

# Forbidden fruit for athletes, but possible divine blessing for rehabilitation: testosterone

Kyung-Jin Chung, Khae-Hawn Kim\*

Department of Urology, Gachon University School of Medicine, Gil Medical Center, Incheon, Korea

Testosterone is regarded as an attractive supplement for obtaining masculinity and sexuality; however, there have been pros and cons regarding its application as a treatment. In addition, there is also conventional repulsion on adoption of testosterone to any kind of exercise to anyone with concern with sports. However, we should keep in mind that in terms of rehabilitation, our main concern is not fairness but efficiency. And there are obvious advantages of testosterone in recovery and rejuvenation. We aim to introduce the possibility of testosterone in

recovery and rejuvenation and are to bring up a topic the application of testosterone in exercise rehabilitation. Considering the light and darkness in testosterone, moderate use of testosterone under professional medication counseling might be an effective possibility to those with sickness and illness and should be considered as a possible option to assist the recovery from frailty and illness.

**Keywords:** Testosterone, Exercise, Rehabilitation, Rejuvenation

## INTRODUCTION

Since the doping test was first adopted in 1968, the 10th Winter Olympic game in France, there has been increasing awareness of the need to intensify the efforts to fight unfairness in sports (Lippi et al., 2008). Testosterone has been a representative forbidden drug and unrecoverable stigma has been attached to the athlete detected as a drug user by doping test, no matter how famous he/she is or how great his/her achievement. Therefore, usage of androgenic hormones like testosterone might be a very sensitive topic to those having any relation with any kinds of sports. This ergogenic aids have been considered as unfairness and immorality in any society governed by the rule of law in the physical competition filed like sports. Therefore, caution is required when introducing the efficacy of an androgenic hormone like testosterone for improving the exercise capacity to those specializing in a field of exercise. We are very sensitive to that. Paradoxically, it has been efficient that way. However, as a matter of fact, you are not an Olympic team coach, but an expert in exercise rehabilitation. Not for breaking a new record, but for efficient recovery and early reversion of an object, such a

minor foul should be admitted, of course. Could we not make this forbidden fruit for athletes, testosterone, as a divine blessing for exercise rehabilitation?

## REHABILITATION AND TESTOSTERONE

Traditionally, androgen is known not only as a material for intensifying the masculine sexuality, but also as a material to assist anabolic mechanism. Therefore, in the viewpoint of action mechanism of testosterone, there might be two types of rehabilitation, and both of these mechanisms might have effective roles in rehabilitation. One is rehabilitation from disease including injury or disease-‘recovery’, the other is rehabilitation from aging-‘rejuvenation’. In fact, these two concepts are overlap significantly.

In view of the recovery aspect, testosterone has a critical role in mediating the improved muscle mass and is essential for skeletal muscle growth (Sinha et al., 2014). Therefore, testosterone therapy might improve exercise capacity, muscle strength, glucose metabolism, and baroreflex sensitivity (Caminiti et al. 2009). Actually, it was reported that exercise induces an increase of sex steroid, testos-

\*Corresponding author: Khae-Hawn Kim

Department of Urology, Gachon University School of Medicine, Gil Medical Center, 21 Namdong-daero 774 beon-gil, Namdong-gu, Incheon 405-760, Korea  
Tel: +82-32-460-3334, Fax: +82-32-460-8414, E-mail: kimcho99@gilhospital.com

Received: February 18, 2015 / Accepted: February 22, 2015

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

terone and exercise-induced increase of testosterone in muscle may positively impact age-related concerns such as life-related diseases and sarcopenia (Sato and Iemitsu, 2015). There are some beneficial effects of testosterone therapy on functional capacity, cardiovascular parameters, and quality of life in patients with congestive heart failure. Therefore, in view of rehabilitation from disease, testosterone administration during exercise rehabilitation is feasible and can positively impact health outcomes in elderly males even those with congestive heart failure who have low testosterone (Caminiti et al., 2009; Stout et al., 2012). In addition, there might be additional beneficial effects on mood, energy, and sense of well-being (English et al., 2000).

In another viewpoint of rehabilitation, rejuvenation, testosterone administration showed some benefit on sexual health related outcome like sexual desire and performance (Krause et al., 2005). In addition, testosterone plays a critical role in the mood and cognitive function of humans. There was evidence supporting the existence of a relationship between testosterone and depression and it was reported that after administration of testosterone, depression showed a significant level of improvement (Pope et al., 2010). Testosterone also seems to influence certain aspects of cognition. This effect of testosterone on behavioral performances is mediated in part through androgen receptors on the brain (Jia et al., 2013). Testosterone replacement in men diagnosed with hypogonadism has shown a beneficial effect on several cardiovascular risk factors, functional exercise capacity and improved mortality (Kelly and Jones, 2014). Testosterone was also reported as an efficacious paradigm in management of sarcopenia, loss of skeletal muscle mass and strength that occurs with aging. In addition, an important regulatory enzyme of inflammation, nuclear factor- $\kappa$ B inducing kinase, which may regulate human skeletal muscle catabolism, and that appears to be counter-regulated by administration of testosterone (Urban et al., 2014). This is important because a number of age-related clinical circumstances trigger acute and chronic muscle loss, including cancer, chronic obstructive pulmonary disease, hospitalization, acute and chronic illness, and diseases in which systemic inflammation occurs (Urban et al., 2014).

Actually, some reports proved the positive effects of steroid in rehabilitation. After anabolic steroid of nandrolone in lean elderly women after femoral neck fracture, less dependency and positive effects on lean body mass, activities of daily living, and health related quality of life were reported (Tidermark et al., 2004). In another report, there were also positive effects on muscle mass, bone mineral density, and clinical function after administration of nandrolone in patients with hip fracture (Hedstrom et al., 2002).

