



Impact of Elastic Resistance Training on Step Length, Stride Length, Toe-Out Angle in patients with Haemophilia

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Abstract: -

Background: Haemophilia is a genetic bleeding disorder that often results in joint damage and muscle weakness due to recurrent hemarthrosis, which significantly affects gait. Physiotherapy interventions such as resistance training may help improve muscle strength and restore functional gait parameters in affected individuals.

Objective: To evaluate the impact of a TheraBand-based progressive resistance strength training program on gait characteristics—specifically step length, stride length, and toe-out angle—in individuals with haemophilia.

Methods: A randomized controlled trial was conducted at the Haemophilia Day Care Centre, PGIMS Rohtak. A total of 69 male patients with moderate to severe haemophilia A were initially enrolled. Of these, 5 participants were excluded for not meeting the inclusion criteria, and 4 withdrew due to bleeding episodes during the study. Sixty participants were randomly assigned to either an intervention group (n=30), which received a 6-week TheraBand-based lower limb strength training program, or a control group (n=30), which continued with routine physiotherapy care. The primary outcome measures—step length, stride length, toe-out angle—was assessed pre- and post-intervention using standardized footprint methods for gait analysis.

Results: Post-intervention analysis revealed statistically significant improvements in the intervention group compared to the control group in step length ($p < 0.01$), stride length ($p < 0.01$), and toe-out angle ($p < 0.05$). No major adverse events were reported in the intervention group.

Conclusion: TheraBand-based resistance training significantly enhances key gait parameters including step length, stride length, and toe-out angle in individuals with haemophilia. This intervention is safe and effective and should be considered as a valuable addition to physiotherapy protocols for this population.

Keywords: Haemophilia, Gait, TheraBand, Resistance training, Step length, Stride length, Toe-out angle.



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Introduction

Haemophilia is a rare, inherited bleeding disorder characterized by a deficiency or dysfunction of clotting factors, primarily factor VIII (Haemophilia A) or factor IX (Haemophilia B). The global prevalence of haemophilia is estimated to be approximately one in 10,000 individuals, suggesting that around 600,000 people worldwide are affected, based on a global population of six billion¹. In India, the incidence of haemophilia was reported to be approximately 2 per 100,000 male births in 2010, with 277 new cases registered annually. However, if a higher incidence estimates of 20 per 100,000 is considered, the number of new haemophilia cases in India during that year could be around 2,768, accounting for approximately 0.01% of total annual births².

Haemophilia is classified into three grades of severity—mild, moderate, and severe—based on the percentage of functional clotting factor present in the patient's blood. Joint involvement in haemophilia, known as haemophilic arthropathy, often begins early in childhood with recurrent episodes of hemarthrosis, especially as children start to walk. These repeated joint bleeds disrupt the normal functioning of chondrocytes, impairing proteoglycan synthesis and triggering chondrocyte apoptosis³. As blood accumulates in the joint, the synovial membrane becomes hypertrophic and fragile, creating a cycle of bleeding and synovial inflammation (hemarthrosis–synovitis–hemarthrosis). If not managed effectively, this can result in chronic joint damage, fixed flexion deformities, and progressive functional impairment².

The pathological cascade eventually leads to invasive hyper vascular synovial hypertrophy, chronic synovitis, articular cartilage degradation, subchondral cyst formation, and bone remodelling. In addition to joints, bleeding can also occur in both skeletal and smooth muscles, commonly affecting the iliopsoas, thigh, calf, and forearm flexors. These episodes often present with pain, swelling, bruising, reduced range of motion (ROM), and muscle imbalances, further contributing to mobility limitations⁴. Given these complications, optimizing musculoskeletal function is a crucial component of haemophilia management. Resistance training using TheraBand—an accessible and graded elastic resistance tool—has been shown to enhance muscular strength, which may lead to improved gait and functional outcomes⁵.

The objective of this study was to evaluate the effectiveness of a TheraBand-based progressive resistance strength training program on improving gait characteristics—specifically step length, stride length, and toe-out angle—as well as lower limb muscle strength in individuals with moderate to severe haemophilia.

