THE EFFEECTIVENESS OF HUR INTEGRATION EXERCISE MACHINCES ON THE KNEE REHABILITATION AFTER ANTERIOR CRUCIATE LIGAMENT (ACL) RECONSTRUCTION SURGERY

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SUMMARY

Objective: To access the effectiveness of Hur integration exercise machines on the rehabilitation of the knee functions after Anterior cruciate ligament reconstruction surgery. Method: 79 patients separated into two groups including one group of 58 patients trained by Hur integration exercise machines and the other of 21 patients controlled. Accessing indexes based on Lysholm score, perimeter muscular of thigh, range of joint motion, and operability of returning to job. Result: No patient has bad knee function, patients having good and very good knee function increased 67.2%; perimeter muscular of thigh increased 1.1cm; no patients of severely limited range of joint motion, middle limitation decreased 29.4%, light limitation decreased 18.9%, non-limitation increased 53.5%, most of the patients have ability of returning their jobs. Conclusions: Integration exercise machines have good effect for the knee rehabilitation after Anteriorcruciate ligaments reconstruction surgery.

Keywords: Rehabilitation, Integration exercise machines, Anteriorcruciate ligament reconstruction surgery, perimeter muscular, range of joint motion

OPENNING

ACL injuries normally occur for the knee joint. If this damage is not treated, it will lead to atrophy and weakness of the thigh muscle quadriceps, joint pain, osteoarthritis and reduce the function of joints and limbs. The currently best treatment is the ligament reconstruction surgery. After the surgery, patients need to continue practicing to recover the knee function fastest and best.

Previous exercises of knee rehabilitation were mainly based on the simple exercise equipment, such as weights, benches for knee exercises in combination with the hand operations trained by the technicians, so the quality and effectiveness were not good. Currently, at the rehabilitation centers in the world, modern training machines are used to make high effectiveness in the knee rehabilitation. In 2010, the Faculty of Physical Therapy - Rehabilitation of Army Central Hospital 108 was equipped with Hur Integration machines (Finland) which are very modern and effective in the joint rehabilitation. To further evaluate the effectiveness of the integration machines for the knee rehabilitation after ACL reconstruction surgery, we do this research with the following objectives:

RESEARCH OBJECTS AND METHODS

1. **Research objects**

Including 79 patients after ACL reconstruction surgery at the Faculty of Physiotherapy - Rehabilitation of Army Central Hospital 108 from August 2011 to June 2013 who have full following criteria: patients aged 15 years and older, muscular strength more or equal to 3* and volunteer to join the research. The patients are separated into two groups:

- Group 1 (58 patients): Trained with the regular rehabilitation exercises plus with integration machines.

- Group 2 (21 patients): Just trained with the regular rehabilitation

2. **Research methods**

Prospective, Interventional and case-control studies

The research variables and indices include:

- Evaluate range of joint motion based on the method Zero which is categorized as follows: no-limitation (over 140°), light limitation (from 90^0 to lower 140^0), middle limitation (from 45^0 to lower 90°) and severe limitation (lower 45^0).

- Evaluate the level of muscle atrophy by measuring the thigh perimeter from poles on the kneecap up to 10cm, compared with the unaffected side, divided into the following levels: no atrophy (equal to the perimeter of the unaffected side), light atrophy (less than 1 cm), middle atrophy (1-2 cm), severe atrophy (over 2 cm).

- Knee functions evaluated by the Lysholm scores:

+ Bad: <65 points

+ Fair: 65 - 83 points

+ Good: 84 - 94 points

+ Excellent: 95 - 100 point

Data are processed by the SPSS 19.0 software.

3. Training technique on Hur Integration machines

Exercises are built basing on the available software initialized on the smart card for each patient. After ACL reconstruction surgery, the patients are trained with three machines in Hur Integration machine system, including: Leg press, Leg press Incline, Leg Extension / leg curt:

- Press strength of agonist: started with the weight equal to 1/3 that of the unaffected side

- Movement times performed in each practice: 50 - 100 times.

- Joint angle extension: relied on the range of knee motion.

After each training period (5 days), the doctors check its progress and adjust the press strength as well as the joint angle extension accordingly.

Monitoring after practice: If the patient is not painful longer than 3 hours and has no knee swelling, the exercise meets the requirements.

4. The common rehabilitation techniques for two groups

- Exercises for the range of joint motion: passive, semi-active, fully active and active exercises with gradually increased press strength which are combined with the passive straightening to reduce joint spasticity and increase the elasticity of the soft tissues.

- The physiotherapy method: message, paraffin, electric pulse, electrolysis on knee injuries.