There was even the effect of reducing the number of hospitalizations and duration of hospital administrations of those undernourished old people in case of administration of testosterone with high calorie oral nutrition (Chapman et al., 2009; Piantadosi et al., 2011). However, unfortunately there was a lack of well systemized and randomized prospective trials proving the efficacy of testosterone administration in patients needing rehabilitation.

We do not intend to insist that testosterone is a panacea for all types of rehabilitation. Surely, there are light and shadow, so there may be pros and cons. Some potential risks of testosterone replacement include hepatic toxicity, endocrine dysfunction, dyslipidemia, violent behavioral changes, and cardiovascular complications, including arterial hypertension, myocardial infarction, congestive heart failure, sudden death, arterial and ventricular thrombosis, and stroke, although most of them have not been fully proven (Handelsman, 2011; Nigro and Christ-Crain, 2012). In addition, there is controversy regarding the efficiency of testosterone administration in patients without abnormal range of testosterone level. Therefore, more high quality evidence based results should be yielded.

## CONCLUSIONS

Therefore, moderate use of testosterone under professional medication counseling might offer effectiveness and efficiency in both recovery and rejuvenation and should be considered a possible option in conducting study for exercise rehabilitation.

## CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

## REFERENCES

- Caminiti G, Volterrani M, Iellamo F, Marazzi G, Massaro R, Miceli M, Mammi C, Piepoli M, Fini M, Rosano GM. Effect of long-acting testosterone treatment on functional exercise capacity, skeletal muscle performance, insulin resistance, and baroreflex sensitivity in elderly patients with chronic heart failure a double-blind, placebo-controlled, randomized study. *J Am Coll Cardiol* 2009;54:919-927.
- Chapman IM, Visvanathan R, Hammond AJ, Morley JE, Field JB, Tai K, Belobrajdic DP, Chen RY, Horowitz M. Effect of testosterone and a nutritional supplement, alone and in combination, on hospital admissions in undernourished older men and women. *Am J Clin Nutr*

- 2009;89:880-889.
- English KM, Steeds RP, Jones TH, Diver MJ, Channer KS. Channer. Low-dose transdermal testosterone therapy improves angina threshold in men with chronic stable angina: a randomized, double-blind, placebo-controlled study. *Circulation* 2000;102:1906-1911.
- Handelsman DJ. Androgen misuse and abuse. *Best Pract Res Clin Endocrinol Metab* 2011;25:377-389.
- Hedstrom M, Sjoberg K, Brosjo E, Astrom K, Sjoberg H, Dalen N. Positive effects of anabolic steroids, vitamin D and calcium on muscle mass, bone mineral density and clinical function after a hip fracture. A randomised study of 63 women. *J Bone Joint Surg Br* 2002;84:497-503.
- Jia J, Kang L, Li S, Geng D, Fan P, Wang L, Cui H. Amelioratory effects of testosterone treatment on cognitive performance deficits induced by soluble A $\beta$ 1-42 oligomers injected into the hippocampus. *Horm Behav* 2013;64:477-486.
- Kelly DM, Jones TH. Testosterone and cardiovascular risk in men. *Front Horm Res* 2014;43:1-20.
- Krause W, Mueller U, Mazur A. Testosterone supplementation in the aging male: which questions have been answered? *Aging Male* 2005;8:31-38.
- Lippi G, Franchini M, Guidi GC. Doping in competition or doping in sport? *Br Med Bull* 2008;86:95-107.
- Nigro N, Christ-Crain M. Testosterone treatment in the aging male: myth or reality? *Swiss Med Wkly* 2012;142:w13539.
- Piantadosi C, Visvanathan R, Naganathan V, Hunter P, Cameron ID, Lange K, Karnon J, Chapman IM. The effect of testosterone and a nutritional supplement on hospital admissions in under-nourished, older people. *BMC Geriatr* 2011;11:66.
- Pope HG Jr, Amiaz R, Brennan BP, Orr G, Weiser M, Kelly JF, Kanayama G, Siegel A, Hudson JI, Seidman SN. Parallel-group placebo-controlled trial of testosterone gel in men with major depressive disorder displaying an incomplete response to standard antidepressant treatment. *J Clin Psychopharmacol* 2010;30:126-134.
- Sato K, Iemitsu M. Exercise and sex steroid hormones in skeletal muscle. *J Steroid Biochem Mol Biol*. 2015;145:200-205.
- Sinha I, Sinha-Hikim AP, Wagers AJ, Sinha-Hikim I. Testosterone is essential for skeletal muscle growth in aged mice in a heterochronic parabiosis model. *Cell and Tissue Research* 2014;357:815-821.
- Stout M, Tew GA, Doll H, Zwierska I, Woodrooffe N, Channer KS, Saxton JM. Testosterone therapy during exercise rehabilitation in male patients with chronic heart failure who have low testosterone status: a double-blind randomized controlled feasibility study. *Am Heart J* 2012;164:893-901.
- Tidemark J, Ponzer S, Carlsson P, Soderqvist A, Brismar K, Tengstrand B, Cederholm T. Effects of protein-rich supplementation and nandrolone in lean elderly women with femoral neck fractures. *Clin Nutr* 2004;23:587-596.
- Urban RJ, Dillon EL, Choudhary S, Zhao Y, Horstman AM, Tilton RG, Sheffield-Moore M. Translational studies in older men using testosterone to treat sarcopenia. *Trans Am Clin Climatol Assoc* 2014;125:27-42.