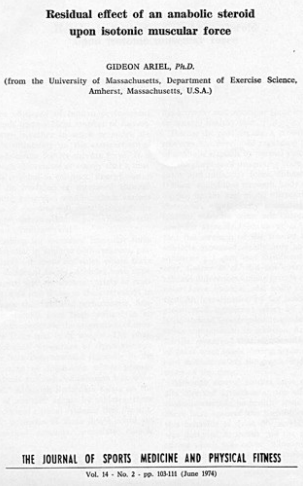




Residual effect of an anabolic steroid upon isotonic muscular force

Anabolic steroids have been utilized in an effort to accelerate the acquisition of muscular force and body weight.

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Residual Effect of an Anabolic Steroid upon Isotonic Muscular Force

This study by Gideon Ariel, Ph.D., from the University of Massachusetts, Department of Exercise Science, investigates the residual effects of anabolic steroids on muscular force. The study involved ten male subjects, aged between 21 to 25, who were divided into two groups. One group received an anabolic steroid during the first four weeks and a placebo during the last four weeks, while the other group received the placebo first, followed by the anabolic steroid.

The results revealed that muscular strength increase was enhanced by using an anabolic steroid, with the rate of increase also significantly greater. However, the lack of significant progress following cessation of the drug may indicate that rate of progress and net muscular strength gain may be independent of each other. The study concludes that anabolic steroids may merely provide a temporal effect by accelerating a normal biological-training effect.

The article discusses the effects of anabolic steroids on muscle strength. The study involved ten volunteers aged between 21 and 25 years, who were divided into two groups. One group received anabolic steroids for the first four weeks and a placebo for the last four weeks, while the other group received a placebo for the first four weeks and anabolic steroids for the last four weeks. The results showed that muscle strength increased significantly when using anabolic steroids. However, the lack of significant progress after stopping the medication suggests that the rate of progress and net gain in muscle strength may be independent of each other. The study concludes that prolonged muscle training without anabolic steroids may produce a net gain equivalent to muscle strength after an extended training period.

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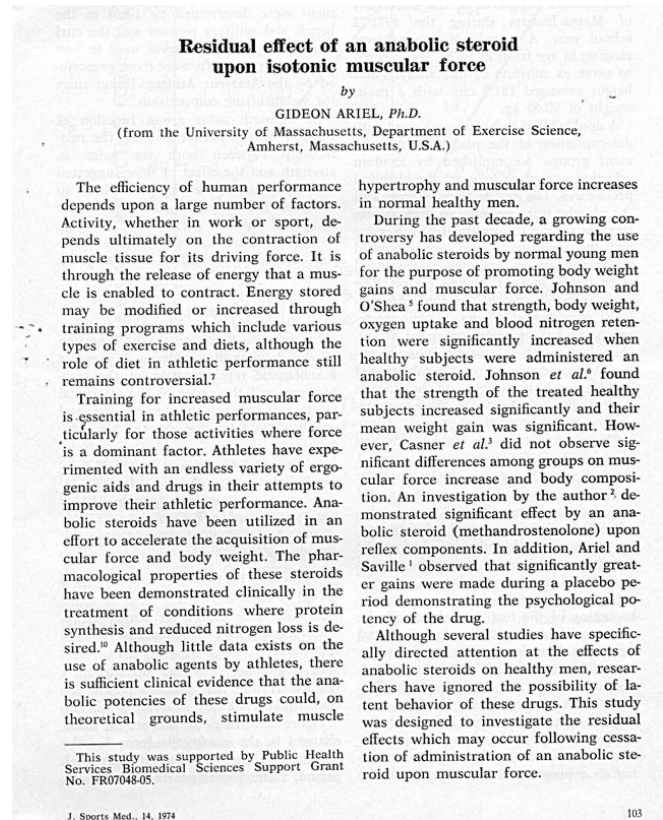
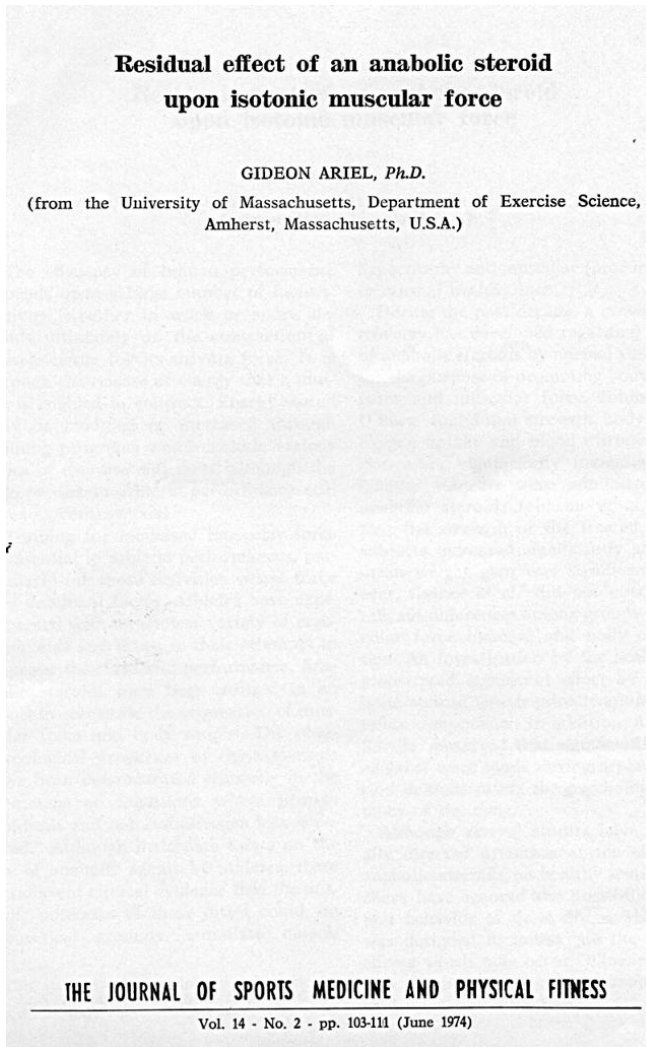
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Below find a reprint of the 10 relevant pages of the article "Residual effect of an anabolic steroid upon isotonic muscular force" in "The Journal of Sports Medicine and Physical Fitness":



