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무릎관절 전치환술을 시행한 혈우병 환자의 무릎관절 가동범위를 향상시키기 위한 물리치료에 관한 고찰

전혜림[1] · 인태성[2]

[1]삼육대학교 일반대학원 물리치료학과
[2]김천대학교 물리치료학과

Consideration of Physiotherapy for the Improvement of Knee Joint Range of Motion after Total Knee Replacement in Patients with Hemopilic Arthropathy

Hye-Lim Chun[1] · Tae-Seong In[2]

[1]Dept. of Physical Therapy, Graduate School, Sahmyook University
[2]Dept. of Physical Therapy, Gimcheon University

Abstract

Purpose: This study aimed to investigate the effect of physiotherapy on the range of motion (ROM) of patients with hemophilic arthropathy after total knee replacement (TKR) during treadmill gait. **Method:** Nineteen patients (age range, 30-61 years) who received physiotherapy at the Korea Hemophilia Foundation (KHF) Clinic in Seoul between 2011 and 2013 after TKR were recruited. Protocol rehabilitation was performed (KHF Clinic, Department of Physiotherapy) with an average follow-up of 70 days (range, 6-141 days). **Result:** Physiotherapy after TKR improved the ROM parameters, including the post-operative average ROM. The post-operative and follow-up ROM also significantly increased. **Conclusion:** Patients with hemophilia require different physiotherapeutic techniques and need dedicated post-operative care in comparison with the general population.

Key words : Hemophilic Arthropathy, Total Knee Replacement, Physiotherapy

Ⅰ. Introduction

Hemophilia A and B are X-linked coagulation disorders caused by the deficiency of factor VIII (FVIII) and factor IX (FIX), respectively. The degree of clotting factor deficiency influences the phenotype and the severe

교신저자: 인태성
주소: 경상북도 김천시 대학로 214 김천대학교 물리치료학과, 전화: 054-420-4068, E-mail: inn8386@naver.com

form of the disease (FVIII/FIX <1 IU dL-1). Spontaneous bleeding episodes occurring in the joints and muscles represent the more common manifestations of these diseases. Over 90% of bleeding episodes in patients with hemophilia (PWHs) occur within the musculoskeletal system, and of these, 80% occur within the joints. This presence of blood within the joints has also been shown to damage the articular cartilages directly. Recurrent bleeding in the joints causes synovial proliferation and neoangiogenesis, increasing the joints' susceptibility to further bleeding and leading to the development of the so-called "target joints." Iron from repeated hemarthroses accumulates in the synovium and promotes a cytokine-mediated inflammatory response leading to the progressive destruction of both the cartilage and bone. The final result of these changes is referred to as chronic hemophilic arthropathy, which is characterized by pain, deformity, and severe contractures (Solimeno 2012). The knee is the most common target joint, presenting with subsequent degenerative arthritis. When advanced hemophilic arthropathy has evolved, total knee replacement (TKR) is recommended for pain relief and functional status improvement. The aim of this study was to assess the availability of modalities of physiotherapy after TKR in patients with hemophilic arthropathy.

Ⅱ. Materials and methods

1. Study design

The records of patients with severe hemophilia and severe hemophilic arthropathy of the knee, who underwent treatment in the Comprehensive Hemophilia Treatment Center of K-University Hospital between 2011 and 2013 were retrospectively reviewed. After surgery, the patients received physiotherapy at the Korea Hemophilia Foundation (KHF) Clinic in Seoul. Two skilled physiotherapists treated the patients for 2-3 months according to the protocol (Table 1). The knee range of motion (ROM) was measured using a conventional goniometer at the first stage and final stage of treatment.

2. Participants of the study

The data for this study were obtained from 19 patients who received physiotherapy at the KHF Clinic in Seoul between 2011 and 2013 after TKR. The mean age of the patients at the time of surgery was 42 years (range, 30-61 years). Eighteen patients were diagnosed with hemophilia A, and one patient was diagnosed with hemophilia B. All patients had severe hemophilia (<1% normal circulating clotting factor). A clotting factor inhibitor was present in two patients.

