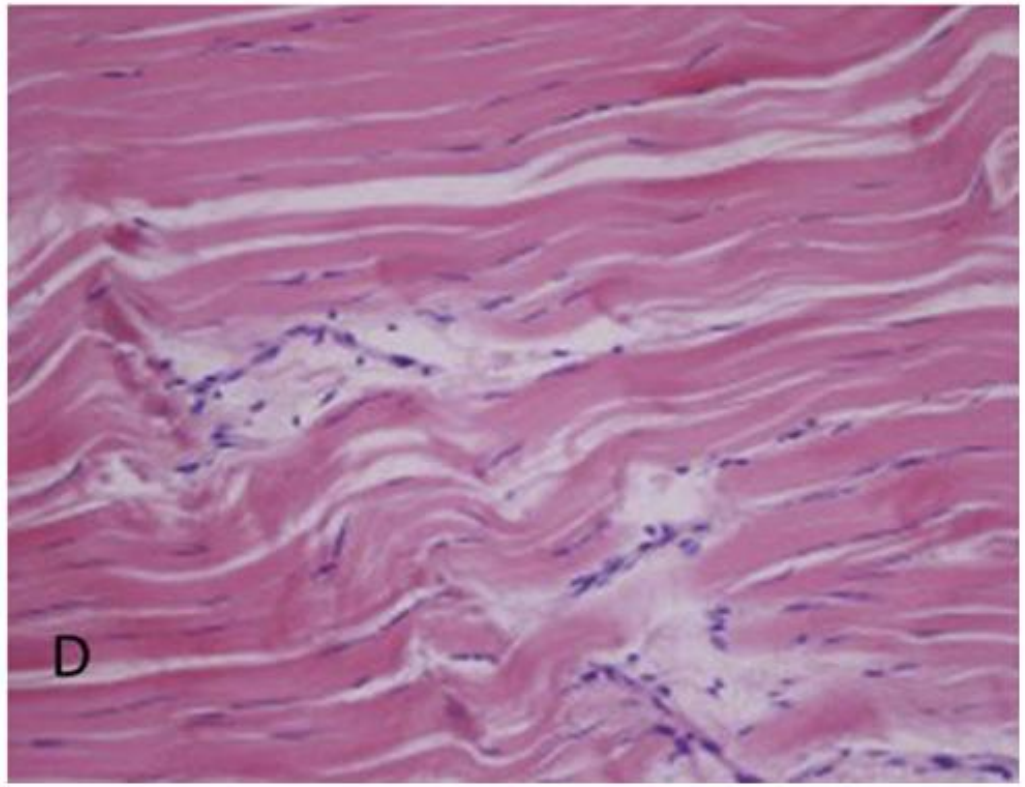
Tsitsilonis S, et al. Foot Ankle Surg. 2014;20(2):94-9.