METHODS

The population consisted of male weightlifters registered at the University of Massachusetts during the 1971-72 school year. A sample of ten subjects ranging in age from 21 to 25, volunteered to serve as subjects in this study. Their height averaged 181.5 cm. with a mean weight of 90.40 kg.

A double-blind technique was used with determination of the placebo and treatment groups accomplished by random selection according to strict double-blind procedures. The oral anabolic steroid and the placebo were assigned to the subjects by code by the University Health Service and the investigator was not informed which subject received the steroid until after the eight-week testing period. The oral anabolic steroid (methandrostenolone) consisted of 15 mg. Methandrostenolone and the placebo consisted of calcium lactate. The University Pharmaceutical Laboratory prepared the tablets and both the anabolic steroid and the placebo were indistinguishable in their appearance.

The ten subjects were divided into two groups. Those five subjects in group 1 (anabolic-placebo) received the anabolic steroid during the first four weeks and the placebo during the last four weeks, while those five in group 2 (placebo-anabolic) received the placebo during the first four weeks and the anabolic steroid during the last four weeks.

For a period of four weeks prior to the beginning of the test procedures all the subjects lifted weights for five days and were tested on the seventh day for maximum lifts in the bench and military presses and the curl and squat exercises. The experiment was conducted during a subsequent eight week period. Subjects trained five times per week for approximately two hours each training session, according to a program designed to work the

major muscle groups of the body utilizing progressive over-load principle. Maximum dynamic contractile force measurements were determined by 1-RM in the bench and military presses and the curl and squat lifts. Techniques used in performing the four lifts were those prescribed by the Amateur Athletic Union rules for weightlifting competition.

As strength gains are a function of training over a period of time, the relationship between both the gains in strength and the effect of time suggested a comparison of the regression lines to compare the strength gain rate in the drug and placebo periods. In addition, analysis of variance and analysis of covariance were utilized in assessing the data.

RESULTS

In order to facilitate the presentation of the data analysis, Figure 1 presents a schematic representation of the comparisons and the order of the statistical treatments between the two experimental groups. The following are the six comparisons:

1. Period I (drug) and Period II (placebo) for group 1.
2. Period I (placebo) and Period II (drug) for group 2.
3. Group 1 (drug) and Group 2 (placebo) in Period I.
4. Group 1 (placebo) and Group 2 (drug) in Period II.
5. The drug period for Group 1 (Period I) and the drug period for Group 2 (Period II).
6. The placebo period for Group 1 (Period II) and the placebo period for Group 2 (Period I).

