The immediate effects of agonist vs. antagonist PNF stretching in hamstring extensibility measured by sit-and-reach test

Randomized Controlled Trial

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Abstract

Background: Proprioceptive neuromuscular facilitation (PNF) is a stretching technique known to be the most effective method for increasing range of motion. There are different techniques within PNF whose mechanism of response has traditionally been attributed to autogenic and/or reciprocal inhibition. The purpose of this study was to compare the immediate effects of PNF target muscle (TM) versus opposing muscle (OM) in hamstring extensibility.

Methods: Ninety-seven healthy college students completed the study. Participants were randomly placed in either PNF-TM or PNF-OM group and were tested pre-intervention and post-intervention by the sit-and-reach test.

Results: Statistical analysis revealed that first: there was not a significant difference (p = 0.364) in the sit and reach test between groups; and second: there was a significant difference between post and pre intervention within the groups with p = 0.000 for PNF-TM group and p = 0.000 for PNF-OM.

Conclusion: These results suggest that PNF-OM is as effective and valuable as PNF-TM.

Keywords

PNF stretching, hamstring extensibility, flexibility, sit-and-reach test

Introduction

Stretching is practiced everywhere in the world, especially when it comes to the field of sports (Shehab et al. 2006). Wilkinson (1992) describes four common basic stretching techniques. These are:

- Ballistic stretch (BS) for which momentum is used to place a muscle

on stretch, and which may involve bouncing at the end of range

- Static stretch (SS): Slow speed, passive movement to place a muscle on stretch
- Contract relax (CR): Passive movement to the onset of muscle stretch and maximal voluntary contraction performed against resistance (usually manually) before passively moving further into range. This technique will be referred to as Proprioceptive Neuromuscular Facilitation target muscle (PNF TM) by the authors.
- Reciprocal relaxation (RR): the agonist produces the stretching force on the opposite muscle (antagonist). A passive force may or may not be used to assist the agonist. This type of stretch is usually termed agonist-contract relax in the North American literature. This technique will be referred to as PNF opposing muscle (PNF OM) by the authors.

However, confusion as to which stretches to perform to optimize performance and treatment still remains. There have been long-lasting discussions about the efficacy of stretching with expert opinion changing approximately every five years (Sady et al. 1982). While there is no common consensus yet whether stretching can prevent injuries (Thacker et al. 2004) it is commonly agreed upon that stretching is a known and practiced way to improve flexibility and thus range of motion (Decoster et al. 2005).

Literature shows that PNF, static, and ballistic stretching are all effective at enhancing the range of motion in a certain joint (Magnusson et al. 1998,Hardy et al.1986, Wallin et al. 1985, Lucas et al. 1984) with PNF stretching proven to be superior to other stretching methods in the research of Funk et al. (2003) and Ferber et al. (2002). Another, contemporary randomized controlled trial from (Wicke et al. 2014) could confirm that PNF was more effective than static stretching.

PNF stretching techniques are commonly used to improve active as well as passive range of motion (ROM) to optimize motor performance and rehabilitation (Sharman et al. 2006). The literature describes different PNF techniques, with the agonist or target muscle (TM) as well as the antagonist or opposing muscle (OM) being stretched to improve range of motion (McAtee et al. 1999). While there is evidence from Etnyre et al. (1986) and Osternig et al. (1990) that PNF opposing muscle (PNF OM) technique added to the PNF stretching regime can lead to greater gains in active range of motion, there has been little investigation into the benefits of PNF OM technique in isolation. We would like to know which PNF technique is the most beneficial in order to give a recommendation as to which technique should be applied by physiotherapists in practice. The outcome of our research is especially useful considering the limited treatment time a physiotherapist can dedicate to each patient.

Therefore, the research question of this RCT is to answer following question:

What is the difference in reach distance in the sit-and-reach test (SRT) for people who receive PNF TM vs. PNF OM immediately after the respective stretching intervention?

We will test the following hypotheses:

H0 – There is no difference of reach distances between the PNF TM and PNF OM group. H1 – There is a difference of reach distances between the PNF TM and PNF OM group

Methods

Study Design

A Randomized Controlled Trial with two groups, PNF TM, as the "control" group and PNF OM, as the "intervention" group was conducted after the approval and in accordance to the Project Plan submitted on the 3rd of October 2015. A blocked randomization in blocks of two was performed to guarantee an equal number of people in each group. To minimize bias, group assignment was done at the time of the enrollment using two closed envelopes.

To avoid expectation bias, the researcher in charge of measuring the outcomes was blinded, by been not present during the intervention and not knowing to which group the patient was assigned. Blinding was also ensured through the permissions settings of the different data sheets (see Appendix).

Population

In order to increase the external validity of the study the target population was healthy young adults. A sample of 100 people was recruited from volunteering Dutch and International students from the Physiotherapy and Occupational Therapy Programs at the Hogeschool van Amsterdam, Netherlands.

The subjects were selected based on the following inclusion and exclusion criteria:

Inclusion criteria:
- Age 17 - 40
- Generally healthy, as in WHO's definition of health: Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity (WHO, 1948). This Definition was completed by the exclusion criteria.

Exclusion criteria:
- Subjects with muscle injury of the lower limbs, fractures, inflammatory or infectious diseases
- Low back pain; any previous accident or surgery of the low back region
- Neurological/vascular disorders
- Workout before the experimental trial
- Not being able to bend over more than 60 degrees

All subjects who volunteered to participate received and signed an informed consent regarding the procedures of the study and as well were made aware of the inclusion and exclusion criteria for participation (see Appendix). The subjects were informed not to wear tight pants on the day of the intervention. Shorts and a changing room were provided to those who forgot to dress accordingly.