Desorganização estrutura do tendão

Tendão calcâneo



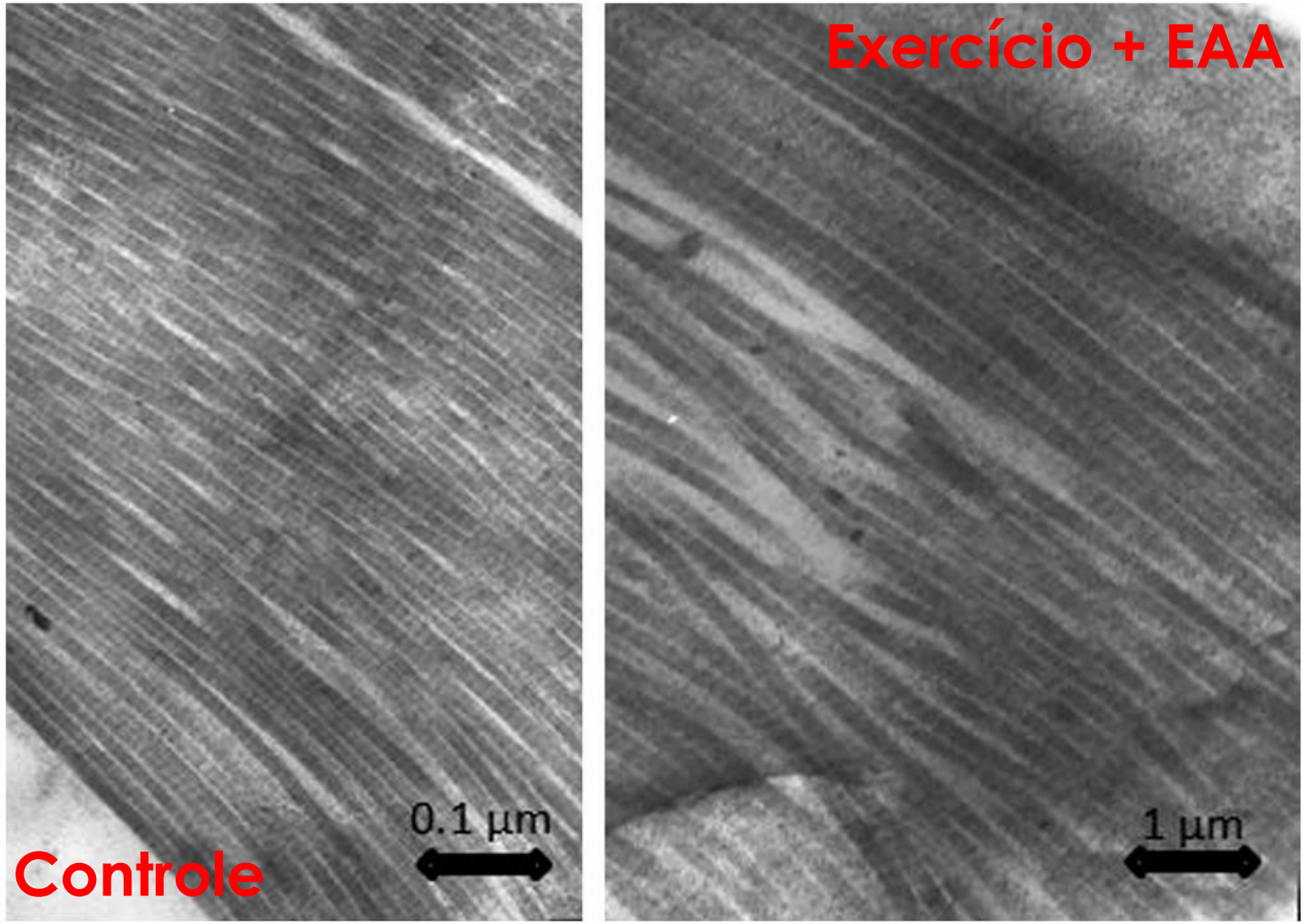
Controle



Exercício + EAA

Tsitsilonis S, et al. Foot Ankle Surg. 2014;20(2):94-9.

Desorganização estrutura do tendão



Tsitsilonis S, et al. Foot Ankle Surg. 2014;20(2):94-9.

Maior chance de lesão musculotendínea com T

Table 3. Number of quadriceps tendon injuries any time after filling prescriptions for exogenous testosterone

		Prior testosterone use		Control			
Population	Age group in years	Total number of patients	Percentage (n) of quad tendon injuries	Total number of patients	Percentage (n) of quad tendon injuries	OR (95% CI)	p value
All patients		151,797	0.34 (520)	151,979	0.18 (274)	1.9 (1.6 to 2.2)	< 0.001
Male		123,627	0.37 (455)	123,627	0.19 (239)	1.9 (1.6 to 2.2)	< 0.001
	35 to 45	31,328	0.32 (99)	31,328	0.19 (59)	1.7 (1.2 to 2.3)	0.002
	46 to 55	37,883	0.42 (160)	37,883	0.26 (100)	1.6 (1.3 to 2.1)	< 0.001
	56 to 65	31,696	0.39 (124)	31,696	0.18 (58)	2.1 (1.6 to 3.0)	< 0.001
	66 to 75	22,720	0.32 (72)	22,720	0.01 (22)	3.3 (2.1 to 5.4)	< 0.001
Female		28,170	0.17 (49)	28,170	0.10 (28)	1.8 (1.1 to 2.8)	0.02
	35 to 45	3719	N/A (< 11)	3719	N/A (< 11)	1.0 (0.3 to 3.2)	> 0.99
	46 to 55	10,228	0.17 (18)	10,228	0.11 (11)	1.6 (0.8 to 3.6)	0.20
	56 to 65	10,052	0.16 (16)	10,052	N/A (< 11)	1.8 (0.8 to 4.2)	0.17
	66 to 75	4171	N/A (< 11)	4171	N/A (< 11)	4.5 (1.2 to 29.6)	0.05

A comparison with a matched cohort of patients; data presented as % (n). The number of patients in a cohort size < 11 is not reportable per the Health Insurance Portability and Accountability Act.

Meghani O, et al. Clin Orthop Relat Res. 2024;482(1):175-181.

Am J Physiol Endocrinol Metab. 2001 Jun;280(6):E973-81. doi: 10.1152/ajpendo.2001.280.6.E973.

