A Pilot Study on The Effect of Proprioceptive Neuromuscular Facilitation on Gait

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Abstract

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Background and purpose. PNF has been used for a long time, for improving gait in patients with different disabilities, but the effect on gait has not been sufficiently proven. This study was done to find out how PNF affects gait in healthy subjects (1), and if this effect was greater when performed by an advanced instructor compared to a student (2). **Subjects**. To get this result we tested the stride length of 12 healthy male subjects between 20-25 years of age. **Method**. The subjects were tested by measuring their mean stride length over 3 x 20 meters, before and after intervention. Intervention was applied 1 x 20 minutes on each subject, 6 of these subjects received the intervention from an advanced instructor and 6 subjects from a student. **Results and conclusion**. The means were used to (1) compare differences in stride length before and after intervention in each group, and (2) compare results between the two groups. Neither showed significant differences (p>0,05), but (1) showed a tendency towards increased stride length in both groups independently. The methods used are sufficient for data collection, but bigger population and time span are necessary for significant findings.

This research was carried out for a bachelor project as part of a physiotherapy education at Saxion University of Applied Sciences. The external client is the International Proprioceptive Neuromuscular Facilitation Association (IPNFA)

Introduction

In the early 1940's Dr. Herman Kabat developed Proprioceptive Facilitation which is the start of what we today know as Proprioceptive Neuromuscular Facilitation (PNF).

By definition *Proprioceptive* means having to do with any of the sensory receptors that give information concerning movement and positioning of the body. *Neuromuscular* means that it involves nerves and muscles. *Facilitation* is to make it easier.[1]

Dr. Kabat was educated neurophysiologist and physician which made his conceptual framework for PNF. The word neuromuscular was added in 1954 by Dorothy Voss. Sister Elizabeth Kenney, who worked as a nurse in Australia, treated polio patients with specific stretching and strengthening activities, was at early influence on Kabat.

Dr Kabat integrated the work of Sister Kenny with Sir Charles Scott Sherrington´s discovery of successive induction, reciprocal innervations and inhibition and the phenomenon of irradiation. Together with the wealthy industrialist they established the Kaiser-Kabat Institute in Washington, DC. In the mid to late 1940´s Kabat started to search for a physiotherapist to work together with him. Maggie Knott, Dorothy Voss and Dr. Kabat together published books, educated other physiotherapists and continued to develop and refine the foundational concepts of PNF.[2]

PNF is an integrated approach where each session of treatment is aimed at a total human being, not just a specific problem or body segment. The focus should be on what the patient can do both on psychological and physiological levels with the primary goal of helping the patients to achieve their highest

level of function. These are seen as important principles that are basic to PNF.[1]

According to the IPNFA, little research is done on the effect of PNF on gait, and it is therefore a request that the influence of a PNF intervention on gait is being investigated. This study investigates if PNF has an effect on stride length in healthy subjects, and if so, is there a difference in results when the PNF is performed by a advanced instructor or by a trainee (student). The objective of this study is:

«Is there a difference in stride length of healthy people walking in comfortable pace after a PNF intervention executed by an expert instructor or a trainee?»

The investigated hypotheses in this case are – "stride length before and after intervention is equal" (1), and "there is no difference in stride length after intervention by an advanced instructor compared to a trainee" (2) –.

Population

The test subjects (t-s) were 12 healthy, young men, recruited from the 1st and 2nd year international physiotherapy classes of Saxion University of Applied Sciences. The t-s were all in the age group 20-25. To exclude any bias in the results, general good health and no current complaints of legs and back were criterions to participate. An additional criterion was that they had not received PNF treatment before. All t-s agreed that the data collected would be used in a bachelor study.

Intervention

The t-s was divided into two groups, which consisted of 6 persons in each group. In this article, group one refers to the advanced instructor, and group two refers to the trainee. The t-s was divided into their respective groups based on height and weight to get the groups as similar as possible. (*see. Table 1*) They where instructed to avoid heavy exercise, on the legs, two days in advance of the testing.

Table 1 (t-s) Descriptive Statistics

	N	Range	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
AGE gr.1	6	3.00	20.00	23.00	21.0000	.44721	1.09545
AGE gr.2	6	4.00	21.00	25.00	22.5000	.67082	1.64317
HEIGHT gr.1	6	20.00	174.00	194.00	184.6667	3.33333	8.16497
HEIGHT gr.2	6	25.00	175.00	200.00	185.6667	3.63012	8.89194
WEIGHT gr.1	6	27.00	67.00	94.00	80.8333	4.45284	10.90718
WEIGHT gr.2	6	43.00	74.00	117.00	86.1667	6.78929	16.63029

Method

This controlled trial was a pilot study, where the main focus was to test the feasibility of the methods used here for further research.

