

Effect of Androgenic and Anabolic Steroids on the Sebaceous Gland in Power Athletes

CSABA L. KIRÁLY,¹ MARKKU ALÉN,² PAAVO RAHKILA³
and MAIJA HORSMANHEIMO⁴

¹Department of Dermatology, Central Hospital of Middle Finland, ²Department of Health Sciences, University of Jyväskylä, ³Research Unit for Sport and Physical Fitness, Jyväskylä, and ⁴Department of Dermatology, University of Kuopio, Kuopio, Finland

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The effect of androgenic and anabolic steroids on sebaceous gland activity and the composition of sebum was studied in power athletes. The subject self-administered large doses of androgenic and anabolic hormones during a 12-week-period of strength training. After 4 weeks of administration of hormones the sebum excretion rate increased significantly ($p=0.002$) and it remained high throughout the period of exogenous steroid use. The amounts of cholesterol were significantly increased during that period. There were no differences in the amounts of the following lipid groups; free fatty acids, squalen, triglycerides, wax esters, diglycerides and paraffins. It was concluded that large doses of androgenic and anabolic steroids lead to an increase in sebum output in healthy young adult males. *Key words: Androgenic hormones; Sebum excretion rate; Sebum composition.* (Received April 15, 1986.)

C. L. Király, Department of Dermatology, Central Hospital of Middle Finland, 40620 Jyväskylä, Finland.

The function of the sebaceous glands reaches its peak in the late teens (1). In young adult males exogenous testosterone is not thought to elicit an increase in sebum output. It is believed that maximal stimulation of the sebaceous glands is achieved via endogenous androgens (2, 3, 4, 5). However, contrary results have also been observed. Exogenous androgens taken/administered have been succeeded to cause acne vulgaris and the increase of seborrhoea (6, 7).

The purpose of the present investigation was to study sebum output and composition in power athletes throughout a 12-week-period, when they self-administered large doses of exogenous androgens.

MATERIAL AND METHODS

Seven male power athletes (mean age 28.7 years, range 24-34 years) who had previously used androgenic steroids in their strength training, volunteered for this study as an experimental group. Three out of the seven athletes had a history of atopic dermatitis. None had a history of acne. None of the athletes used any hormones for a 12-week-period prior to starting the study. They were included in the study from the moment they began the self-administration of androgenic and anabolic steroids. The steroids were obtained from the black market and were used outside of medical control.

The self-administration of hormones was followed by means of medication diaries. Methandienone (5 mg-20 mg) was taken orally by most of the subjects daily. Nandrolone (50 mg) and stanozolol (50 mg) were usually injected once a week. Testosterone (250 mg, consisting 30 mg testosterone propionate, 60 mg testosterone phenylpropionate, 60 mg of testosterone isocaproate and 100 mg testosterone decanoate) was self-administered 1-2 times per month. The use of hormones continued for 12 weeks. The doses and the drugs used are shown in Fig. 1.

The total weight of all the subjects was noted before and after completion of the study. The amount of body fat was examined before and after the study, using the Durnin and Rahaman method (8), and the testicular volume, using the Prader method (9), was also measured before and after the study.

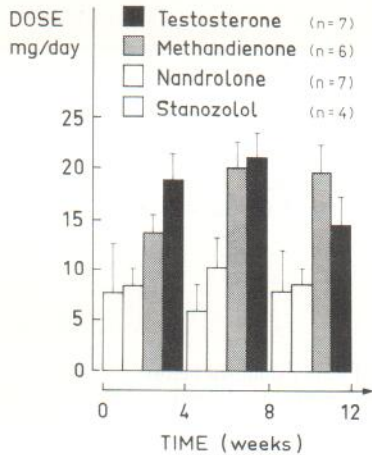


Fig. 1. Mean daily doses (\pm SE) of self-administered androgenic and anabolic steroids (mg/day) of the experimental group (EG) during the periods between the sebum collections. Trivial and systematic names: methandienone: 17 α -methyl-17 β -hydroxy-1, 4-androstadien-3-one; nandrolone phenylpropionate: 17 β -hydroxy-4-estren-3-one phenylpropionate; stanozolol: 17-methyl-5- α -androstano (3, 2-c)-pyrazol-17 β -ol; testosterone: 17 β -hydroxy-4-androsten-3-one.

The sebum excretion rate (SER) of the forehead skin was measured by the Strauss and Pochi method (10) as modified by Cunliffe & Shuster (11). Briefly, the duplicate samples were collected on absorbent paper sheets (Tervakoski Oy, Tervakoski, Finland), placed for 3 hours on the previously defatted forehead area symmetrically and measured gravimetrically. Each collection was performed in the same room at the same time of day (between 10 a.m. and 2 p.m.) at a stable consistent room temperature. The subjects were instructed to refrain from washing for 12 hours prior to collection. If the subject perspired, the collection was interrupted as sweating reduces the amount of absorbed lipids (12).