Anabolic steroids increase exercise tolerance

T Tamaki [1], S Uchiyama, Y Uchiyama, A Akatsuka, R R Roy, V R Edgerton

Affiliations + expand

PMID: 11350779 DOI: 10.1152/ajpendo.2001.280.6.E973

Free article

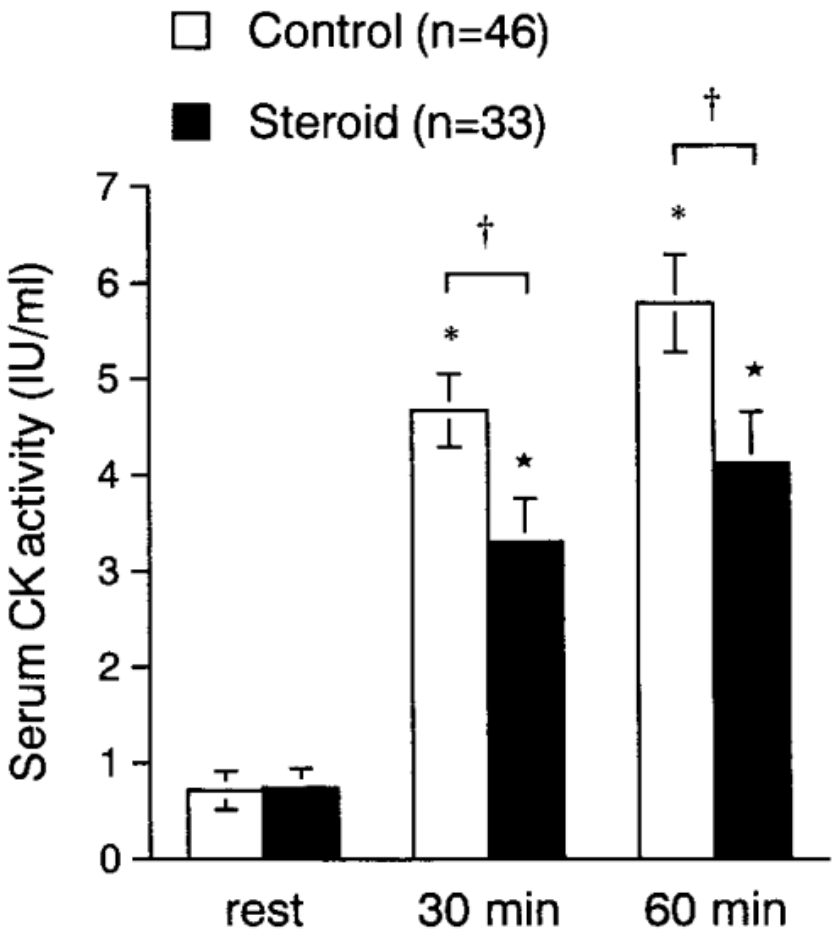
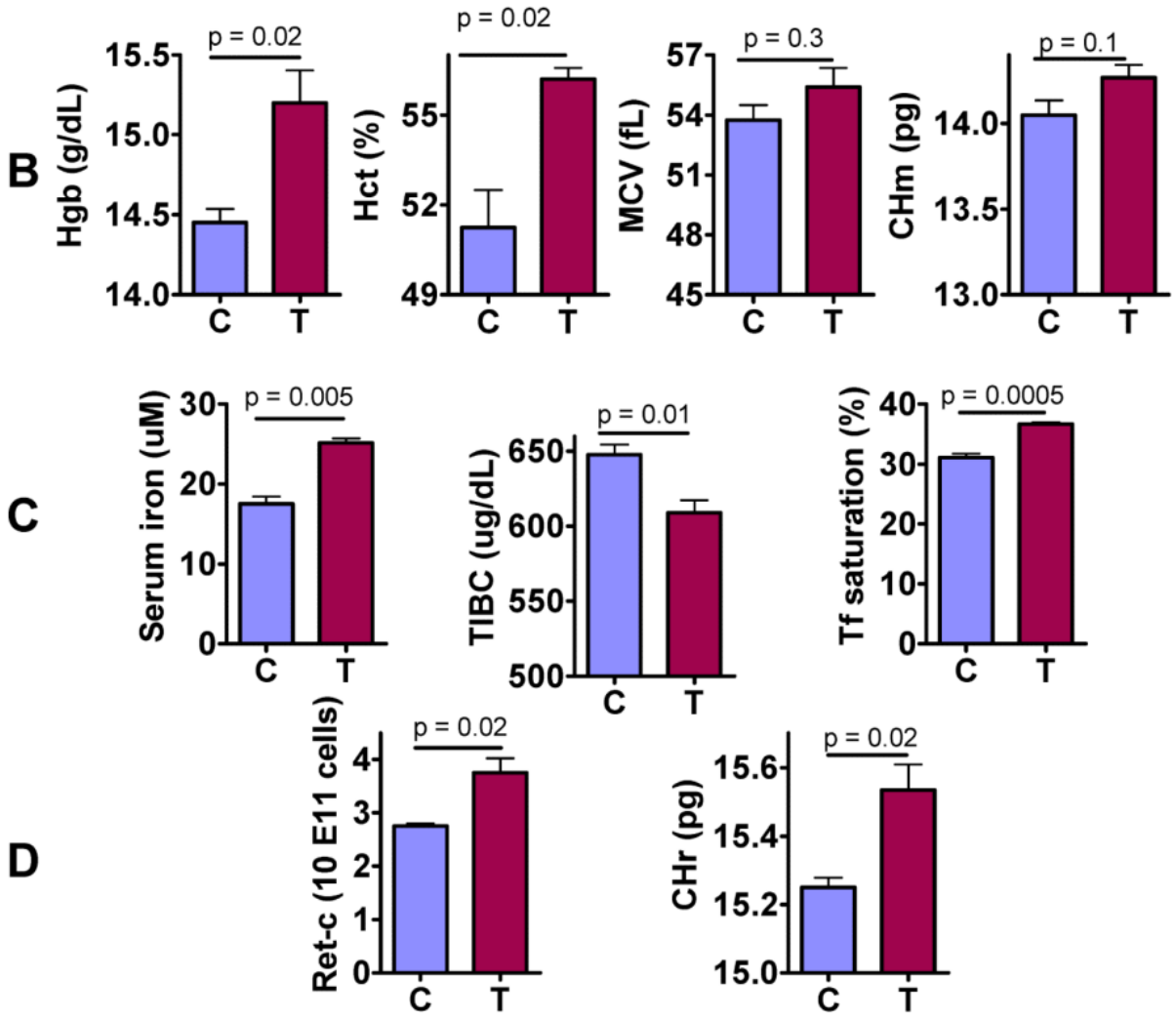