Figures 2 through 5 illustrate the mean changes in the contractile force for the experimental tests during the eight week period. Table 1 presents the F-ratios ob-

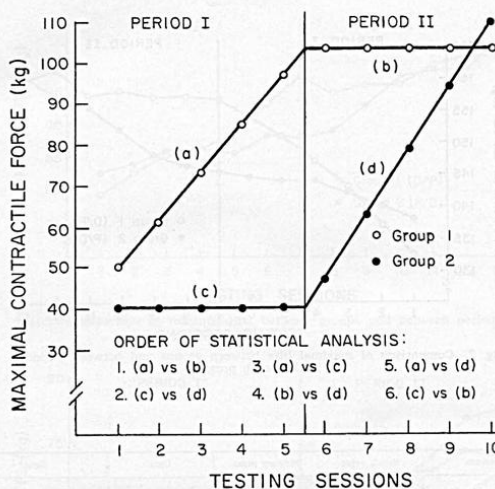


Fig. 1.—Schematic representation of statistical comparisons between groups and between periods.

tained in the different statistical analyses for the experimental tests.

When comparing the drug period and the placebo period for group 1, significant gains in muscular force were observed in both periods in the bench press, military press and curl exercises. In the squat exercise, significant gains were obtained only in the drug period. The regression slopes were significantly different for all the exercises.

Comparison between the two periods for group 2 (comparison 2), revealed significant differences for all experimental tests.

When comparing group 1 and 2 in the first period (comparison 3), no significant differences in strength levels were obtained

in the bench-press, military-press or the squat exercises. However, significant differences were obtained when comparing the regression slopes of the two groups, indicating different rates of progress.

Comparison of the two groups in the second period (comparison 4), yielded significant differences in the benchpress and squat exercises but no significant differences in the military-press and curl. However, as in comparison 3, all the regression slopes yielded significant differences between the groups.

When comparing the drug period of group 1 with the drug period of group 2 (comparison 5), significant differences were obtained between the means. When

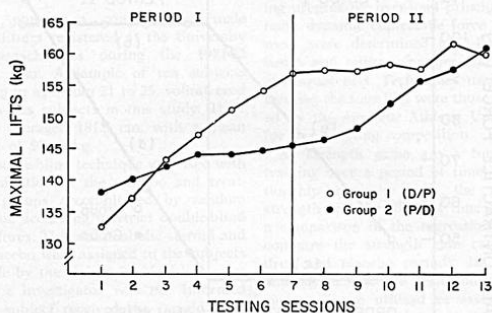


Fig. 2.—Comparison of maximal lifts between groups and between periods, in the bench press.

TABLE 1.—F-ratios of the six comparisons.

Comparison	Bench press	Military press	Curl	Squat
1. Analysis of:				
Variance	13.75**	16.34**	15.32**	9.18* (1.12)
Covariance	35.83**	52.39**	42.09**	18.19** (1.11)
Slope	148.81**	30.32**	53.86**	111.11** (1.10)
2. Analysis of:				
Variance	16.59**	18.80**	20.69**	19.77** (1.12)
Covariance	102.74**	74.09**	71.28**	126.20** (1.11)
Slope	44.43**	22.54**	151.51**	86.55** (1.10)
3. Analysis of:				
Variance	0.97	0.54	2.95	0.92 (1.12)
Covariance	3.59	1.98	10.19**	4.10 (1.11)
Slope	103.21**	47.82**	54.50**	96.53** (1.10)
4. Analysis of:				
Variance	8.08*	1.33	0.44	4.88* (1.12)
Covariance	26.69**	4.39	1.21	9.91** (1.11)
Slope	87.66**	15.95**	119.51**	91.52** (1.10)
5. Analysis of:				
Variance	2.47	6.00*	5.02*	14.52** (1.12)
Covariance	38.43**	117.20**	178.77**	512.60** (1.11)
Slope	29.85**	1.66	0.82	11.21** (1.10)
6. Analysis of:				
Variance	181.27**	103.21**	229.61**	27.60** (1.12)
Covariance	903.60**	330.02**	1,140.06**	53.93** (1.11)
Slope	4.80	0.05	1.12	13.36** (1.10)

*F-ratio significant at the .05 level of confidence.
**F-ratio significant at the .01 level of confidence.