3. Modalities of Physiotherapy

Ice pack is beneficial in relieving pain, muscle spasm, and inflammation, preventing bleeding, and promoting rest of the joints. It was applied for 10-15 minutes after therapeutic exercise and at the early stage of post-operation. Hot pack was applied for 20 minutes after 2 weeks rather than at the early stage of post-operation. It improves elongation of the body tissues and blood flow and reduces joint stiffness and pain, muscle spasm, inflammation, edema, and exudation. Transcutaneous electrical neurostimulation was applied at a low-intensity electrical impulse to stimulate the peripheral nerves, which inhibits the transmission of pain information along the nerves and may result in the release of endorphins. Manual manipulation (manual traction, mobilization techniques, muscle strengthening and stretching exercises, and joint stabilization training) is most useful in the recovery of the ROM of the knee joints and training of the joint function. The knee joint should be manipulated very carefully to prevent femoral fractures. Stable and adequate manipulation owing to osteopenia is then

necessary. Continuous passive movements (CPMs) facilitate flexion but are not as helpful in gaining extension as a knee immobilizer, which is recommended at night for patients with a flexion contracture. CPM is usually started at the third post-operative day from 30° to 80-90° at discharge with an increase of 5-10° per day. Hydrotherapy is a useful adjunct in enabling patients to work on gait re-education, strengthening, and proprioception and particularly beneficial for those who have multiple affected arthropathic lower limb joints, as the buoyancy of the water decreases weight-bearing stresses through the joints, yet allow the knee to improve its strength and function. According to the protocol of rehabilitation in patients who underwent TKR, training starts in bed, which includes deep vein thrombosis prevention, Move and Isometric exercise from #2. Isometric exercises are recommended in the early stage of post-operation to achieve better muscular strength. There are passive exercises started from #3, Stretching and muscular strength exercise from #7, Assistant active exercise from #10, active exercise and resistance exercise in the stage of muscle strengthening exercise. After it started move weight bearing from #10, start balance exercise from 4 weeks in the time of training of proprioceptive receptor (Table 1).

4. Statistical analysis

All analyses were performed using the PASW Statistics 18. A matched sample t-test was used to compare the post-operative and follow-up ROMs. A two-sided P-value of <0.05 was considered statistically significant.

Ⅲ. Results

The average age at the time of TKR was 42 years with an average follow-up of 70 days (range, 6-141 days). Physiotherapy after TKR improved the ROM parameters. The youngest age among the patients was 30 years, and oldest age was 61 years (Table 2).

The post-operative average ROM was 39.4°, which improved to 63.6° at the final outcome after physiotherapy. The minimum post-operative and follow-up ROMs were 20° and 35°, respectively. The ceiling post-operative and follow-up ROMs were 70° and 100°, respectively. The average number of physiotherapy was 43 (range, 3-84) (Table 3).

The statistical post-operative and follow-up ROMs were .169 and .173. Based on the significance probability of the Kolmogorov-Smirnov testa, the post-operative ROM was .160, and the follow-up ROM was .136. Because there were P-values greater than .05, the null hypothesis adopted was the normal distribution (Table 4).

The t-value was -5.703, with the P-value of .000. Based on the null hypothesis, there was no difference between the average ROMs of the two groups. The P-value was less than .05; thus, the null hypothesis was not valuable. This indicates that there was a difference between the post-operative ROM and follow-up ROM. The average of both the post-operative and follow-up ROMs was -24.21053, which indicates that the ROM increased to 24.21° after physiotherapy. The standard deviation was 18.50399; its average was 4.24511. The lowest limit in the 95% confidence interval was -33.12916, and the upper limit was -15.29189 (Table 5).

Ⅳ. Discussion

The results of this study showed that the ROM of the knee joint increased after physiotherapy. The requirement for physiotherapy input following TKR for the stiff knee is paramount. However, the results of TKR in patients with end-stage hemophilic arthropathy cannot be compared with those in patients with osteoarthritis.

There are some differences between hemophilic ar-

thropathy and osteoarthritis. First, quadriceps contracture is more severe in hemophilic arthropathy. Second, it is difficult to differentiate between the pain that originates from bleeding and the surgery itself.

It is beneficial if the physiotherapists have had experiences in managing PWHs so that they are not excessively fearful of causing joint bleeding and can utilize the appropriate amount of force in assisted active ROMs.

This study has some limitations. First, it has a small sample size with a short follow-up duration. A lack of a control group also prevents us from making any comparative analysis. A longer follow-up duration is then required to assess the effect of physiotherapy and whether such good results are maintained over time. Second, we cannot actually treat patients directly yet because we are still students. Thus, we only depended on the data and had little knowledge on the effect of the individual modalities of physiotherapy.

