

Effect of short-term use of Glucocorticoids on skeletal muscle strength and endurance

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Background: The study was carried out to investigate the effect of short-term use of glucocorticoids on skeletal muscle strength and endurance.

Methods: Pre test and post test experimental design was made. Twenty-four healthy university students participated in the study. Eight subjects were given Prednisolone 5 mg tablets, 1 tablet, once daily for 10 days and other eight subjects were given Betamethasone 1mg tablets, one tablet, once daily for 10 days. Eight subjects were given all-purpose flour as placebo. Pre test and post test peak force, average force and fatigue index of quadriceps in extension moment was computed.

Results: Non-significant differences were found in all the above variables ($p > 0.05$) in both Prednisolone and Betamethasone groups.

Conclusion: Short-term use of glucocorticoids has no significant effect on isometric strength and endurance in skeletal muscle.

Key words: Glucocorticoids, Peak force, Average force, Fatigue index.

Introduction

Glucocorticoids are potent inhibitors of collagen synthesis and are therefore used clinically in the therapy of fibrotic conditions of the liver¹, lung² and skin.³ Glucocorticoid overuse causes muscle atrophy and loss of muscle function^{4,5}. The overall protein synthesis in skeletal muscle is inhibited by glucocorticoids^{6,7,8} and even a single dose of glucocorticoid treatment rapidly increases the gene expression and enzymatic activity of glutamine synthetase in skeletal muscle indicating protein catabolism.⁹ These studies have been done *in vitro* on mammals other than the humans. The *in vivo* studies done on humans have seen the effect of long-term use of glucocorticoids on skeletal muscle strength in patients suffering from chronic ailments with contrary reports of no change¹⁰ or generalized muscle weakness.¹¹ There is no reference to skeletal muscle endurance in these studies. According to our knowledge, no previous studies have been published to investigate the effects of short-term use of glucocorticoids on skeletal muscle strength

and endurance in human subjects. So, the present study was planned with the objective to find whether any symptomatic changes in skeletal muscle strength and endurance appear after a short-term use of glucocorticoids especially as glucocorticoid usage is not allowed as per the World Anti Doping Agency (WADA) norms.

Materials and Methods

Subjects: Twenty-four healthy sedentary university student volunteers (mean age 20.4 ± 0.95 yrs, mean height 173.16 ± 7.78 cm, mean weight 62.93 ± 6.27 kg) were analyzed for the study. The experimental protocol and potential risk of the study were explained to each subject both verbally and in writing before their informed written consent was obtained. The study was approved by the Institutional Medical Ethics Committee.

Pre-experimental protocol: Each subject visited the laboratory before the start of the study and performed two maximum voluntary isometric contractions on HUR 5340 Leg Extension/

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Curl computer controlled isotonic/isometric dynamometer (University of Technology, Helsinki, Finland) to determine Peak Force (PF), Average Force (AF) and Fatigue Index (FI) of the quadriceps muscle of the dominant leg measured at optimal standardized angle of knee joint¹² (for which the quadriceps muscle applies maximal torque i.e. 60° of knee flexion; 0° means full extension).

Experimental Protocol: The subjects were randomly divided into two experimental groups and one placebo group with eight subjects in each group. In Prednisolone group, subjects were given Prednisolone 5mg tablets, one tablet, once daily for 10 days orally. In Betamethasone group, subjects were given Betamethasone 1mg tablets one tablet, once daily for 10 days orally (the dosage taken was near the lowest effective dosage in adult subjects). In Placebo group, all-purpose flour in gelatin capsules was given. Subjects were asked to arrive at 11 am (to rule out the effects of circadian rhythm and to have a uniform time gap between ingestion of drug and measurements) at the laboratory (tablet was ingested at 8 am). Following a 5 minutes warm up (static stretching of quadriceps and hamstrings muscles with 15 seconds hold, 4 repetitions followed by unloaded pedaling on cycle ergometer for 3 minutes), the PF, AF and FI were measured. The isometric protocol was applied as per standardized procedure mentioned by HUR Research line software user manual (version 1.3).

Analysis: Isometric strength measurement: The torque (Nm) was measured at 10 second isometric contraction at 60° knee flexion for quadriceps. It was normalized to force (N) by dividing the torque (Nm) by lever arm length (m). Thereafter PF and AF were calculated (AF for 4 quarters; 1 quarter = 2.5 seconds).