The target group was mainly members of IPNFA. It is a pilot study which can be used to determine if there is any use in doing more extensive research on the area, and if so, the pilot may indicate points of improvement for any further research.

Both groups received the same intervention, PNF treatment, for approximately 20 minutes in total. Every t-s was scheduled for 30 minutes, which included pre-test, intervention and post-test. Two different performers performed the PNF treatment, one for each group. One of the performers is skilled at the intervention after taking several courses and having many years of clinical experience (advanced instructor, F.S,), while the other performer has just been trough a few sessions of instructions on the intervention and

therefore has little knowledge and experience in the field (trainee).

The intervention was separated into two parts. Both interventions are based upon the idea or goal to facilitate a natural gait pattern. Intervention was given with the t-s lying supine on a bench with a PNF technique called dynamic reversal lasting for 5-10 minutes. During this intervention the patient is given resistance in diagonal flexion pattern and diagonal extension pattern. The flexion pattern consists of hip flexion/adduction/lateral rotation, knee flexion and ankle dorsal flexion. The extension pattern consists of hip extension/abduction/medial rotation, knee extension and ankle plantar flexion. The agonist/antagonist muscles contracts concentrically in reversal without relaxation in between. In practice the wanted effect of dynamic reversals is to increase active range of motion, strength, develop better coordination, prevent fatigue, and increase endurance of muscles.[1]

The second intervention was given in a more functional way. During gait the pelvis is facilitated through approximation and resistance while the t-s were walking forward. The approximation was given in a downward direction on the stance leg at heel strike. Resistance was given constantly throughout the movements. This combination stimulates the erected posture and a reflex reaction, promotes weight acceptance, and facilitates and strengthens extensor musculature.[1] The intervention was given during a total of 200m (10x20m) walking.

Data collection

Testing was done before and after application of PNF treatment; three pre-tests and three post-tests for each t-s, from which average pre- and post-intervention stride length was calculated. The t-s were asked to walk 20 meters in their comfortable walking pace. Before and after the 20-meter mark there were lines at a 5-centimeter interval. The test was finished when the first heel crossed the 20-meter line and struck the ground. Stride length was calculated from this exact distance.

Three fixed cameras were used to observe the t-s during the whole sequence. One camera observed the t-s from in front and another observed the t-s from behind. The third camera was fixed at the 20 m finish line so the measurement of the last step was clearly visible and accurate.

A stopwatch was used to document gait velocity.

Data analysis

The collected data was statistically analyzed to decide how likely it was that the results

Table 2 (Testing) Descriptive Statistics

	N	Range	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Mean Steps pre	12	7.33	25.00	32.33	28.4722	.62423	2.16239
Mean Steps post	12	9.00	24.00	33.00	27.6389	.68098	2.35899
Pre-test	12	.3602	1.2691	1.6293	1.437646	.0313104	.1084623
Post-test	12	.4736	1.2339	1.7075	1.483505	.0368327	.1275923
Results	12	.1592	-.0352	.1240	.045858	.0158525	.0549146
Pre-test Gr.1 mean	6	.3144	1.2691	1.5835	1.394124	.0424885	.1040752
Post-test Gr.1 mean	6	.4736	1.2339	1.7075	1.445549	.0641866	.1572245
Results Gr.1	6	.1592	-.0352	.1240	.051425	.0267705	.0655740
Pre-test Gr.2 mean	6	.3181	1.3113	1.6293	1.481168	.0418397	.1024859
Post-test Gr.2 mean	6	.2375	1.4224	1.6600	1.521460	.0356804	.0873987
Results Gr.2	6	.1146	-.0035	.1112	.040292	.0194081	.0475399

match the null hypotheses. A p-value (probability value) is used to decide whether there is enough evidence to reject the null hypothesis, or say the research hypothesis is supported by the data. If the p-value is less than 0.05 ($p<0.05$), the results are considered significant, and the null hypotheses can be rejected.[3] The statistical inference of this analysis provides insight in wether the pilot should, and if so – how it should, be investigated further in a more extensive study.

