The Effects of Anabolic and Androgenic Steroid on the Heart

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ABSTRACT

In the last couple decades, anabolic and androgenic steroids have significantly grown in popularity despite them being illegal in the US and it is estimated that 1 – 3% of the US population are using some form of anabolic and anabolic study. This equates to roughly 3 – 4 million people, mostly in the range of 19 – 50 years of age. This trend has also been observed on a global scale with the Annals of Epidemiology estimating that 3.3% of the world's population have tried anabolic and androgenic steroids at least once. While there are medical applications for anabolic and androgenic steroids, a large proportion of users are athletes and fitness enthusiasts who abuse them for their aesthetic or performance benefits. Since anabolic and androgenic steroids promote protein synthesis, they can increase growth of muscle tissues as desired by athletes and fitness enthusiasts however they also simultaneously effect other processes of the body which can be extremely detrimental to an individual's overall health. This study investigated the effects of prolonged anabolic and androgenic steroid abuse focusing specifically on the physiological effects steroid use can have on the heart. In particular, we analyzed primary literature and clinical case studies involving individuals with a history of steroid abuse. While a definite conclusion could not be made associating heart conditions like cardiovascular disease and anabolic and androgenic steroid use, our research suggest that long term steroid abuser, defined as individuals who self-administer anabolic and androgenic steroids to raise their testosterone levels beyond the natural range of 300 – 1000 nanograms per deciliter for prolonged amounts of time exhibit significantly diminished cardiac performance. The two separate case studies that were analyzed involving individuals with a history of anabolic and androgenic steroid abuse provide evidence that their prolonged was detrimental to their cardiac performance. Specifically, both individuals exhibited left ventricle hypertrophy that resulted in ejection fractions around 15%, at least 35% lower than the normal ejection fraction for their respective ages.

METHODS

- Identify the structure of anabolic-androgenic steroids (AASs)
- Understand the anabolic-androgenic mechanisms behind AAS's hypertrophic effects on muscle tissues
- Understand the physiology of the heart to recognize how AAS use can affect cardiac muscle (myocardium) tissue.
- Identify common heart conditions that could result from AAS abuse
- Review case studies involving AAS abusers to find evidence linking heart disease and AAS use

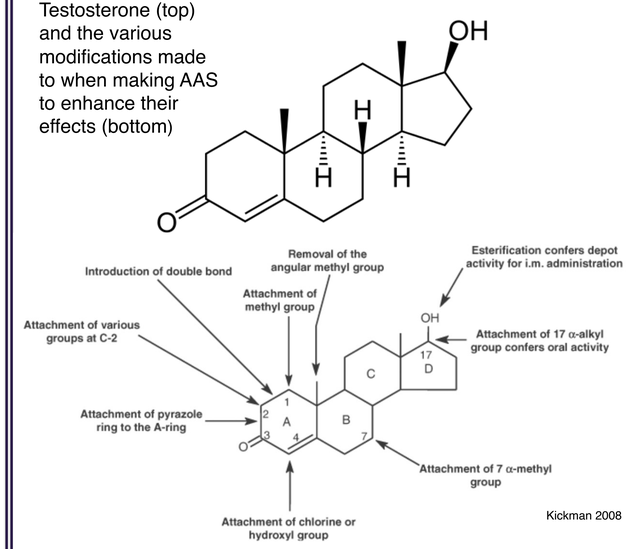
Anabolic-Androgenic Steroids (AAS)

Anabolic-androgenic steroids are synthetic derivatives of testosterone

- Anabolic effect: Promotes the protein synthesis responsible for muscle and strength development
- Androgenic effect: Responsible for the development of male characteristics like body hair growth and plays a role in muscle development

Figure 1. Testosterone vs. AAS Modifications

Chemical structure Naturally occurring Testosterone (top) and the various modifications made to when making AAS to enhance their effects (bottom)



