Effects of Norandrostenedione and Norandrostenediol in Resistance-Trained Men

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OBJECTIVES: The purpose of this study was to determine the effects of norsteroid supplementation (224 mg of 19-nor-4-androstene-3,17-dione and 120 mg of 19-nor-4-androstene-3,17-diol, total daily dose = 344 mg) on body composition and strength in resistance-trained men.

METHODS: In a placebo-controlled, double-blind, randomized fashion, 10 subjects received the norsteroid (11 capsules containing a combination of both norsteroids) or a placebo for 8 wk (five subjects per group). Each subject participated in resistance training an average of 4 d/wk for the duration of the study. Body composition was determined via dual-energy x-ray absorptiometry. Strength was determined using a one-repetition maximum bench press and a one-repetition maximum biceps curl.

RESULTS: With regard to all measures in both groups, there were no significant changes between before and after the study.

CONCLUSIONS: Therefore, in this small sample of resistance-trained men, 344 mg/d of norsteroid supplementation had no effect on strength or body composition. *Nutrition* 2002;18:734–737. ©Elsevier Science Inc. 2002

KEY WORDS: androgen, androstenedione, exercise, steroid, weight lifting

INTRODUCTION

For many years, athletes have used illegal androgens (i.e., anabolic steroids) to increase skeletal muscle mass and muscular strength.[1] Recent studies have shown that testosterone enanthate is effective in promoting skeletal muscle hypertrophy.[2,3] Testosterone enanthate is an illegal androgen; however, supplement companies have introduced legal alternatives to these androgens. These supplements include androstenedione (A-dione), androstenediol (A-diol), 19-norandrostenedione (N-dione), and 19-norandorstenediol (N-diol); moreover, these supplements purportedly have effects similar to those of the illegal androgens.

A-dione and A-diol are precursors to testosterone. It has been suggested, but not proven, that A-dione and A-diol convert into testosterone, thus increasing the anabolic processes that result in skeletal muscle hypertrophy.[4–7] An increase was found by Leder et al.,[8] but only after the ingestion of 300 mg of A-dione, but no increase was found with 100 mg. Also, Broeder et al.[9] found a significant increase in total testosterone levels after 1 mo of supplementation with 200 mg/d of A-dione; however, testosterone levels returned to pretreatment values by the end of 12 wk.

Further, significant increases in serum estradiol after ingesting A-dione and/or A-diol have been observed by Ballantyne et al.,[4] King et al.,[6] Rasmussen et al.,[7] Leder et al.,[8] and Broeder et al.[9] Estradiol does not have an anabolic effect on skeletal muscle. All peer-reviewed studies on the training effects of A-dione and/or A-diol ingestion have shown no significant gains in strength or an enhancement in muscle hypertrophy with strength training.[6,10]

Two more recent over-the-counter androgens on the market are N-dione and N-diol (i.e., norsteroids). These supplements have had the 19th carbon of A-dione and A-diol removed. The anabolic effect of N-dione and N-diol is due to their conversion to nortestosterone.[11,12] It has been shown that nortestosterone is 2.4 times more anabolic than testosterone.[12] Further, nortestosterone is not significantly 5-α reduced like testosterone.[12] This may provide an increased anabolic potency of N-dione and N-diol when compared with A-dione and A-diol. Therefore, we investigated whether the ingestion of 344 mg/d of these norsteroids would increase lean body mass and/or strength in resistance-trained men over an 8-wk period.

MATERIALS AND METHODS

Subjects

Ten healthy men with an average of 7 y of resistance-training experience (self-reported) were recruited from the university campus population via posted advertisements. To participate in the study, subjects had to meet the following criteria: 1) age 19 to 35 y, 2) not currently taking any type of androgens (legal or illegal), and 3) already performing resistance training at least 3 d/wk for the previous year. All subjects were personally interviewed and asked if they were currently taking any androgens. None of the subjects had been taking androgens for at least the previous 3 mo. Subjects also were asked to maintain their current supplementation regimens. Informed consent was obtained from each subject and the university's institutional review board approved the experimental procedures. After completing the study, subjects were compensated with dietary supplements (i.e., whey protein) worth approximately $75.

Experimental Procedure

Subjects were randomly assigned to consume a norsteroid (19-nor-4-androstene-3,17-dione [N-dione] and 19-nor-4-androstene-3,17-diol [N-diol]) or a placebo (rice flour). Each subject was instructed

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TABLE I.