Fig. 1. Mean serum creatine kinase (CK) activity at rest and 30 and 60 min after an exhaustive resistive bout of weight lifting. Bars are SE. A significant increase in CK leakage was observed 30 and 60 min after exercise in both groups. However, the values were significantly

- **Otimização na recuperação após treinamento de força**

Testosterone Administration Inhibits Hepcidin Transcription and is Associated with Increased Iron Incorporation into Red Blood Cells



Guo W, et al. Aging Cell. 2013;12(2):280-91.

Hipertrofia prostática

TABLE I. Prostate Volume and Serum Concentrations of PSA, SHBG, FSH, Testosterone, and LH Before and After 8 Months of Testosterone Treatment and in Controls

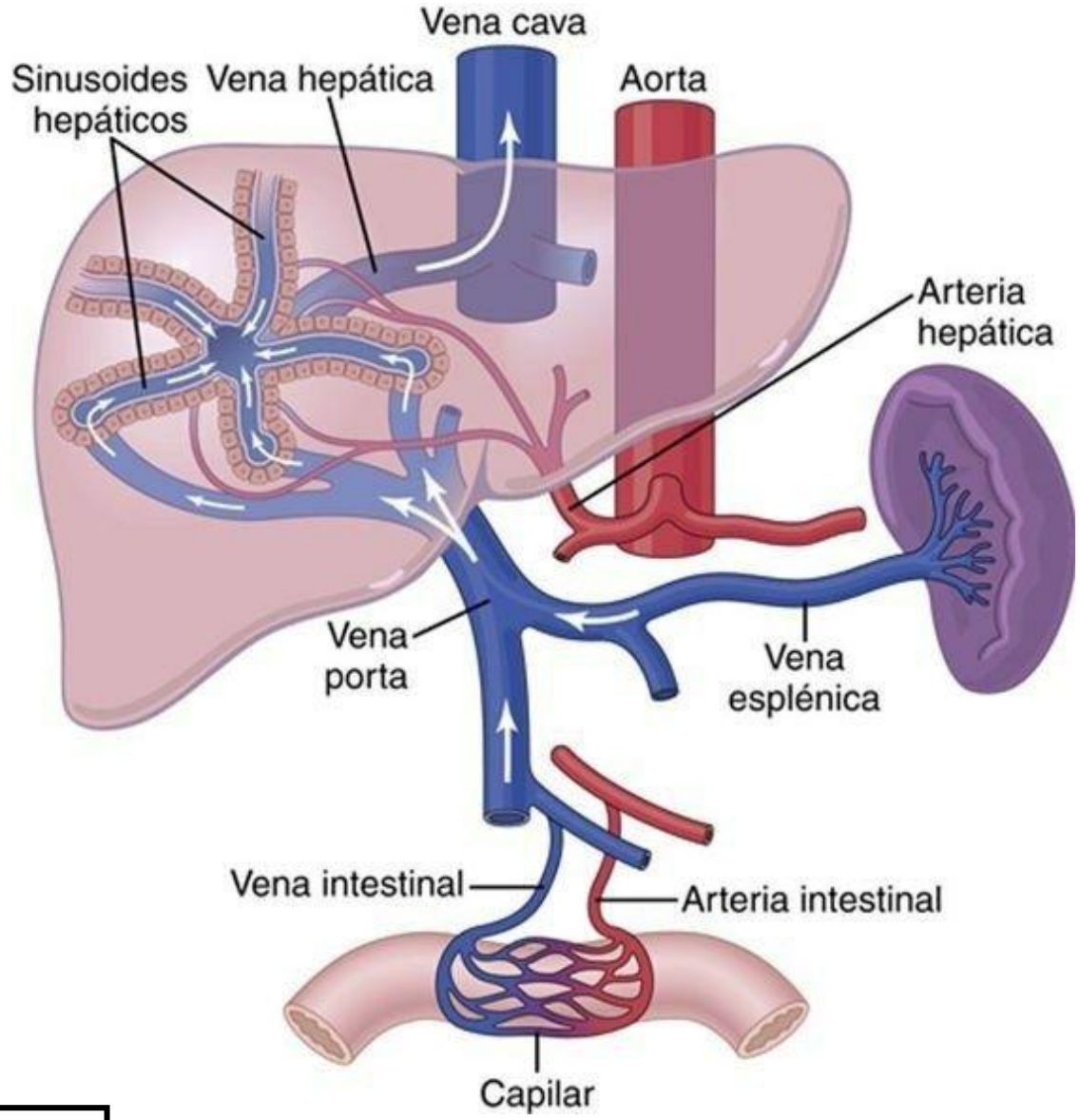
12%

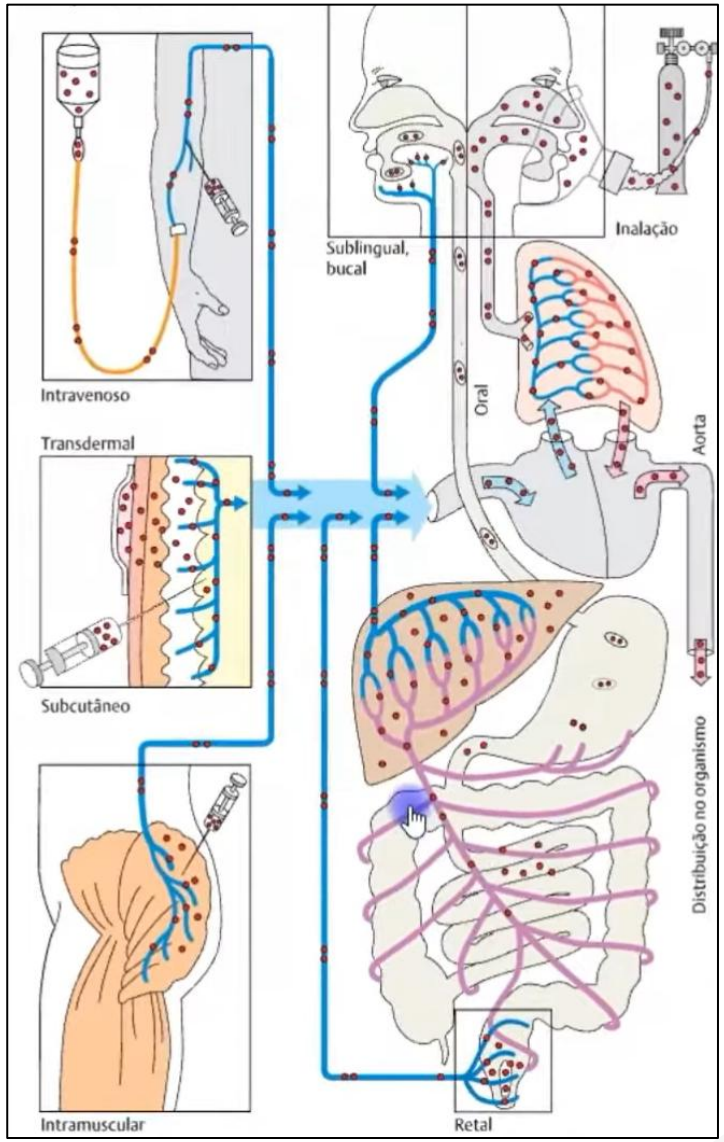
	Treatment group (n = 11)			Placebo group (n = 8)		
	Before	After		Before	After	