Methodology

The ethical clearance was taken from Institutional Ethical Committee of Pandit Bhagwat Dayal Sharma University Health Science, Rohtak (PGIMS) wide letter No. BREC/23/TH-Physiotherapy/31, date 20/07/. Subjects were screened as per inclusion and exclusion Criteria. A participation sheet questionnaire was provided and clearly explained to selected subjects and their consent were recorded. After comprehensive description of study, sociodemographic details of the participants were collected including name, age, height (cm), BMI, Blood group. The following clinical variables were collected from the medical record, the type and severity of Haemophilia, the prophylaxis regimen (weekly coagulation factor dose), the annual bleeding joint rate (ABJR) in the lower extremities. Subjects were randomly divided among two groups: Group A and Group B. Initially baseline assessment shall be taken using foot print methods of gait parameters to assess gait. Before intervention Group A (experimental group) were performed knee strengthening exercises with TheraBand and Group B (Control group) were performed best practice usual care in physiotherapy for knee strengthening. Before and after intervention ice pack were used. This protocol performed two times a week for 6 weeks at day care centre of Haemophilia, PGIMS, Rohtak. Assessment was taken again after 3 weeks and 6 weeks with using the same baseline assessment procedure. Results of both group pre and post-test were noted and analysed with help of suitable statistical test.

Inclusion and Exclusion Criteria

The study included male patients aged between 18 and 60 years who were enrolled at the Haemophilia Day Care Centre of Pt BDS PGIMS Rohtak. Individuals diagnosed with either Haemophilia A or Haemophilia B were considered eligible for participation. Only those meeting these criteria were recruited for the intervention. Participants were excluded from the study if they had any known neurological or psychological disorders, recent fractures, a history of brain injury or intracranial bleeding, or any significant peripheral nerve injury resulting in sensory loss. Additionally, patients who had experienced a severe knee joint bleed within the past 14 days were not included in the study to ensure safety during exercise intervention⁶.

To assess the gait ink footprint method was used. We will measure Step length, stride length and toe angle.⁷