PHYSICAL CHARACTERISTICS AND BODY COMPOSITION*

	Age (y)	Height (cm)	Weight (kg)	% Fat	LBM (kg)	Fat mass (kg)
Norsteroid						
Pre	22.4 ± 3.4	179.8 ± 6.3	87.7 ± 20.6	17.0 ± 4.8	68.9 ± 12.4	15.8 ± 7.6
Post	22.4 ± 3.4	179.8 ± 6.3	89.6 ± 22.0	17.6 ± 6.1	69.6 ± 13.4	16.9 ± 9.0
Placebo						
Pre	24.8 ± 4.0	179.8 ± 6.6	91.0 ± 23.1	18.4 ± 6.4	70.2 ± 8.4	17.9 ± 11.0
Post	24.8 ± 4.0	179.8 ± 6.6	90.1 ± 22.0	19.7 ± 6.7	67.7 ± 8.9	19.0 ± 11.8

* Values are mean ± standard deviations. There were no significant differences between groups.
LBM, bone-free lean body mass

to consume five capsules each morning and six capsules each evening for 8 wk. This is equal to twice the manufacture's recommended dosage (MuscleTech Research & Development, Inc., Mississauga, ON). The subjects were instructed to ingest the supplements in the morning and evening to help maintain a constant level of circulating androgens. The concentrations of N-dione and N-diol were examined by an independent laboratory (San Rafael Chemical Services, Salt Lake City, UT, USA) using high-performance liquid chromatography. Data from this independent laboratory showed that there were 20 mg and 11 mg of N-dione and N-diol per capsule, respectively. Thus, the total dose consumed daily was 224 mg of N-dione and 120 mg of N-diol.

All subjects were instructed not to change their dietary habits. Twenty-four–hour dietary recalls were obtained from all subjects before and after the intervention. Energy, protein, carbohydrate, and fat intake were determined via computer analysis (Nutribase '98, Phoenix, AZ, USA). All subjects were also instructed to continue their current resistance-training programs for the duration of the study. Trained subjects seem to be hesitant toward changing their training regimens; however, the subjects provided a training log of a typical week of training to assess their programs. Also, an exit interview was completed to ensure compliance with the supplementation regimen. Therefore, the only change that was imposed on each subject was the regular ingestion of the norsteroids or placebo.

Testing

After approximately three progressively heavier warm-up sets, subjects were instructed to perform a one-repetition maximum (1-RM) on the supine free-weight bench press. During the 1-RM test, subjects had their feet planted on the floor, hips and scapula on the bench at all times, and a slight lumbar lordosis was allowed. Also, a 1-RM biceps curl was performed with the EZ-curl bar after approximately three warm-up sets. During the 1-RM test, subjects stood with their feet approximately 22 cm from the wall, scapula against the wall at all times, and a slight lumbar lordosis was also allowed. The bench press and biceps curl are commonly performed by recreational bodybuilders and provide a good representation of upper body strength.

Body composition was assessed via whole-body, dual-energy x-ray absorptiometry (DEXA; Lunar DPX-IQ, Madison, WI, USA) using the adult, medium resolution mode (software 4.6b). The subjects were positioned on the DEXA machine in a supine position with the palms of their hands on the lateral aspect of their thighs. The subjects' lower extremities were placed in a comfortable position within the parameters of the DEXA machine. Each scan lasted approximately 20 to 25 min. A single pre- and posttest scan was performed in a fasted state before performance testing. The use of DEXA as a method for estimating body composition has been validated.[13,14]

In addition, the coefficients of variation for fat mass and lean body mass were estimated to be in the ranges of 1.8% to 6.4% and 0.6% to 3.1%, respectively.[14–16] Unpublished data from our laboratory showed DEXA measures have coefficients of variation of 1.49% and 1.00% for fat mass and bone-free lean body mass, respectively. To ensure quality control, the DEXA unit was calibrated daily by using the standard calibration block provided by the manufacturer.

Statistics

All data were analyzed with a two-way analysis of variance. Statistical significance was set at $P < 0.05$; data are shown as means ± standard deviations.

RESULTS

There were no significant baseline differences between groups for age, height, weight, or percentage of fat (Table I). In addition, the reported resistance training programs and dietary intakes did not differ between groups (Tables II and III). Further, there were no significant pre versus post differences for body composition or exercise performance (Tables I and IV).

DISCUSSION

N-dione and N-diol are weak androgens that are available over the counter in the United States; however, these substances have been banned in many competitions. In fact, the use of the supplements may result in a positive drug test.[17]

N-dione and N-diol are androgens derived by removing the 19th carbon from A-dione and A-diol. The illegal androgens, testosterone and 19-nortestosterone (NT), have the same relationship. When testosterone is 5-α reduced to dihydrotestosterone, its androgenic properties are amplified due to a higher affinity for

TABLE II.

REPORTED TRAINING REGIMEN*

	Training (y)	d/wk	Sets/session	Repetitions
Norsteroid	7.6 ± 2.5	4.0 ± 0.8	28.4 ± 12.9	8.3 ± 2.1
Placebo	7.3 ± 5.4	3.3 ± 1.5	19.2 ± 10.1	7.2 ± 3.2

* Values are means ± standard deviations. There were no significant differences between groups.

TABLE III.