Prostate volume (mL)	24.6 (1.8)	27.6 (2.1)	$P < .012$	22.1 (2.4)	22.1 (2.2)	n.s.
	Treatment group (n = 11)			Placebo group (n = 12)		
	Before	After		Before	After	
s-PSA (μg/L)						
IFMA	1.28 (0.3)	1.30 (0.3)	n.s.	0.72 (0.1)	0.76 (0.1)	n.s.
IRMA	0.96 (0.3)	1.04 (0.2)	n.s.	0.46 (0.1)	0.52 (0.1)	n.s.
Hormone analyses						
s-testosterone (nmol/L)	16.0 (1.2)	16.2 (1.9)	n.s.	16.8 (1.0)	17.5 (1.1)	n.s.
s-SHBG (nmol/L)	21.2 (3.1)	18.1 (3.9)	$P < .05$	25.0 (2.7)	24.3 (2.7)	n.s.
s-FSH (IU/L)	10.0 (2.1)	6.7 (1.5)	$P < .05$	9.9 (1.2)	10.0 (1.2)	n.s.
s-LH (IU/L)	2.1 (1.1)	1.8 (0.2)	n.s.	2.5 (0.3)	2.6 (0.3)	n.s.

Values are expressed as mean (SE). IFMA, immunofluorometric assay; IRMA, immunoradiometric assay; n.s., not significant.

Tamaki T, et al. Am J Physiol Endocrinol Metab. 2001;280(6):E973-81.

Metabolismo de primeira passagem ou pré-sistêmico





Petrovic A, et al. World J Gastroenterol. 2022;28(26):3071-3080.