The statistical tool used to calculate the test-results was the software SPSS statistics Version 16.0.[4]

Results

All twelve t-s were tested three times both before and after the intervention was applied. (*See Table 2*) The stride length of each t-s was calculated from these results, and the means from all pre- and post-intervention tests were again calculated to take away any learning moment bias. To exclude learning moment, the validity of the pre-tests had to be checked, and the data from pre-test one and pre-test three were analyzed in a t-test. No significant difference between test one and test three rules out the presence of a learning moment ($p>0.05$). This confirmed that the means were valid and could be used for further analysis.

Mean values from pre-tests and post-tests were then compared to show the influence of intervention on both groups. Group one, the advanced instructor group, showed a mean increase in stride length of 0,0514 m/pr stride (+3.7%), while group two, the trainee group, showed an increase of 0,0403 m/pr stride (+2.7%). (*See Table 3)*

No significant difference were found in stride length in either of the groups after intervention ($p>0.05$), but they both show a tendency towards an increase.

When comparing the mean result of both groups in an independent t-test to investigate the difference of intervention effect between the advanced instructor and the trainee, no significant difference were found ($p>0.05$). (*See Table 4)*

Discussion

The objective of this study was to find out if there is any difference in stride length on healthy subjects walking in a comfortable pace after a PNF intervention, and to see if it makes a bigger difference performed by an advanced instructor or a trainee. In methods, it was mentioned that a stopwatch was used as a measurement tool for velocity; this showed to be unreliable, thus it could not be used in the statistics.Without putting further emphasis on analyzing the time data, they subjectively showed an indication of increase in gait velocity. Electronic time measurement devices fixed at start and finish, similar to those used in sports, should be used for an accurate measurement in further research.

Whether the increased speed made the stride length longer or the increased stride

Table 3 (Pre-test VS Post-test) Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Pre-test Gr.1mean - Post-test Gr1mean	-.0514249	.0655740	.0267705	-.1202406	.0173908	-1.921	5	.113
Pair 2	Pre-test Gr.2 mean - Post-test Gr.2 mean	-.0402920	.0475399	.0194081	-.0901821	.0095980	-2.076	5	.093

Table 4 (Advanced instructor VS Trainee results) Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Results	Equal variances assumed	.805	.391	.337	10	.743	.0111329	.0330656
	Equal variances not assumed			.337	9.118	.744	.0111329	.0330656

length had an impact on the speed is unclear. This is something that should be looked more into if doing similar studies in the future.

The session treatment duration was set to approximately 20 minutes per t-s, but the time used varied from each t-s depending on the individuals condition. The caregivers gave an estimation of 5 minutes on each leg during the bench treatment and the time it took to perform the walk treatment varied as each t-s walked 10 x 20 m with facilitation. When the t-s were treated it was more important that the quality of the treatment was there, rather then continuing the treatment if they were exhausted. One session of intervention, and an individually adapted treatment based on a subjective perception of exhaustion, return non measurable variables that might influence the result.

The intervention and testing was performed once. In a larger study, the outcomes of testing and intervention might be very different from this pilot. Both groups showed a tendency towards increased stride length after intervention, but from such a small population (n=12), no conclusion can be drawn. For more reliable results, further studies with a larger population are indicated.

The small research population gives a less generalized result compared to a larger research population. The bigger the population group the more generalized the result is, and this will automatically give more significant data. In a smaller group, like the one in this project, the results from group one and two are not significant when compared, even though the results differ with 1,2 cm per stride.

A study executed by Wang (1994) investigates both the immediate effects (after one session) of PNF treatment, and the cumulative effects (after 12 sessions) in patients with hemiplegia of long and short duration. The data from that study shows that, in both groups, the cumulative effect was larger than the immediate effect.[5]

In this pilot study, only the immediate effect is tested. The result from the testing indicates that there is no significant difference ($p>0.05$) between an advanced instructor and a trainee performing the intervention. The study by Wang indicates that the cumulative effect, in contrast to the immediate effect, provides more reliable insight to the total effect of PNF as an intervention. The experience and ability to adapt and regulate the intervention to the patients and their progress in time will most likely benefit the advanced instructor group. Several sessions will presumably show higher significance levels in comparing the effect of intervention performed by an advanced instructor and a trainee. To support these statements, further research is indicated.

Conclusion

In this pilot, both null hypotheses are not rejected. Stride length before and after intervention is not significantly different, and there is no significant difference in stride length after intervention by an advanced instructor compared to a trainee. Further research needs to be done to conclude that our findings is valid in a larger population, and with a greater time span.

It is feasible to execute this study in a larger scale; the methods used, with certain adaptations as mentioned in the discussion, proved sufficient for data collection.

Acknowledgements

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