To date, there is no study conducted on the modalities of physiotherapy after TKR in PWHs in Korea.

Ⅴ. Conclusions

Aggressive physical therapy and a high level of patient cooperation are essential for sustained improvement in the ROM gained at surgery. Unfortunately, the fibrous tissues tend to reform rapidly in many severe cases. The patients will have a good ROM initially and then lose such a range gradually over a period of weeks to months, ending up with a very restricted range and fibrous ankyloses in some cases. This occurs despite post-operative CPM and rigorous physical therapy. In patients whose ROMs are slowly gained after knee replacement, knee manipulation under general anesthesia may help. Forces must be balanced around the knee to avoid factures of the distal femur or proximal tibia as many of these patients have osteopenia. Manipulation is best performed within 3 weeks of surgery before adhesions become too strong.

Managing PWHs represents a challenge for physiotherapists because in comparison with the general population, they require different physiotherapeutic techniques and need dedicated post-operative care. Hence, the contribution of skilled physiotherapists is crucial in achieving good outcomes.

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Appendix 1. Table

Table 1. Protocol of rehabilitation in patients with TKR (KHF Clinic department of Physiotherapy)

<table>
<tr><td></td><td colspan="2">POD</td><td>#2</td><td>#3</td><td>#7</td><td>#10</td><td>2wks</td><td>3wks</td><td>4wks</td><td>5wks</td><td>6wks</td><td>2~3 mon</td></tr>
<tr><td></td><td colspan="2">Clotting Factors</td><td colspan="2">50~100%</td><td colspan="2">25~50%</td><td colspan="6">12~25%</td></tr>
<tr><td rowspan="15">TE</td><td rowspan="3">Training in bed</td><td>DVT prevent</td><td>○</td><td>●</td><td>●</td><td>→</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Move</td><td>○</td><td>◎</td><td>◎</td><td>●</td><td>→</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="10">Training in bed (#2), Crutch Gait training (#5), Stair training (#10)</td></tr>
<tr><td>Isometric Ex.</td><td>○</td><td>◎</td><td>●</td><td>→</td><td>→</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="10">QF / Hamstring / Gluteus M. : 3 times a day 10~20 Repeat to POD#7</td></tr>
<tr><td rowspan="6">Muscle Strengthening exercise</td><td>Passive Ex.</td><td></td><td>○</td><td>◎</td><td>◎</td><td>●</td><td>→</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="10">POD #3 :Start from CPM 30°(Increase 5~10°/Day), Discharge ROM : Aim 80~90°</td></tr>
<tr><td>stretching Ex./muscular strength ex.</td><td></td><td></td><td>○</td><td>◎</td><td>◎</td><td>●</td><td>→</td><td></td><td></td><td></td></tr>
<tr><td colspan="10">Stretching : Calf M. / Hamstring, Muscle Strengthening : thigh / Buttock
Necessary Active full extension : Active Extension Ex(CPM is effective to flextion)</td></tr>
<tr><td>AAEx</td><td></td><td></td><td></td><td>○</td><td>◎</td><td>◎</td><td>●</td><td>→</td><td></td><td></td></tr>
<tr><td>AEx</td><td></td><td></td><td></td><td></td><td>○</td><td>●</td><td>●</td><td>→</td><td></td><td></td></tr>
<tr><td>REx</td><td></td><td></td><td></td><td></td><td>○</td><td>●</td><td>●</td><td>→</td><td></td><td></td></tr>
<tr><td rowspan="2">Training of Proprioceptive receptor</td><td>Move Wright bearing</td><td></td><td></td><td colspan="2">○</td><td colspan="2">◎</td><td>●</td><td>→</td><td></td><td></td></tr>
<tr><td rowspan="2">Balance Ex.</td><td></td><td></td><td colspan="4">Training of Moving Weight-Bearing</td><td>○</td><td>●</td><td>→</td><td></td></tr>
<tr><td colspan="10">Training of Moving Weight-Bearing, Standing one leg, Exercise on balance disk, Training strength of Deep muscle.</td></tr>
<tr><td rowspan="3">Gait training</td><td rowspan="2">crutch & gait</td><td colspan="2">Touch down</td><td>three point gait</td><td>◎</td><td>●</td><td>→</td><td colspan="3">Treadmill</td><td>full</td></tr>
<tr><td colspan="10">POD # 3 : Weight bearing partially
POD # 5 : Long distance→Crutch & Stick, Short distance→Without Crutch & stick</td></tr>
<tr><td>Weight bearing</td><td colspan="10">Weight bearing after 4 weeks TKR without cement and 4~6 weeks bone graft</td></tr>
<tr><td colspan="2" rowspan="2">Hydrotherapy</td><td></td><td></td><td></td><td></td><td></td><td>○</td><td>◎</td><td>◎</td><td>●</td><td></td></tr>
<tr><td colspan="10">Walking underwater, strengthening of muscle and joint mobilization</td></tr>
<tr><td rowspan="2">PT</td><td colspan="2">Cold pack</td><td colspan="10">Take cold pack Heat, Swelling and After exercise during Post-operation 2~3month without bleeding</td></tr>
<tr><td colspan="2">Hot pack, Electrotherapy</td><td></td><td></td><td>○</td><td>●</td><td>→</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2"></td><td colspan="10">Hot pack, low frequency therapy, EST, FES</td></tr>
</table>