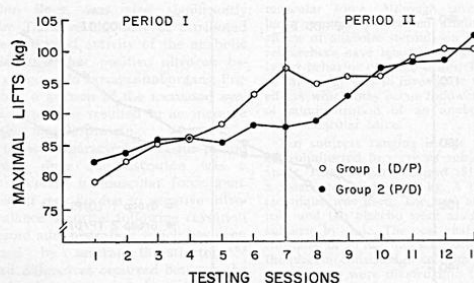


Fig. 3.—Comparison of maximal lifts between groups and between periods, in the military press.

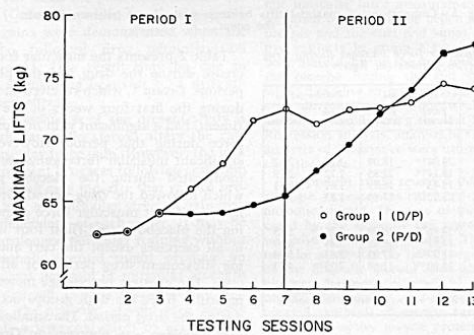


Fig. 4.—Comparison of maximal lifts between groups and between periods, in the curl.

comparing the regression slopes, no significant differences were found in the military-press and the curl, although significant differences were obtained between the regression slopes in the bench-press and squat exercises.

Comparison of the placebo periods of the two groups (comparison 6) permits evaluation of the residual effects of the anabolic steroid. The placebo period for group 1 followed four weeks of drug ingestion, while the placebo period for

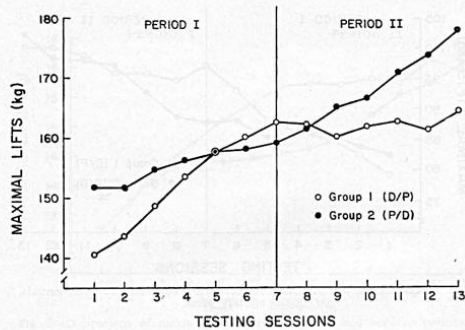


Fig. 5.—Comparison of maximal lifts between groups and between periods, in the squat.

TABLE 2.—Muscular force increase during drug and placebo periods (in Kg.).

Exercise	Drug period		Placebo period	
	Force increase	Percent increase	Force increase	Percent increase
Group 1				
Bench P.	24.04**	18.09	3.17	2.02
Military P.	18.14**	22.85	2.72	2.79
Curl	10.43**	16.79	1.82	2.51
Squat	22.22**	15.80	1.83	1.12
Group 2				
Bench P.	14.96**	10.28	7.26**	5.25
Military P.	14.51**	16.49	5.44*	6.59
Curl	11.79**	17.93	3.63	5.94
Squat	18.60**	11.68	7.25**	4.77

*F-ratio significant at the .05 level of confidence.

**F-ratio significant at the .01 level of confidence.

group 2 preceded receiving the steroid. This comparison demonstrated significant difference in the man strength levels in all the experimental tests. However, the regression slopes yielded no significant differences in the bench-press, military-press, or the curl exercises. The regression slopes in the squat exercise were statistically significant.

Table 2 presents the muscular force increase during the drug and the placebo periods. Group 1, which received the drug during the first four weeks of the experiment, had a significant gain in muscular force during that period. However, no significant muscular force gains were demonstrated during the placebo period which followed the drug period. Group 2 had significant muscular force gains during the placebo period (first four weeks) in all exercises except the curl and during subsequent drug period for all exercises. The greatest percentage increase in muscular force for both groups occurred during the drug period. The smallest percent increase was observed in Group 1 during the placebo period which followed drug administration.

DISCUSSION

The present study revealed that muscular strength increase was enhanced by using an anabolic steroid. The rate of increase, indicated by the slope of the re-

gression lines, was also significantly greater. These results may be attributed to the biological activity of the anabolic steroid such that positive nitrogen balance occurred in extragenital organs. Presumably, a portion of the increased synthesis of protein resulted in an increase of active muscle protein.