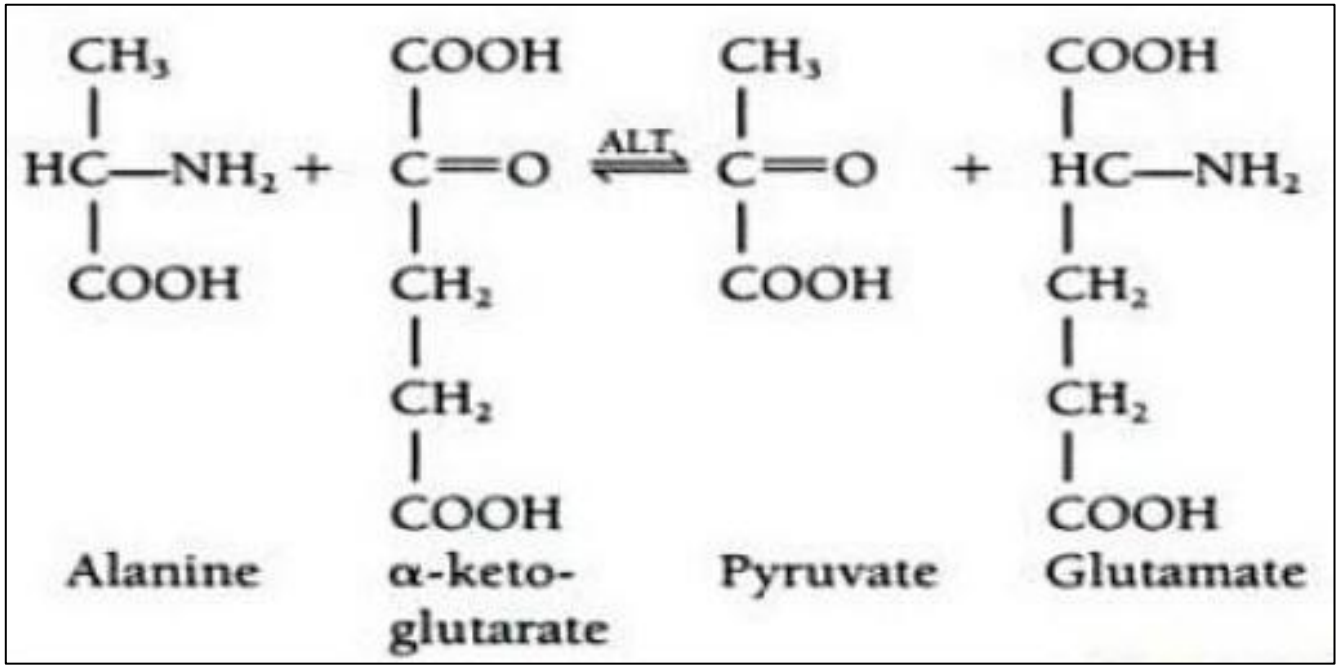
Alterações hepáticas e renais

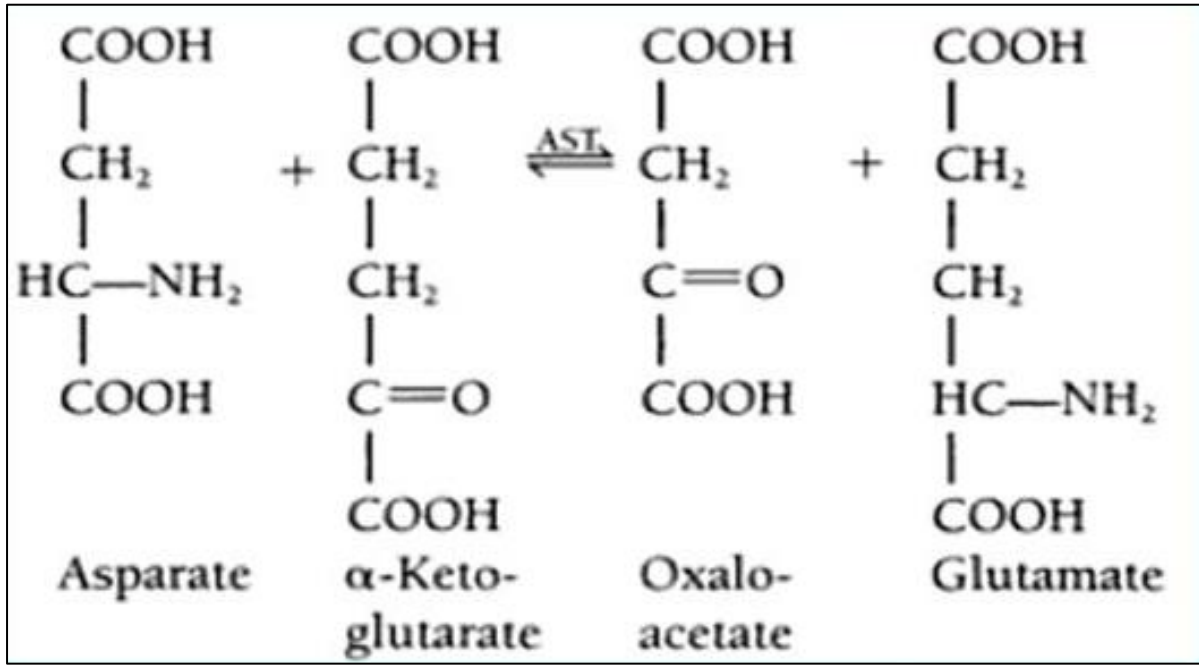
Table 1
Physical characteristics, clinical biomarkers, and hormonal profile in anabolic androgenic steroid users (AASU), anabolic androgenic steroid nonusers (AASNU), and sedentary control (SC).