REPORTED DIETARY INTAKE*

	kcal†	CHO (g)	PRO (g)	Fat (g)	C:P:F
Norsteroid					
Pre	2288 ± 1100	217 ± 99	125 ± 111	82 ± 45	38:22:32
Post	2274 ± 912	252 ± 76	102 ± 58	60 ± 50	44:18:24
Placebo					
Pre	2930 ± 1667	333 ± 161	130 ± 37	97 ± 60	45:18:30
Post	2467 ± 652	292 ± 49	128 ± 7	83 ± 7	47:21:30

* Values are means ± standard deviations. There were no significant differences between groups.
† Conversion factor: 1 kcal ± 4.1840 kJ. Alcohol consumption is not reported.
CHO, carbohydrate; C:P:F, carbohydrate:protein:fat ratio (kcal); PRO, protein

androgen receptors.[12] When NT is 5-α reduced, its androgenic properties are reduced due to a decrease in the affinity for androgen receptors, whereas NT maintains its anabolic properties.[12] One might deduce from this that N-dione and N-diol are more effective at increasing skeletal muscle hypertrophy than A-dione and A-diol due to the fact that they have the same relationship as testosterone and NT.

The current study is the first to examine the effects of 344 mg/d of N-dione plus N-diol (i.e., norsteroids) on strength and body composition. The subjects in this study were similar to the subjects in the study by Wallace et al.[10] in age, height, and body composition; however, the subjects in the current study were approximately 10 kg heavier than those in the study by Wallace et al.[10] Further, subjects in the current study had less body fat than did those in the study by King et al.[6] (17.02–18.36% for the current study versus 21.3–23.5% for the study by King et al.). The use of untrained, non-lean subjects by King et al. may have altered the effect of A-dione.

To participate, the subjects must have been previously engaged in resistance training for at least 1 y (at an average of at least 3 d/wk). Upon further examination, we found that the subjects had trained an average of more than 7 y, and that the subjects had an average bench-press strength to body weight ratio of 1.44. According to the American College of Sports Medicine,[18] a strength ratio of 1.34 or greater is considered superior for males younger than 20 y. Thus, it is clear from their strength data that these were indeed well-trained (with regard to strength) individuals. Thus, it would be more difficult to induce a strength or body composition change with such trained individuals (particularly in comparison with untrained individuals); therefore, any improvements presumably would be due to supplementation with these norsteroids.

TABLE IV.

EXERCISE PERFORMANCE*

	1-RM bench press (kg)	1-RM biceps curl (kg)
Norsteroid		
Pre	130.0 ± 51.4	50.9 ± 11.3
Post	135.0 ± 54.9	54.1 ± 12.6
Placebo		
Pre	127.7 ± 31.3	50.0 ± 5.1
Post	132.3 ± 34.9	54.6 ± 12.0

* Values are means ± standard deviations. There were no significant differences between groups.
1-RM, one-repetition maximum

Our study did not show a performance-enhancing effect of norsteroid supplementation. This is consistent with previous studies that have used over-the-counter steroids. Wallace et al.[10] showed slight but insignificant increases in the 1-RM bench (3.4 kg) and leg (10.8 kg) presses after supplementation with 100 mg/d of A-dione. King et al.[6] found significant pre- to postimprovements in several strength parameters after 300 mg/d of A-dione, but these improvements were not significant when compared with the placebo. The increase in strength shown by King et al.[6] was due most likely to the fact that their subjects were untrained, whereas our study used highly trained subjects

Eight weeks of daily supplementation with the norsteroids did not alter the subjects' body compositions. Our data on body composition were consistent with those of previous studies on A-dione and A-diol. When King et al.[6] administered 300 mg/d of A-dione for 8 wk, there was a significant increase in lean body mass (61.2–64.1 kg and 63.1–66.0 kg for the A-dione and placebo groups, respectively) and a significant decrease in fat mass (19.3–17.12 kg and 18.0–17.2 kg for the A-dione and placebo groups, respectively) as estimated via hydrostatic weighing; nonetheless, these changes were not significant when compared between groups. One reason for the improvement in body composition in the study by King et al.[6] is that the subjects were untrained. It is probable that untrained subjects would show improvements in body composition after participating in resistance training. Moreover, Wallace et al.[11] found no significant changes in body composition after the administration of two 50-mg/d doses of A-dione for 12 wk.

The subjects' dietary recalls showed no significant differences in the amount of energy, carbohydrate, protein, or fat consumed between groups. Therefore, it is likely that we can eliminate the subjects' diet as a confounding factor. It has been noted that 3-d diet recalls may be more appropriate because they take into account fluctuations in individuals' diets.[19] Also, some individuals tend to underestimate the amount of food they consume.[20] An increase in the number of diet recalls obtained may have improved the accuracy of our dietary data; however, 1-d diet recalls should provide a reasonable estimation of the subjects' diets.

In conclusion, the ingestion of 224 mg of N-dione and 120 mg of N-diol daily for 8 wk had no effect on body composition or strength in well-trained male athletes. Future research should examine the effects of higher dosages of these androgens for longer treatment durations with endocrinologic parameters examined.

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