The sebum samples were also analysed immediately with thin-layer chromatography (TLC) in order to measure the relative (%) values of the main lipid groups of sebum. TLC was used as a modified version of the Downing method (13). Briefly, the 10 \times 20 cm Kieselgel 60 F plates with a 0.25 mm of silica gel were developed in ether and dried. Duplicate samples, each 7 μ g/ μ l as a central lipid spot, were applied to 7 mm wide lanes. Each plate was developed in three successive solvent systems; hexane, hexane and ether (90:10) and hexane, ether and acetic acid (70:30:1), up to a distance of 3 cm from the top of the plate. The developed plates were dipped in 3% sulfuric acid and heated to 170 $^{\circ}$ C. The quantitation of the components present in sebum was achieved by scanning each lane with a photodensitometer (Backman CDS). The following lipid groups were measured; free fatty acids (FFA), squalen (SQ), triglycerides (TG), wax esters (WE), cholesterol (CHO), diglycerides (DG) and paraffines (PAR) (13).

The SER, FFA, SQ, TG, WE, CHO, DG and PAR as components of sebum were studied in the following weeks 0, 4, 8 and 12 in all seven subjects.

Eight power athletes (mean age 31 years, range 24–34 years) with no previous experience in the use of androgenic hormones volunteered as the control group. Four out of these eight subjects had a

Table I. Anthropometric characteristics of the groups studied

EG = experimental group, $n=7$, CG = control group, $n=8$. EG self-administered androgenic and anabolic steroids during weeks 0–12. The values indicate means \pm SE

		Body weight (kg)	Body fat (%)	Testicular volume (ml)
Before	EG	90.9 \pm 3.4	11.1 \pm 1	21.4 \pm 1.7
	CG	75.3 \pm 4.7*	13.5 \pm 0.01 NS	
After	EG	97.1 \pm 3.1***	11.0 \pm 2.1 NS	13.0 \pm 2.3
	CG			

* $p<0.05$, *** $p<0.001$ (two-tailed Student's t -test), NS=not significant

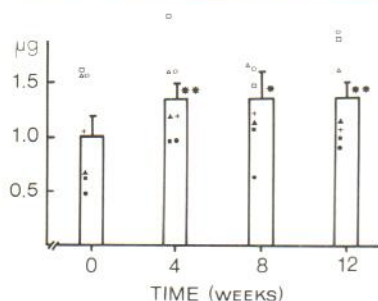


Fig. 2. The mean and individual values of sebum excretion rate (SER) of forehead skin $\mu\text{g} \times \text{cm}^{-2} \times \text{min}^{-1}$. Mean \pm SE are given. ** $p < 0.01$, * $p < 0.05$ (two-tailed Student's t -test).

history of acne. The total weight and amount of body fat from each individual were examined before the study period. The SER, FFA, SQ, TG, WE, CHO, DG and PAR as components of sebum were studied once in the control group.

Statistically, the means and standard error of the means (SE) were calculated. Differences between the mean values of the experimental and control groups were tested by an unpaired t -test and differences between the mean values inside the experimental group were tested by the paired t -test for significance, using the SPSS program (15).

RESULTS

A decrease of testicular size by (34.7%) (Table I) was noticed in the experimental group as a consequence of the use of androgenic steroids (14). The total weight of the athletes and the amount of body fat before and after the study are shown in Table I.

To determine the reproducibility of the paper absorbent method, lipid collection from both sides of the forehead was tested in 15 subjects during weeks 0, 4, 8 and 12 of the study. A correlation coefficient of 0.955 was found.

No significant differences in sebum excretion rates (SER) were observed between the 0-values of experimental and control groups before the use of androgenic and anabolic

Table II. The main lipid fractions of the serum in the groups studied

CG = control group ($n=8$). EG = experimental group ($n=7$). The EG self-administered exogenous androgens during weeks 0–12 (see Fig. 1). The figures indicate percent values detected by thin-layer-chromatography. Mean \pm SE are given