RESEARCH RESULTS

General characteristic

- **Positions and types of Injuries**

Table 1.Injury positions and types

Positions	Total (n=79)		Injury types	Total (n=79)	
	Quantity	%		Quantity	%
Right	37	46.8	Single	55	69.6
Left	42	53.2	coordinated	24	30.4

Review: Injury position is evenly distributed between the right and the left. Single ligament damage accounts for a higher percentage than combined ligament injuries.

- **Causes of Injuries and treatment methods**

Table 2: Causes of Injuries and Treatment methods

Causes	Total (n=79)		Treatment Methods	Total (n=79)	
	Quantity	%		Quantity	%
Sport	10	12.7	arthroscopy	58	73.4
Traffic accident	69	87.3	open surgery	21	26.6

Review: Traffic accidents are the main causes leading to damages. The arthroscopy surgery method is preferred to the open surgery method.

- **The time of the rehabilitation exercises after the surgery**

Table 3: The time of the rehabilitation exercises after the surgery

Time		Less than a week	One week – one month	More a month
Total (n = 79)	Quantity	3	30	46
	%	3.8	38	58.2

Review: Most of patients need more than one week to do rehabilitation exercise.

- **The training time of two groups**

Table 4: The training time

Time (Days)	Group 1 (n=58)	Group 2 (n=21)	P
Least	3	3	0.69

Most	55	50	
Average	23 +_ 12	14 +_ 11	

Review: The differences about the average training time of two groups have no statistic meaning (p>0.05).

- **Characteristics and symptoms before intervention**

Table 5. The knee functions evaluated by Lysholm scores

Points	Group 1 (n = 58)		Group 2 (n = 21)		Total (n = 79)	
	Quantity	%	Quantity	%	Quantity	%
<65	16	27.6	12	57.1	28	35.4
65 – 83	27	46.6	9	42.9	36	45.6
84 – 94	15	25.9	0	0	15	19.0
95 – 100	0	0	0	0	0	0
P	0.006				79	100

Review: According to the Lysholm scores, the knee functions on pre-training are average which gets the highest proportion (65 – 83). There is no difference between two groups (P>0.05).

Table 6: Assessment on the muscular atrophy (Reduced thigh perimeter)

Muscular atrophy (cm)	Group 1 (n = 58)	Group 2 (n = 21)
Least	1	1
Most	5	5
Average	2.6+_1.1	2.5+-0.9
P	0.17	

Review: The average muscular atrophy is over 2 cm. There is no difference between two groups (P>0.05).

Table 7. Evaluate the limitation of the range of joint motion

Range of joint motion (Degree)	Group 1 (n= = 58)		Group 2 (n= = 21)		Total (n=79)	
	Quantity	%	Quantity	%	Quantity	%
<46	3	5.2	9	42.9	12	15.2
45 - 89	19	32.8	9	42.9	28	35.4

90 – 139	30	51.7	3	14.3	33	41.8
<140	6	10.3	0	0	6	7.6
P	0.06				79	100

Review: Most of patients have the range of motion for their joints limited. There is no difference on the range of motion between 2 groups (P>0.05).

2. Result treatment

2.1. Symptoms improved after the treatment

- *Functions of the knee joints improved according to Lysholm scores*

Table 8: Functions of the knee joints improved according to Lysholm scores

Scores	Group 1 (n= = 58)		Group 2 (n= = 21)		Total (n=79)	
	Quantity	%	Quantity	%	Quantity	%
<65	0	0	3	14.3	3	3.8
65 -83	4	6.9	9	42.9	13	18.5
84 - 94	30	51.7	8	38.1	38	48.1
96 - 100	24	41.4	1	4.8	25	31.6
P	0.001				79	100

Review: After the treatment, the functions of the knee joints are improved dramatically (the good and very good rates are achieved up to 79.7%) in which for the combined group, there is no patient with the bad functions and the number of patients having good and excellent functions gets the highest rate of 93.1% while the licensed group gains 42.9%. The difference on the improved functions of the knee joints has the statistic meaning with P<0.05.

- Improve the muscle atrophy (increase the thigh circumference)

Table 9. Improve the muscle atrophy (increase the thigh circumference)

Muscular atrophy (cm)	Group 1 (n= = 58)	Group 2 (n= = 21)
Least	0	1
Most	4	4

Average	1.5+_0.9	2.1+-0.7
P	0.02	

Review: After the treatment, the thigh perimeter is increased dramatically in 2 groups. The thigh muscle atrophy of the group practicing the Hur integration machine decreases. There is the difference with statistic meaning for two groups with P < 0.05.