An obvious characteristic of the period following drug administration was a sharp decrease in muscular force gain. This effect may be due to negative nitrogen balance occurred following cessation of steroid administration which has been reported by several investigators.^{4,5,9} Marked differences occurred between the muscular force gains of the two groups with respect to the placebo period. Significant gains in muscular strength were observed when the placebo preceded the drug (Group 2), while small, non-significant gains were demonstrated when the placebo followed drug administration (Group 1). This result may be due to some latent drug behavior or a drug-stimulated effect.

One conclusion of the present study is that the anabolic steroid alters the rate of muscular force gain. However, the lack of significant progress following cessation of the drug may indicate that rate of progress and net muscular strength gain may be independent of each other. It may be that prolonged muscular training without an anabolic steroid might produce an equivalent net gain of muscular strength following an extended training period. Hence, the anabolic steroid may merely provide a temporal effect by accelerating a normal biological-training effect.

SUMMARIES

G. ARIEL

Residual effect of an anabolic steroid upon isotonic muscular force.

During the past decade, a growing controversy has developed regarding the use of anabolic steroids by athletes for the purpose of promoting body weight gains and

muscular force. Although several studies have specifically directed attention at the effects of anabolic steroids on healthy men, researchers have ignored the possibility of latent behavior of these drugs. The purpose of this study was to investigate the residual effects which may occur following cessation of administration of an anabolic steroid upon muscular force.

Ten subjects ranging in age from 21 to 25, volunteered to serve as subjects in this study. Their height averaged 181.5 cm. with a mean weight of 90.40 kg. A double-blind technique was used. The oral anabolic steroid and the placebo were assigned to the subjects by code. The oral anabolic steroid consisted of 15 mg. Methandrostenolone and the placebo consisted of calcium lactate. The ten subjects were divided into two groups; anabolic-placebo group, and placebo-anabolic group. Subjects trained five times per week according to a program designed to work the major muscle groups. Maximum dynamic muscular force measurements were determined by 1-RM in the bench and military presses and the curl and squat lifts. Those five subjects in group 1 received the anabolic steroid during the first four weeks and the placebo during the last four weeks, while those five in group 2 received the placebo during the first four weeks and the anabolic steroid during the last four weeks. Regression analysis, analysis of variance and analysis of covariance were utilized in assessing the data.

The present study revealed that muscular strength increase was enhanced by using an anabolic steroid. The rate of increase, indicated by the slope of the regression lines, was also significantly greater. These results may be attributed to the biological activity of the anabolic steroid such that positive nitrogen balance occurred in extragenital organs. Presumably, a portion of the increased synthesis of protein resulted in an increase of active muscle protein. One conclusion of the present study is that the anabolic steroid alters the rate of muscular force gain. However, the lack of significant progress following cessation of the drug may indicate that rate of progress and net muscular strength gain may be independent of each other. It may be that prolonged muscular training without an anabolic steroid might produce an equivalent net gain of muscular strength following an extended training period.

G. ARIEL

Effet résiduel d'un stéroïde anabolique sur la force musculaire isotonique.

Au cours de ces 10 dernières années, une controverse croissante s'est développée au sujet de l'utilisation par des athlètes de stéroïdes anaboliques en vue de produire une augmentation du poids corporel et de la force musculaire. Bien que plusieurs études ont attiré spécialement l'attention sur les effets des stéroïdes anaboliques sur les sujets sains, les chercheurs ont ignoré la possibilité d'un comportement latent de ces médicaments. Le but que se propose ce travail est d'examiner les effets résiduels, qui peuvent se produire après l'arrêt de l'administration d'un stéroïde anabolique sur la force musculaire.

Dix volontaires, âgés de 21 à 25 ans, ont servi de sujet pour cette étude. La taille moyenne s'élevait à 181,5 cm, et le poids moyen à 90,40 Kg. La technique du double-blind a été utilisée. Le stéroïde anabolique oral et le placebo ont été assignés aux sujets par code. Le stéroïde anabolique oral consistait en 15 mg. de Méthandrostenolone et le placebo en lactate de calcium. Les dix sujets ont été divisés en deux groupes: le groupe anabolique-placebo et le groupe placebo-anabolique. Les sujets s'entraînaient cinq fois par semaine selon un programme établi en vue de faire travailler les groupes musculaires les plus importants. Les mesures de la force musculaire dynamique maximum ont été déterminées par 1RM dans le développé et l'arraché, courbé et accroupi, aux haltères. Les cinq sujets du groupe 1 ont reçu le stéroïde anabolique au cours des quatre premières semaines et le placebo au cours des quatre dernières semaines, alors que les cinq du groupe 2 ont reçu le placebo au cours de 4 premières semaines et le stéroïde anabolique au cours des quatre dernières semaines. Les données ont été évaluées à l'aide de l'analyse de la régression, de la variance et de la covariance.