	Time (weeks)				
	0 CG	0 Experi- mental group	4 Experi- mental group	8 Experi- mental group	12 Experi- mental group
Free fatty acids (FFA)	6.6 \pm 1.0	10.6 \pm 2.2	10.0 \pm 2.4	11.6 \pm 6.0	10.6 \pm 2.9
Squalen (SQ)	14.8 \pm 0.2	13.3 \pm 0.4	13.4 \pm 0.5	12.9 \pm 0.8	15.4 \pm 1.2
Triglycerides (TG)	25.9 \pm 3.7	27.0 \pm 1.7	27.7 \pm 2.0	26.6 \pm 2.3	25.1 \pm 1.7
Wax esters (WE)	31.5 \pm 0.6	29.1 \pm 1.4	28.6 \pm 0.9	25.8 \pm 0.9	30.9 \pm 1.0
Cholesterol (CHO)	2.9 \pm 0.3	2.4 \pm 0.1	4.2 \pm 0.7***	4.0 \pm 0.9*	3.6 \pm 1.3
Diglycerides (DG)	1.1 \pm 0.2	3.3 \pm 0.2	4.2 \pm 0.7	3.5 \pm 0.5	3.8 \pm 3.3
Paraffines (PAR)	0	1.1 \pm 0.7	0.2 \pm 0.2	0.3 \pm 0.3	0.1 \pm 0.3

* $p < 0.05$, *** $p < 0.001$ (two-tailed Student's t -test).

steroids; values $1.171 \pm 0.076 \mu\text{g} \times \text{cm}^{-2} \times \text{min}^{-1}$ and $0.989 \pm 0.191 \mu\text{g} \times \text{cm}^{-2} \times \text{min}^{-1}$ respectively (Fig. 2) were obtained. A significant increase in SER values at weeks 4 ($p=0.002$, Fig. 2) during androgen use was observed.

Only minimal differences were found in the relative (%) values of the main lipid of forehead sebum as measured by thin-layer-chromatography (Table II). The relative proportion of cholesterol was increased to the value of 4.2 ± 0.7 after 4 weeks of androgen use compared with the 2.4 ± 0.1 of 0-value ($p < 0.001$). However no significant differences were detected in the other main lipid fractions during the use of androgenic and anabolic hormones (Table II).

DISCUSSION

There are few available reports in the literature concerning the effects of excess testosterone and anabolic steroids on the sebaceous gland. Concerning young healthy men, the literature suggests that exogenous testosterone administered to young healthy males does not increase the sebum production (2, 3, 4, 5). In this study, however, a significant increase ($p < 0.005$) in the sebum excretion rate was observed after 4 weeks of treatment with anabolic and androgenic steroids and the SER remained high during the 12 weeks' use of exogenous steroids. To our knowledge this is the first study to demonstrate that exogenous androgens are capable of over-stimulating the sebaceous glands in healthy young men. The observed increase in the SER during the 12-week-study period is thought to be a direct effect of the exogenous androgenic and anabolic steroids, because the sebaceous glands do not possess a secretory mechanism for rapid response to stimulation (16). The synthesis and discharge of the lipids contained in sebaceous cells require approximately 3–4 weeks to reach the skin surface (17). Several reports have indicated that the sebum excretion rate and the constitution of sebum remain stable in an individual subject (13, 18) and therefore an individual's rate can be compared at various times (19). The excretory activity has been reported to be greater in acne vulgaris (20) and lower in atopic dermatitis (21). It should be noted that in our material four out of eight subjects in the control group had a history of acne, whereas three out of seven subjects in the experimental group had a history of atopic dermatitis. This probably affected the 0-values of the SER in the control and experimental groups (1.171 ± 0.976 and $0.989 \pm 0.191 \mu\text{g} \times \text{cm}^{-2} \times \text{min}^{-1}$ respectively). However, the difference is not significant.

In this study the amount of cholesterol increased significantly after 4 weeks of androgen use. Skin lipids are derived from two sources: from sebum and from epidermal keratinisation. In areas rich in sebaceous glands such as the forehead, the lipids derive largely from sebum (approximately 95–97%) and only 3–5% are obtained by epidermal keratinisation (22). In areas where sebaceous glands are sparsely located, such as the extremities, a greater proportion of epidermal derived lipids are found. Surprisingly, the only component of sebum found to be increased were the cholesterol, which has been reported to be of predominantly epidermal origin (22). The increased cholesterol values are close to the distribution of lipids reported on the extremities of normal subjects (22). Otherwise the findings of thin-layer-chromatographic analysis of sebum are in accordance with the findings of Green et al. (22).

Our results unequivocally show that at least in the subjects studied the sebaceous glands were not maximally stimulated. We strongly suggest that exogenous androgens may be able to overstimulate the sebaceous glands in young adult males. Our findings are in contrast to those of Pochi & Strauss (5). We therefore suggest that further research is necessary to help better understand the hormonal response of the human sebaceous gland.

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