Variables	AASU (n = 20)	AASNU (n = 20)	SC (n = 10)	*p*
Age (years)	29 ± 5	29 ± 5	29 ± 3	0.861
Weight (kg)	97.4 (90.1–104.9) *†	82.0 (74.0–88.0)	74.8 (70.0–87.5)	0.003
Height (m)	1.78 ± 0.04	1.80 ± 0.09	1.76 ± 0.08	0.841
BMI (kg/m^2)	31.11 ± 3.45 *†	25.45 ± 1.92	25.70 ± 3.38	< 0.001
SBP (mmHg)	130 (130–140) *†	120 (100–120)	120 (110–120)	< 0.001
DBP (mmHg)	90 (80–90) *†	80 (70–80)	80 (70–80)	< 0.001
TC (mg/dL)	186 (143–208)	155 (134–188)	189 (175–200)	0.07
HDL-c (mg/dL)	19 (13–25) *†	44 (41–54)	50 (40–55)	< 0.001
LDL-c (mg/dL)	144 (105–179) *†	96 (81–125)	122 (105–132)	0.001
Non-HDL-c (mg/dL)	157 (121–198)†	111 (94–139) *	147 (128–152)	0.03
Triglycerides (mg/dL)	74 ± 23	75 ± 35	98 ± 45	0.15
Glucose (mg/dL)	90 ± 7	90 ± 6	92 ± 8	0.66
Urea (mg/dL)	36 ± 8	33 ± 6	30 ± 9	0.13
Creatinine (mg/dL)	1.30 ± 0.16 *†	1.11 ± 0.21	1.02 ± 0.12	< 0.001
GOT (U/L)	41 (34–55) *†	23 (20–32)	23 (19–29)	< 0.001
GPT (U/L)	63 (54–88) *†	36 (30–51)	35 (29–54)	0.001
Gamma GT (U/L)	26 (21–36) *	29 (24–44)	36 (27–53)	0.02

De Souza, et al. Atherosclerosis. 2019;283:100-105.

Alteração das enzimas hepáticas



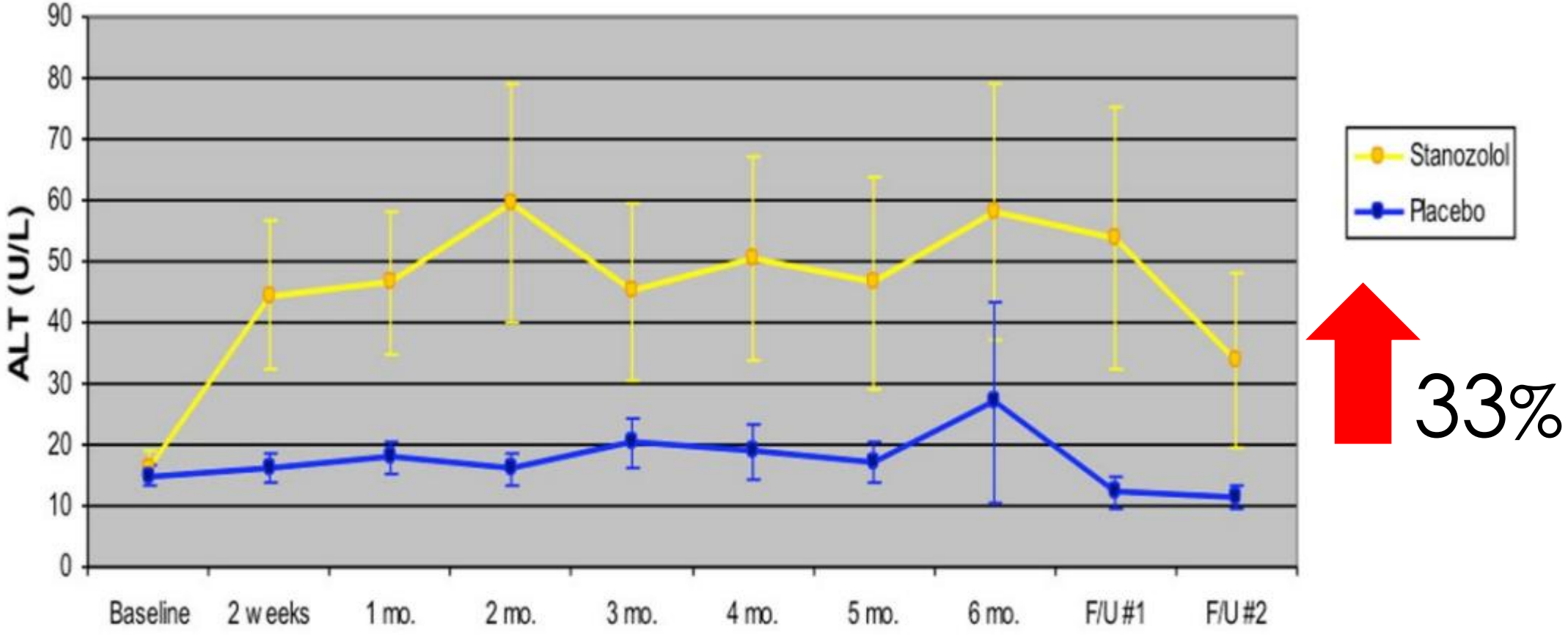


TGP/ALT: 7-56 U/L

TGO/AST: 5-40 U/L

Tamaki T, et al. Am J Physiol Endocrinol Metab. 2001;280(6):E973-81.

