

Scientific paper

ISOKINETIC MUSCULAR TRAINING OF PILOTS OF COMBAT AVIATION

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Abstract. *It was presented during work a specific isokinetic training program lasting for four weeks. Isokinetic training of pilots of supersonics combat aviation led to significant increase of strength of muscles extensor ($p < 0.01$) and flexor ($p < 0.05$) of lower extremity. As contribution to better bearing of high Gz acceleration during flight, we increased to pilot's muscular strength of lower extremities. Results of the testing may well help, both with military aviation and sport training, rehabilitation after injuries or illness, and for clinical investigations.*

Key words: *isokinetic muscular training, +Gz acceleration, pilots of combat aviation*

1. INTRODUCTION

Present development of military air force techniques mostly depends on capability of pilots to bear +Gz acceleration and other damaging factors of flight. Combat aircrafts of new generation request significant musculoskeletal capabilities of pilots to bear adequately high +Gz load. Therefore the goal of this investigation was to increase muscular strength by specific exercises, to enable pilots of combat aviation to bear high acceleration during aerial combat maneuvers. Numerous facts showed that persons with stronger muscular of lower extremities could bear higher load +Gz (3,6). Pilot, when exposed to higher levels of +Gz acceleration during flight, did muscular contractions of lower extremities similar to isokinetic. That was the reason why we, in the course of the investigation, decided for a form of isokinetic training (7,13).

2. METHODS

Subjects of examination included 26 pilots of supersonic combat aviation who had been found at regular complete checking to have lower values of muscular strength of lower extremities. The most often cause of lower values of muscular strength were injuries, illness or operations as well as irregular or inadequate physical training.

Subjects were exposed to **specific training program** on isokinetic device (Cybex 340), with automatic, individual dosage of training loading during four weeks. The specific training program consisted of isokinetic exercises of maximum extension and flexion of knee joint. At the beginning and at the end of four weeks period of training it was estimated that isokinetic strength of quadriceps and back thread of thigh (hamstrings) at speed of 60 degrees in second shown in Nm (Newton x meter)

Training program (one session) on the isokinetic equipment consisted of exercises of maximum intensity, high frequency and short duration of 1-2 minutes with break of 1-5 minutes, with resistance progressively increasing from first to fourth week (300, 180, 90 and 60 degrees/sec). Training program (one session) was done equally for right and left leg in 6 series lasting 45 minutes, five times in a week. Rest at change of extremity side lasted 6 minutes (Table 1).

Table 1. Protocol of first week training program of one session

Isokinetic Training	Set					
	1	2	3	4	5	6
Speed (degree/s)	300	300	300	300	300	300
Repetition	030	040	050	060	070	080
Rest/min	001	002	003	004	005	006

Anthropometric measurements comprised measurements of body mass and high. Index of body mass (BMI - Body Mass Index) is calculated from relationship of body mass (kg) and square of body high (m²).

For all parametric marks of perception a mean value is calculated (X) and standard deviation (SD). Significant differences between means, a paired t-test was used for analyses. Significant differences were accepted at level 0.05 and higher).

3. RESULTS

Average age of trainees and basic anthropometric parameters are shown on Table 2.

Table 2. Anthropometric parameters (n = 26)

Variables	x	SD
Age (years)	30.45	4.55
Height (cm)	177.8	6.82
Body weight (kg)	81.3	8.82
BMI (kg/m ²)	25.69	2.71

Results of four weeks' isokinetic training are shown on Table 3.

Table 3. Maximum isokinetic strength of muscles of thigh (n = 26), 60 degrees/sec.

Variables	Isokinetic training	
	Before	After
Extension (Nm)	192 ± 24	218 ± 29**
Flexion (Nm)	136 ± 18	146 ± 19*

**p < 0.01 *p < 0.05

Four weeks' isokinetic training of pilots significantly increased their muscular strength of lower extremities (Table 3).

4. DISCUSSION

Muscular tissue is specifically trained for contraction; therefore its most important physiologic characteristic is contraction. Done muscular contraction under constant angular speed and variable resistance along amplitude of movements is called isokinetic. Used angle force under fixed speed along amplitude of movements is called moment of rotation. Moment of rotation is isokinetic force of done muscular contracts. Thus by control of movements the maximum resistance is done along whole amplitude of movements, further it spares and shortens training time to achieve wanted muscular strength (4,5).

For execution of isokinetic training, equipment is needed - dynamometer type Cybex 340. Cybex gives possibility of optimal dosage of muscular contracts to constant speed, leading to quick and safe increase of skeleton-muscular readiness both with patients and sportsmen (6,8,9). Muscular contracts under constant speed of movements on the isokinetic equipment leads to increase strength quicker than isometric or isotonic contracts. Isokinetic muscular contracts through a specific isokinetic training increase muscular strength as it make better functional and structural adaptation of neuromuscular systems (1,11,14).

From the point of sports physiology the interval training with isokinetic equipment is the most satisfying method for muscular increase of strength. One of primary goals of program for achieving physical condition is to achieve the utmost possible action with least physiological strain (tiredness). This can be best done by methods of interval training (2,10, 12).

Interval training on the isokinetic equipment consists of short periods of maximum activity replaced by

Short periods of rest. Isokinetic interval training, thanks to the equipment, consists of

Elements of training of strength and speed with programmed over-load (Table 2). Thanks to interval training with gradual increase of load strength is significantly increased (extension and flexion) of front and back muscular lodges of lower extremities. (Table 3).

5. CONCLUSION

Specific training program on isokinetic equipment lasting four weeks led to significant increase of muscular strength, and proportional increase of capability for better bearing of damaging factors of flight to fighting aviation.

Results of our investigation could be used for sports training, for rehabilitation of patients and other clinical investigations.

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IZOKINETIČKI MIŠIĆNI TRENING PILOTA BORBENE AVIJACIJE

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U radu je prikazan specifičan izokinetički trenažni program koji je trajao četiri nedelje. Izokinetički trening pilota supersonične avijacije rezultirao je kod njih signifikantnim poboljšanjem snage mišića ekstenzora ($p < 0.01$) i fleksora ($p < 0.05$) donjih ekstremiteta. Kao doprinos boljem podnošenju velikih +Gz ubrzanja tokom letenja, kod pilota smo izokinetičkim treningom povećali mišićnu snagu donjih ekstremiteta. Rezultati ovog ispitivanja mogu korisno da posluže, kako u vojnom vazduhoplovstvu tako i pri sportskom treningu, zatim u rehabilitaciji nakon povreda ili oboljenja, kao i pri drugim kliničkim istraživanjima.

Ključne reči: *izokinetički mišićni trening, +Gz ubrzanje, piloti borbene avijacije.*