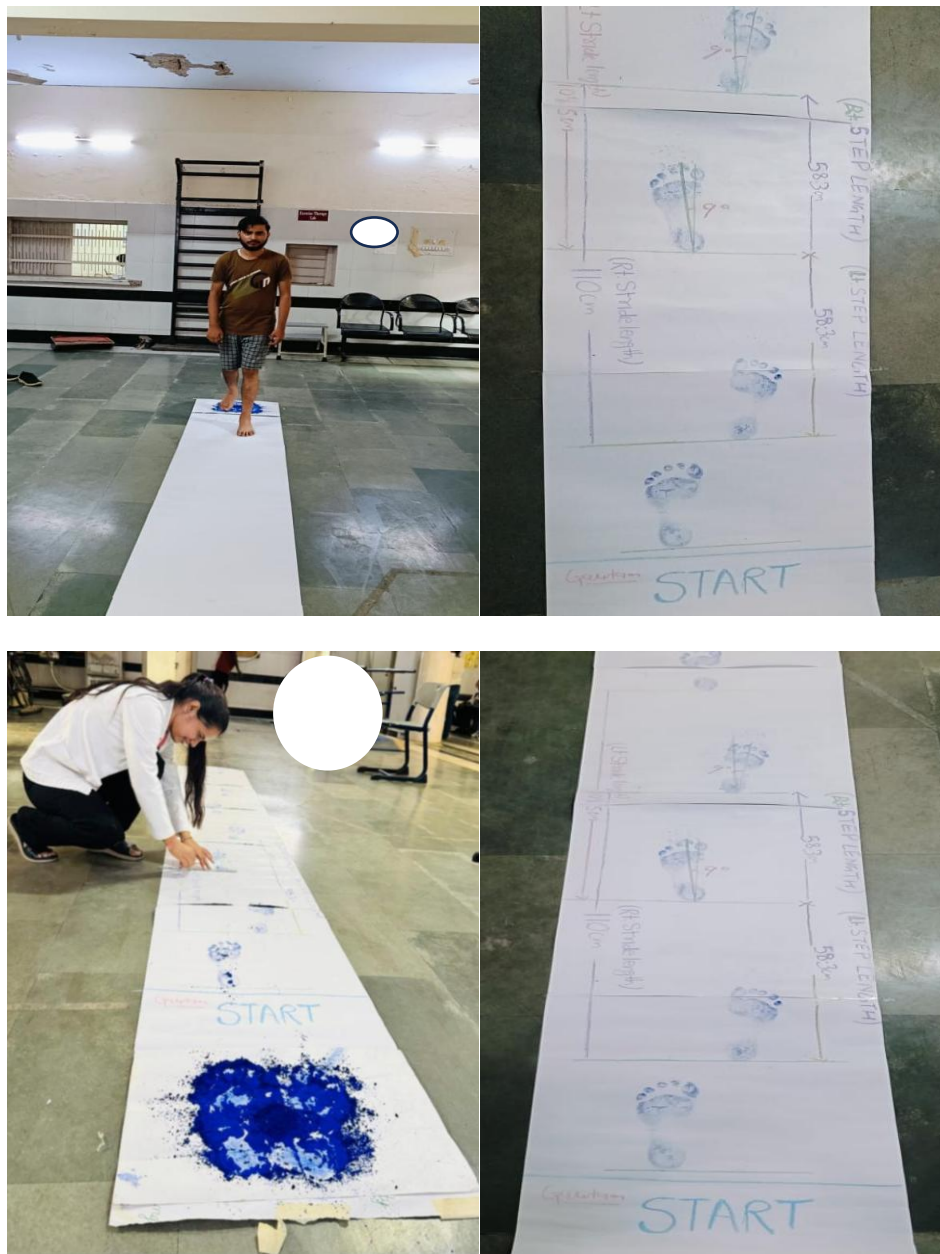


Figure 1. Gait ink footprint method

Intervention (Experimental Group)

Group A (n = 30) received a supervised TheraBand-based resistance training program for 6 weeks. The exercise protocol included knee flexion, knee extension, bilateral leg press, straight leg raises, prone leg lift, and calf raises. Exercises were performed twice weekly, with 10–15 repetitions, each held for 5 seconds with 10 seconds rest between repetitions. The program progressed through three phases: Week 1–2 (1–2 sets at 40–50% intensity), Week 3–4 (3 sets at 50–65%), and Week 5–6 (3 sets at 60–75%). Intensity was based on isometric strength assessed by hand-held dynamometer and increased by 5–10% weekly if no pain or swelling occurred⁸.

Intervention (Control Group)

The control group received basic strengthening exercises targeting the quadriceps and hamstrings for 6 weeks. Participants performed

2 sets of each exercise, repeated 10–15 times, holding each repetition for 5 seconds with a 10-second rest between repetitions. The repetitions were progressively increased based on tolerance⁹.

Data analysis

For between group analysis, independent t-test was used. For all statistical tests, a p-value of ≤ 0.05 was taken as a significant difference.

Result

A total of 60 Hemophilia patients were included in the study who randomly divided by using chit method into experimental and control groups. Both the groups were evaluated for muscle strength of quadricep muscles and hamstrings and gait parameters.

Table.1.1. Demographic representation of data

Variable	Experimental group (Mean±SD) (n=30)	Control group (Mean±SD) (n=30)	p-value	t-value
Age (years)	28.56 ± 8.64	26.53± 9.82	0.39 ^{NS}	0.85
BMI (Kg/m ²)	23.19± 3.48	21.84± 2.67	.099 ^{NS}	1.67
Bleeding Rate	15.30± 9.77	14.36± 6.91	.671 ^{NS}	0.427

Table no.1.2 shows the distribution of patients in terms of type, severity of Haemophilia and site of bleeding in Both the groups.

Demographic	Groups	Type of Hemophilia	Frequency	Percentage
Types of Hemophilia	Group A	Hemophilia A	28	93.3%
		Hemophilia B	2	6.7%
	Group B	Hemophilia A	29	96.7%
		Hemophilia B	1	3.3%
Severity of Hemophilia	Group A	Mild	1	3.3%
		Moderate	3	10.0%
		Severe	26	86.7%
	Group B	Mild	1	3.3%
		Moderate	1	3.3%
		Severe	28	93.3%
Site of bleeding	Group A	Joints	30	100.0%
		Muscles	20	66.7%
	Group B	Joints	30	100.0%
		Muscles	22	73.3%

Table.1.3. Comparison of all variable between experimental and control group at baseline, 3 weeks and 6 weeks.