Le présent travail a montré que l'augmentation de la force musculaire a été renforcée en faisant appel à un stéroïde anabolique. Le taux d'augmentation, indiqué par l'inclinaison des lignes de régression, s'est révélé aussi plus grand de façon significative. Ces résultats peuvent être attribués à l'activité biologique du stéroïde anabolique, de façon qu'un bilan positif de l'azote s'in-

staura dans les organes extra-génitaux. Il est probable qu'une portion de la synthèse accrue des protéines se traduise en une augmentation des protéines musculaires actives. L'une des conclusions de ce travail est que le stéroïde anabolique modifie le taux du gain de force musculaire. Cependant le manque d'un progrès significatif à la suite de l'arrêt du médicament peut indiquer que le taux de progrès et le gain net de force musculaire peuvent être indépendants l'un de l'autre. Il est possible que l'entraînement musculaire prolongé sans stéroïde anabolique produise un gain net équivalent de la force musculaire à la suite d'une période d'entraînement étendue.

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G. ARIEL

Efecto remanente de un esteroide anabolico sobre la fuerza muscular isotónica.

Durante los últimos diez años, se ha desarrollado una creciente controversia sobre el empleo de esteroides anabólicos por los atletas, con el objeto de producir un aumento de peso corporal y de la fuerza muscular. A pesar que numerosos estudios han llamado particularmente la atención sobre los efectos de los esteroides anabólicos sobre los sujetos sanos, los investigadores han ignorado la posibilidad de un comportamiento latente de estos medicamentos. El objeto de este trabajo es el de examinar los efectos remanentes, que se pueden producir después de cesación de administración de un esteroide anabolico sobre las fuerzas musculares.

Diez voluntarios, entre 21 y 25 años, han servido para este estudio. Su altura media era 181,5 cm con peso medio de 90,40 Kg. Se utilizó la técnica de double-blind. El esteroide anabolico oral y el placebo se destinaron a los sujetos por clave. El esteroide anabolico oral consistia en 15 mg Methandrostenolona y el placebo en lactato de calcio. Los diez sujetos se dividieron en dos grupos: el grupo anabolico-placebo y el grupo placebo-anabolico. Los sujetos se entrenaron cinco veces por semana de acuerdo con un programa establecido para hacer trabajar a los grupos musculares más importantes. Las mediciones del máximo de la fuerza dinámica muscular se determinaron en el desenvolvimento y arranque, encorvamiento y acurrucamiento, de los levantamientos. Los cinco sujetos del grupo 1

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han recibido el esteroide anabolico durante las cuatro primeras semanas y el placebo durante las últimas cuatro semanas, mientras que los del grupo 2 recibieron el placebo durante las cuatro primeras semanas y el esteroide anabolico durante las últimas cuatro semanas. Los datos se valoraron por medio de un análisis de la regresión, de la variación y de la covariación.

Este trabajo ha demostrado que el aumento de la fuerza muscular se ha acrecentado usando un esteroide anabolico. La cuota de aumento, indicada por la inclinación de las líneas de regresión, se demostró significativamente mayor. Estos resultados pueden atribuirse a la actividad biológica del esteroide anabolico, de manera que un balance positivo del nitrogeno se establece en los órganos extra-génitales. Probablemente una parte de la aumentada síntesis de proteína se traduce en un aumento de las proteínas musculares activas. Una de las conclusiones de este estudio es que el esteroide anabolico modifica la tasa de ganancia de fuerza muscular. Sin embargo, la falta de progreso significativo después de cesación del medicamento puede indicar que la tasa de progreso y la ganancia neta de fuerza muscular pueden ser independientes uno de otro. Es posible que el entrenamiento muscular prolongado sin esteroide anabolico produce una ganancia neta equivalente a la fuerza muscular después de un periodo de entrenamiento prolongado.

[* J. Sports Med., 14, 103-111, 1974]

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[Author's address:

G. Ariel
Department of Exercise Science
University of Massachusetts
Amherst, Massachusetts (U.S.A.)]

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