Enzimas hepáticas: ALT



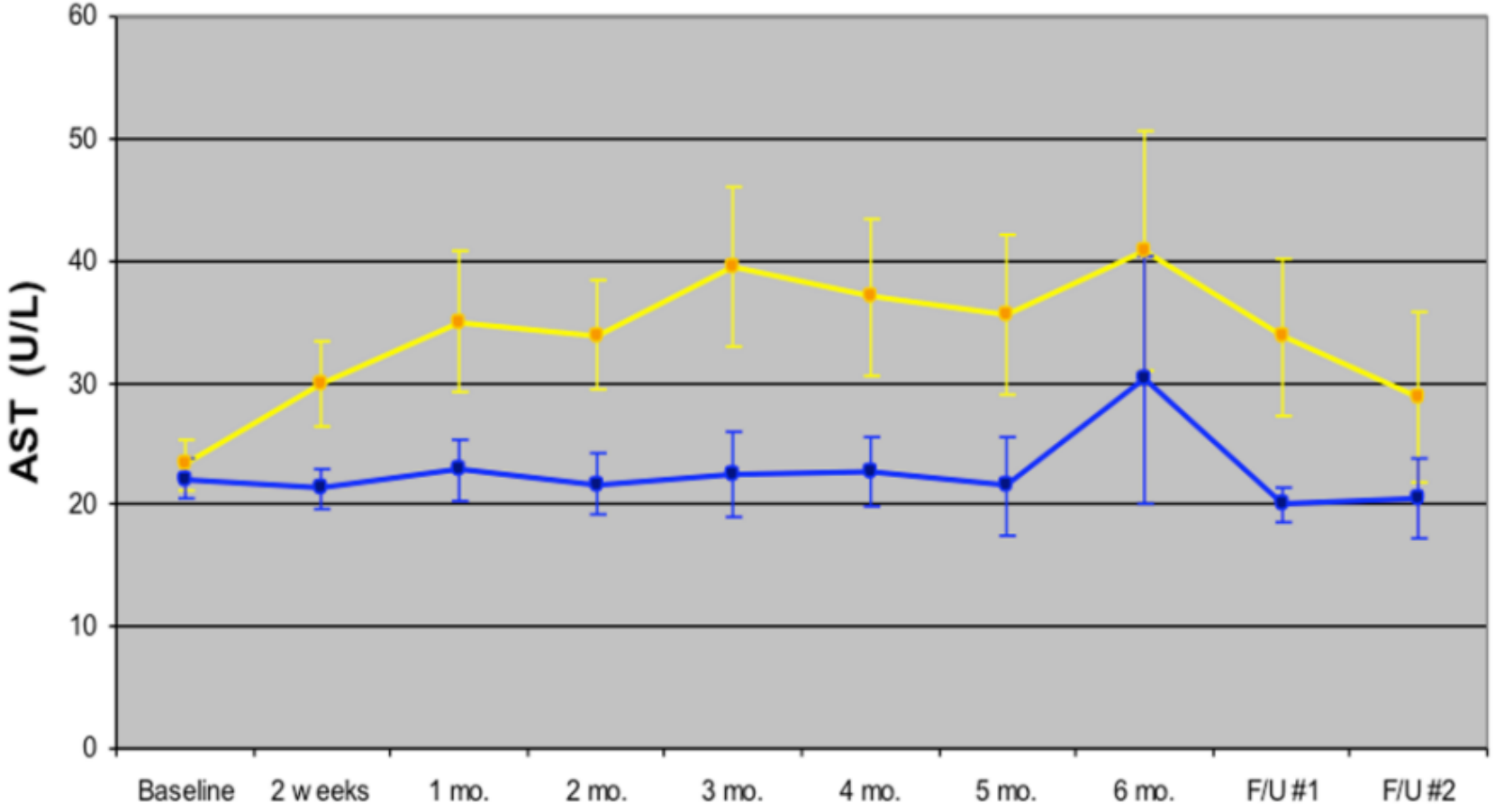
33%

P-values for significance as compared to baseline values

Stanozolol	0.6496	0.0361	0.0182	0.0422	0.0795	0.0876	0.1348	0.0402	0.1792	0.1253
Placebo	>0.05	0.6609	0.2605	0.5011	0.0645	0.4271	0.5078	0.4843	0.4328	0.4070

Carson P, et al. Int J Low Extrem Wounds. 2015;14(1):11-8.

Enzimas hepáticas: AST



29%

Stanozolol
Placebo

P-values for significance as compared to baseline values

Stanozolol	0.6376	0.1180	0.0663	0.0145	0.0365	0.0809	0.1200	0.0500	0.0692	0.4664
Placebo	>0.05	0.9207	0.9541	0.4431	0.9694	0.9175	0.5431	0.4558	0.1067	0.7084

Carson P, et al. Int J Low Extrem Wounds. 2015;14(1):11-8.