Kickman 2008

Figure 2. AAS activity vs Natural Testosterone

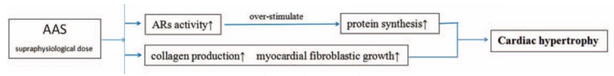
Steroid	*Route*	*Reference steroid*	*Activity*		*Index value*
			Myotrophic	*Androgenic*	
Chloromethyl T	p.o.	17α-MeT	0.5	0.10–0.15	3–5
Methandienone	p.o.	17α-MeT	0.60	0.20	3
Methenolone acetate	p.o.	17α-MeT	0.86	0.12	7
Nandrolone decanoate	par.	T propionate	3.29–4.92	0.41–0.31	12.1–10.6
Norbolethone[a]	par.	T propionate	3.44	0.15–0.17	20
Norethandrolone	par.	T propionate	0.77–1.0	0.06–0.38	2–16
Oxandrolone[b]	par.	17α-MeT	3.22	0.24	13
Oxymesterone	p.o.	17α-MeT	1.34	0.42–0.61	2.2–3.2
Oxymetholone	p.o.	17α-MeT	3.20	0.45	7.1
Stanozolol	p.o.	17α-MeT	2.0–3.7	0.33–0.52	6–10.6
T	p.o.	17α-MeT	0.36	0.28–0.50	0.7–1.3

Kickman 2008

This table shows the increased myotrophic activity and decreased androgenic activity of AASs in comparison to naturally occurring testosterone (T).

Left Ventricular Hypertrophy and AASs

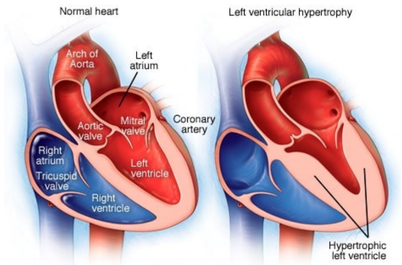
Anabolic-androgenic steroids can cause hypertrophy of the left ventricle myocardium



(Liu and Wu 2018)

Figure 3. Left Ventricle

The left ventricle (LV) pumps oxygenated blood throughout the body. The anabolic effects of AASs enhance protein synthesis and play a role in the enlargement of cardiac muscle



(Image from Mayo Clinic)

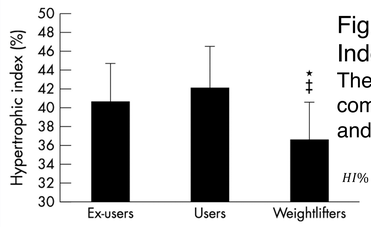


Figure 4. Hypertrophic Index

The hypertrophic index % compares the wall thickness and chamber diameter of the LV

$$HI\% = \frac{Septum\ thickness + Post.wall\ thickness}{Internal\ diameter}$$

Urhausen et al. 2004

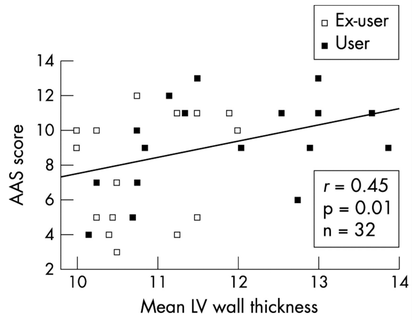
Figure 5. AAS Score

AAS score developed to estimate extent of AAS abuse

1 – 4 points per category:

- Years of administration
- Weeks of use per year
- Weekly dose (mg)

Higher AAS scores are correlated with thicker LV walls

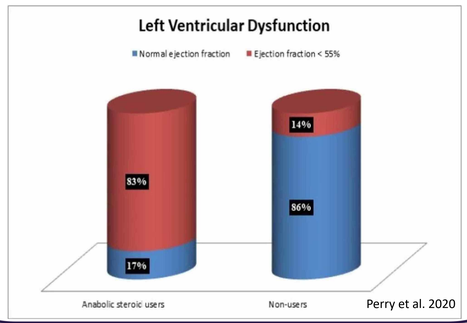


Urhausen et al. 2004

Figure 6. LV Ejection Fraction

LV hypertrophy leads to decreased ejection fractions (EF) in AAS users indicating diminished cardiac output

$$EF = \frac{End\ diastolic\ vol\ - End\ systolic\ vol}{End\ diastolic\ vol}$$



Perry et al. 2020

CONCLUSIONS

Main Conclusion:

- Based on the apparent correlation between LV hypertrophy and AAS abuse, their recreational use for aesthetic purposes is inadvisable.
- Both the anabolic and androgenic mechanism by which AASs work appear to play a role in the development of cardiomyopathy and/or LVH.

Future Direction:

- Update and gather more data on steroid use prevalence
- Identify possible thresholds of steroid dosages/hormone levels that could allow for safe steroid use
- Identify ethical methods to test the androgenic effects of steroids on human cardiac tissue samples
- Develop steroids that allow for targeted hypertrophic response of skeletal muscles only

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