- *The range of joint motion improved*

Table 10.The range of joint motion improved

Range of joint motion (Degree)	Group 1 (n= = 58)		Group 2 (n= = 21)		Total (n=79)	
	Quantity	%	Quantity	%	Quantity	%
<45	0	0	1	4.8	1	1.3
45 - 89	2	3.4	8	28.6	8	10.1
90 – 139	19	32.8	12	57.1	31	39.2
>140	37	63.8	2	9.5	39	49.4
P	0.001				79	100

Review: The range of joint motion is improved after the treatment (Severe limitations are just at 1.3% while the light and no-limitations reach to 88.6%) in which there is no patient with the severe limitations in the group 1 and the patients with the light and no-limitations in this group reach to 96.6% compared to 66.6% in the group 2. The difference on the effectiveness after the treatment has statistic meaning between 2 groups with P<0.05.

2.2 Ability to return previous job

Table 11: Ability to return the jobs

Ability	Group 1 (n= 58)		Group 2 (n = 21)		P
	Quantity	%	Quantity	%	
Not yet	3	5.2	12	57.1	0.001
Full	55	94.8	9	42.9	

Review: Most of the patients trained with the Hur integration exercise machines can return their previous jobs after the treatment (94.8%) while number of patients without this treatment who are unable to return the previous job accounts for high rate (57.1%). The difference has statistic meaning with P<0.05.

2.3. Evaluation on the treatment results

Table 12. General treatment results compared between 2 groups

Result	Group 1 (n=58)		Group 2 (n=21)		Total (n=79)	
	Quantity	%	Quantity	%	Quantity	%
Average	1	1,7	8	38,1	9	11,4
Fair	23	39,7	11	52,4	34	43,0
Good	34	58,6	2	9,5	36	45,6
P	0.001				79	100

Review: The general rehabilitation results of the group trained by the combined treatment (group 1) are much more effective than the group 2: The good rehabilitation rate reaches up to 58.6% (group 2 to 9.5%) while the average reduces to 1.7% (the group 2 to 38.1%). The differences on the rehabilitation between 2 groups have statistic meaning with P<0.005.

DISCUSSION

Witnessing the treatment results, we realized that the patients would get the considerable improvement on the thigh perimeter as they were trained with Hur integration machines. Among 58 trained patients, the number of patients having the symptoms of muscular atrophy is changed dramatically after treatment: the average perimeter of muscular atrophy on pretreatment is 2.6 cm which reduces to 1.5 cm on post-treatment. The difference has the statistic meaning with P<0.05 and more specially, they are much better than that of the group trained by hands or with the simple equipment which the gap is 95%. With the research statistics, we found the priority of Hur exercise machines for the rehabilitation of knee joints after the surgical reconstruction of anterior cruciate ligament that was not seen in the previous researches due to being less consistent in selecting the patients.

The training results achieved on HUR integration machines showed that there was very good improvement on the range of motion of the knee joints for the patients trained with the combined treatment. The average results reduce up to 29.4% while the fair and good ones increase to 34.6%. The difference has the statistic meaning compared with that prior to being trained and

more specially, they are much better than that of the group without being trained with the HUR integration machines.

On research, we also get results that the improved function of knee joins is much better in the group treated with Hur integration machines than that without this treatment. In details, the good and very good results get over 90% for the treatment Hur with integration machines compared with lower than 50% for other therapy.

Specially, the ability for the group trained with the Hur integration machines to be back their jobs is very high (94.8%) and the difference has the statistic meaning compared to the group without this treatment with P<0.05.General evaluation on the results: we found that the rehabilitation of the knee joints trained with HUR integration exercises is very optimistic. The rate of patients who got the fair and good results is 98.3%. As being compared with the group 2, it is much more effective (P<0.05).

Thanks to designing the reasonable exercises with the great support of Hur integration machines, the rehabilitation of the knee joints for the patients after the surgical reconstruction of anterior cruciate ligament gets good achievement. The rehabilitation time, in our point of view, is fairly short (the average is 23 days equal to 4 training weeks). The functions of the knee joints are improved considerably, Lysholm scores get good and very good in the range from 25.9% to 93.1% and the number of the patients who can return their previous jobs reaches to 94.8%.

Besides, in the course of doing research, we have not found the case who meets unexpected adverse side effects.

IN CONCLUSION

HUR integration machines bring high effectiveness for the rehabilitation of thigh perimeter (atrophy scale) and the range of motion of the knee joints after the surgical reconstruction of anterior cruciate ligament.

- Thigh perimeter is improved considerably after treatment: The perimeter increases to about 1.1 cm in average which has the statistic meaning compared with that on pre-treatment and of group 2 (P<0.05)
- The range of motion of the knee joints after treatment is also improved dramatically. No patient meet the serious limited range of motion; the middle declines to 17.9% while the light increases to 9% and the full range reaches to 29.5%. Compared with the results

on pre-treatment and for the licensed group, the difference has the statistic meaning (P<0.05).

Thanks to being trained with the integration machines, the functions of the knee joints are also improved considerably and fast which 93.1% gets the good and very good Lysholm scores. It helps the patients to be back their previous jobs in the shortest time.