○ : Start
◎ : Softly
● : Normally
→ : Consistently
TE : Therapeutic exercise
: Days
POD : post-operation day

Table 2. Comparison of ROM After Physiotherapy (2011~12)

	Age	Type of Hemophila	Post-OP ROM		Follow-up ROM		Physiotherapy		
			FC	FF	FC	FF	No.	Start	Finish
1	37	A	10	40	0	100	75	2011-02-26	2011-06-15
2	41	A	5	25	5	40	76	2011-03-17	2011-06-17
3	40	A	15	50	5	90	66	2011-03-30	2011-07-09
4	38	A	10	55	0	80	59	2011-05-06	2011-09-05
5	51	A	0	70	5	90	69	2011-05-09	2011-09-30
6	30	A	15	55	20	70	46	2011-06-14	2011-10-04
7	30	A	5	40	5	55	40	2011-06-13	2011-08-04
8	41	A	5	40	5	45	14	2011-07-19	2011-08-03
9	39	A	5	45	5	80	29	2011-10-04	2011-11-05
10	34	A	15	35	15	50	44	2011-10-06	2012-03-14
11	42	A	0	65	0	70	3	2012-02-22	2012-02-27
12	42	B	5	55	0	75	19	2012-03-05	2012-03-30
13	53	A	10	40	5	40	51	2012-03-19	2012-06-05
14	49	A	10	45	5	65	17	2012-03-30	2012-04-21
15	36	A	15	40	15	55	84	2012-04-25	2012-08-04
16	49	A	5	50	5	85	13	2012-05-14	2012-06-09
17	43	A	15	55	5	100	45	2012-09-06	2012-11-01
18	61	A	10	45	10	50	30	2012-12-10	2013-01-25
19	40	A	5	60	5	85	39	2012-11-05	2012-12-22

*FC : Flexion Contracture

*FF : Further Flexion

*Post-OP Range of Motion : the first post-operative visit Range Of Motion

*Follow-up Range of Motion : the final visit Range Of Motion

Table 3. Statistics of Post-operation ROM, Follow-up ROM, Numbers, Age

	Post-OP ROM(°)	Follow-up ROM(°)	No	Age(years)
N	19	19	19	19
average ± SD	39.47±13.43	63.68±22.16	43.11±23.94	41.89±7.85
minimum value	20.00°	35.00°	3.00	30.00years
ceiling value	70.00°	100.00°	84.00	61.00years

*OP - operation SD
*SD - standard deviation

Table 4. Test of normality of Post-operation and Follow-up ROM

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	SV	DOF	SP	SV	DOF	SP
Post-OP ROM	.169	19	.160	.934	19	.203
Follow-up ROM	.173	19	.136	.899	19	.046

*OP - operation
*SV - statistics value
*DOF - Degree of freedom
*SP - significance probability

Table 5. Matching sample t-test between Post-operation ROM and Follow-up ROM

	Corresponding margin							
	Average(°)	Standard deviation	SD of Average	95% of difference confidence interval		t	DOF	SP(both side)
				lowest limit	upper limit			
Post-OP ROM	-24.210	18.5039	4.24511	-33.1	-15.2	-5.70	18	.000
Follow-up ROM	53	9		2916	9189	3		

*OP - operation
*SD - standard deviation
*SV - statistics value
*DOF - Degree of freedom
*SP - significance probability