Variable	Assessment day	Experimental group	Control group	t=value	p=value
		Mean $\pm$ SD (n=30)	Mean $\pm$ SD (n=30)		
Step length (Lt.) (Cm.)	baseline	48.18 $\pm$ 7.82	48.98 $\pm$ 5.95	-.445	0.658 ^{NS}
	3 weeks	54.60 $\pm$ 7.45	51.04 $\pm$ 5.81	2.063	0.044 *
	6 weeks	58.73 $\pm$ 7.32	52.9 $\pm$ 6.23	3.282	0.002**
Step length (Rt.) (Cm.)	baseline	50.30 $\pm$ 7.56	49.35 $\pm$ 6.82	0.511	0.611 ^{NS}
	3 weeks	56.20 $\pm$ 6.61	51.78 $\pm$ 6.81	2.549	.013*
	6 weeks	60.14 $\pm$ 6.31	53.40 $\pm$ 7.11	3.883	0.000**
Stride length (Lt.) (Cm.)	baseline	100.44 $\pm$ 16.09	98.41 $\pm$ 14.60	0.511	0.611 ^{NS}
	3 weeks	108.05 $\pm$ 16.37	100.31 $\pm$ 14.67	1.928	0.05 **
	6 weeks	111.23 $\pm$ 16.02	101.93 $\pm$ 14.74	2.338	0.023**
Stride length (Rt.) (Cm.)	baseline	100.49 $\pm$ 15.12	98.33 $\pm$ 14.7 8	0.558	0.579 ^{NS}
	3 weeks	108.22 $\pm$ 15.50	100.44 $\pm$ 14.69	1.995	0.05*
	6 weeks	111.33 $\pm$ 15.40	101.97 $\pm$ 14.75	2.402	0.02**
toe out angle (Lt.) (Degree)	baseline	13.50 $\pm$ 2.68	12.86 $\pm$ 0.93	1.219	0.228 ^{NS}
	3 weeks	10.56 $\pm$ 1.30	11.93 $\pm$ 0.90	-4.731	0.01 *
	6 weeks	10.33 $\pm$ 1.15	11.40 $\pm$ 0.77	-4.209	0.001**
Toe out angle (Rt.) (Degree)	baseline	13.93 $\pm$ 3.55	13.10 $\pm$ 1.44	1.190	0.239 ^{NS}
	3 weeks	11.16 $\pm$ 2.42	12.13 $\pm$ 1.30	-1.930	0.05*
	6 weeks	10.06 $\pm$ 2.03	11.56 $\pm$ 1.07	-3.574	0.001**

*The mean difference was significant when value of p was ≤ 0.05 and ** highly significant when value of p was ≤ 0.01 . NS- Not Significant

Discussion

The present study demonstrated that progressive resistance training using TheraBand's led to significant improvements in gait parameters—specifically step length, stride length, and toe-out angle—in individuals with moderate to severe haemophilia. These findings were evident in both within-group and between-group analyses, with the experimental group showing greater improvements than the control group over the six-week intervention period.

Step length and stride length significantly improved in the experimental group, with left and right step lengths increasing by 21% and 19%, respectively, and stride length by 10% bilaterally. In comparison, the control group showed only an 8% increase in step length and a modest 3% increase in stride length. These improvements can be attributed to enhanced muscle strength and neuromuscular control resulting from the resistance training. Stronger lower limb muscles contribute to more forceful and coordinated movements, enabling individuals to take longer, more stable steps and strides¹⁰⁻¹¹.

Toe-out angle also showed significant enhancement in the experimental group—by 23% on the left and 28% on the right side—compared to an 11% bilateral improvement in the control group. An optimal toe-out angle plays a critical role in balance, weight distribution, and shock absorption during walking¹². The

improvements observed may be due to better muscle control around the hip, knee, and ankle joints, which resistance training is known to promote. Strengthening these muscle groups enhances joint alignment, proprioception, and movement precision, which are essential for efficient gait patterns¹³.

Furthermore, the between-group analysis confirmed that while there were no significant baseline differences in any gait parameters, the experimental group demonstrated statistically superior improvements at both 3 and 6 weeks ($p < 0.05$), supporting the effectiveness of the intervention. These results align with previous literature suggesting that progressive resistance exercises improve motor function, gait coordination, and joint stability in populations with chronic musculoskeletal conditions, including haemophilia¹⁴.

Overall, the findings suggest that incorporating a structured TheraBand-based strengthening program into physiotherapy management for individuals with haemophilia can significantly enhance gait performance, reduce compensatory movements, and improve functional mobility.

Conclusion

This study concluded that resistance training exercises yield superior outcomes compared to conventional therapy in improving gait parameters among individuals with Haemophilia. These

findings highlight the potential benefits of incorporating resistance training into rehabilitation programs for Haemophilia patients. Therefore, emphasizing resistance training exercises plays a crucial role in enhancing functional abilities and gait performance in this population.

Limitations and Future Scope

This study was limited by a small sample size, short intervention duration of six weeks, and lack of follow-up, which restricts the generalizability and understanding of long-term effects. Future studies should include larger, more diverse samples across genders and age groups, and assess long-term outcomes. Comparative studies between different resistance training methods (e.g., elastic bands vs. free weights) are also recommended. Additionally, future research should explore the impact of resistance training on quality of life, mental health, and social participation, as well as its combined effect with other therapies for enhanced functional outcomes.

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