Isometric endurance measurement: After 2 minutes FI was measured as an indicator of isometric endurance. An isometric contraction of 60 seconds was performed to calculate isometric endurance. Torque at the end of 1st second (T_1) and torque 60th second (T_{60}) were observed. T_1 and T_{60} were normalized to force F_1 and F_{60} respectively. FI was calculated¹³ using the formula:

$$FI = \frac{F_1 - F_{60}}{F_1} \times 100 (\%)$$

Data Analysis

Data was presented as Mean \pm Standard Deviation. The data was analyzed for statistical significance by Statistical Package for Social Sciences (SPSS 14.0) software. Pre test and post test values of the dependent variables PF, AF and FI were analyzed using the related t-test. Comparison between placebo and each experimental group was done

using unrelated t-test. The level of significance for all tests was set at 5% ($p < 0.05$).

Results

Prednisolone group: Related t-test for the pre test and post test values of PF in Prednisolone group showed a non-significant change ($t = -0.324$, $p > 0.05$). There was also a non-significant change in AF ($t = -0.233$, $p > 0.05$). No significant change was found in FI ($t = -0.088$, $p > 0.05$).

When comparison of Prednisolone group with Placebo group was done using unrelated t-test non-significant results were obtained for PF ($t = 0.686$, $p > 0.05$ for pre test values and $t = 0.794$, $p > 0.05$ for post test values). The comparison with Placebo group showed non-significant differences in AF ($t = 1.035$, $p > 0.05$ for pre test values and $t = 0.949$, $p > 0.05$ for post test values). On comparing Prednisolone and placebo groups non significant results were found for FI ($t = -0.784$, $p > 0.05$ for pre test values and $t = 0.651$, $p > 0.05$ for post test values).

Betamethasone group: The pre test and post values of PF in Betamethasone group showed a non-significant change ($t = -0.203$, $p > 0.05$). On comparing pre test and post values of AF non-significant results were obtained ($t = -0.107$, $p > 0.05$). No significant change was found also in FI ($t = 0.859$, $p > 0.05$).

The unrelated t-test for Betamethasone and Placebo group showed non-significant results for PF ($t = 0.729$, $p > 0.05$ for pre test values and $t = 0.593$, $p > 0.05$ for post test values). Comparison with Placebo group also showed non-significant differences in AF ($t = 0.980$, $p > 0.05$ for pre test values and $t = 0.543$, $p > 0.05$ for post test values). Betamethasone and Placebo groups also showed non-significant differences in FI ($t = 0.037$, $p > 0.05$ for pre test values and $t = 0.408$, $p > 0.05$ for post test values).

Discussion

There is a high correlation among the three testing modes i.e. isometric, isotonic and isokinetic modes (when tested at joint angles of peak isometric torque).¹⁴ In the present study, the effect of short-term use of glucocorticoids on maximum voluntary contraction of the dominant knee extensors was measured in isometric mode for the convenience.

The effects of short-term use of glucocorticoids on isometric strength and endurance of skeletal muscles have not been explored yet. Thus the present study is one of its kinds. The results of the study show that there is neither negative nor positive significant change in isometric strength

and endurance of skeletal muscle following a short-term administration of glucocorticoids. These results are contrary to the previous reports of negative effects of glucocorticoids on muscle protein synthesis.^{4,5,6,7,8} A possible reason for this discrepancy can be that the previous studies have not established any correlation between extent of reduction in protein synthesis and reduction in gross muscle strength and endurance. Moreover all these studies have been done on mammals other than humans. Glucocorticoids have been included in the prohibited drugs list by WADA as glucocorticoids are widely used by the athletes for pain suppression and euphoria.¹⁵ According to the present study there are no performance enhancing effects because of the euphoria caused by glucocorticoids.

The studies done on human subjects can not be compared to the present study as these studies have been done on patients suffering from chronic ailments and were taking glucocorticoids on a long term basis.^{6,7} Moreover these studies were done on a very small sample size of two¹⁰ and three¹¹ patients.

Thus the present study has a wide scope for further research. Studies done on other mammals should be replicated in humans taking care of the ethical issues and the similar studies can be replicated for other glucocorticoids and by different routes of administration.

Conclusion

It is concluded from the present study that there is no significant effect of short-term use of glucocorticoids on isometric strength and endurance of skeletal muscles in humans.

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