Intervention

The PNF-TM group received stretching consisting of a passive placement of the target muscle (in this case the hamstrings) into a

position of stretch, followed by a static contraction of the target muscle held for approximately three seconds at no more than 20% of a maximum voluntary contraction. Both duration and intensity were recommended by Sharman et al. (2011) to avoid injury and increase time efficiency. This procedure was performed first in the right leg and then in left one.

The PNF-OM group received a stretching bout, consisting of a passive placement of the target muscle (in this case the hamstrings) into a position of stretch, followed by a static contraction of the opposing muscle (in this case the rectus femoris and iliopsoas) held for approximately three seconds at no more than 20% of a maximum voluntary contraction. Due to the lack of evidence in literature, the same duration and intensity for both stretching techniques was implemented to allow comparison of both groups.

A Standard Operative Procedure (SOP) was created for each intervention describing the procedure in more detail (see Appendix).

Measurements

Both groups received a pre- and post-test measurement plus initial anthropometric measurements.

  Primary Outcome:
In order to measure hamstrings extensibility three attempts of the SRT were recorded both pre- and post-intervention with the average distance noted in centimeters (cm) to the nearest 0.5 cm. The SRT has shown to have a high intra-class correlation coefficient, ICC:

0.95 (21). In a meta-analysis conducted by Mayoral-Vega et al. (2014) they concluded that the SRT had a moderate mean correlation coefficient of criterion-related (sex of participants, age of participants, and level of hamstring extensibility) validity for estimating hamstring extensibility (rp range = 0,16-0,35). The minimal clinically important difference (MCID) for the SRT is 4 cm (Lopez-Miñarro et al. 2010).

A standard SRT box devised of the following dimensions was used to perform the measurements: length of base 35cm, width 45cm, height 32cm and length 55cm will be used. A standard meter ruler is attached on top of the box, with the reading of 23 cm in line with the heel position. A metal slider, 90° in relation to the ruler is used to facilitate reading.

  Secondary Outcomes:
Anthropometric measurements age in years, gender male or female, height in centimeters, weight in kilograms and BMI were recorded in order to analyze any influence in gains in the hamstrings extensibility measured by the SR test.

Procedure

Participants were first seen by researcher #1 to fill out a consent form and have baseline measurements taken including height, weight, age, and gender (see Appendix). Followed by their group allocation as described above.

Picture 1: Researcher measuring height.

Researcher #2 collected measurements of reach distance via the SRT from each participant before (T0) and after each intervention (T1). The participant was allowed one practice attempt after which they were asked to perform the SRT three times. Their score was recorded each time and the average of the three attempts was calculated.

Picture 2: Researcher measuring SRT

Once this step was completed, participants went to the interventions room, where researcher #3 and #4 were waiting.

Both researchers performed both interventions according to the SOP independent of which

Picture 3: Researcher performing PNF OM

group the participant had been assigned to. Researcher #3 and #4 performed interventions separately from each other and therefore did not see the other. Furthermore, the researchers #3 and #4 were blind to the measurements recorded pre- or post-intervention.

Picture 4: Researcher performing PNF TM

After the intervention, participants were directed back to researcher #2, who then recorded their post intervention reach distance via the SRT. Again, the participant was asked to perform the SRT three times, this time without a practice attempt. The final outcome was the average taken of all three attempts. During the trials, if a participant performed the SRT incorrectly during any attempt that was not their practice attempt, their previous score

or their following score that was acceptable was inserted into the spreadsheet.

If a participant reached beyond the SRT box, the highest score on the box (50 cm) was recorded.

Data collection

The data was collected directly into Google spreadsheets organized by our group during the month of November 2015. To save time and to eliminate errors in our data, the entry processes were separate. Data validation was set up so that the computer rejected implausible values entered into the data sheet. This was done by range-checks, skip-logic, questions must be answered, and consistency checks. To analyze the data we used IBM[®] SPSS[®] version 23.0. After we performed our trial the Google spreadsheets were downloaded into a Microsoft[®] Excel format.

Statistical Analysis

From the Microsoft[®] Excel format the data was converted to an SPSS[®] data sheet. In SPSS[®], we checked for any missing data or abnormalities.

All of the data collected was continuous data except for the variable of gender and group, which were dichotomous. With the data we also created six new variables. Four of these were continuous: SRT pre-intervention (SRTpre); SRT post-intervention (SRTpost), Body Mass Index (BMI); and Change. The final two: BMIcategory and Heightsplit were created as categorical and dichotomous variables respectively.

SRTpre comprised of the average of the first three SRT measurements taken before the intervention was given. SRTpost comprised the average of the three SRT measurements taken after the intervention was given. Subtracting the values of SRTpre from the SRTpost values for each person created the improvement variable, representing the average difference between measurements. BMI was calculated from the formula ($BMI = weight (kg)/height(m)^2$). We further split the BMI variable into a new variable called BMIcategory, placing each person into a category ranging from 1 (underweight), 2 (normal), 3 (obese) to 4 (obese), based on their body mass index classification (WHO, 2006).

Heightsplit was split into two categories of tall and short people. A person with a 1 in the heightsplit group was in the shorter half of the group and a person with a 2 was in the taller half of the group.

To determine if there was a difference in SRT within a group from their SRTpre to their SRTpost, we used a *paired samples t-test*.To determine if there was a difference in SRT between the groups post intervention, we used an *independent samples t-test*.

We will use a *p* value of <0.05 to reject our null hypotheses.

Results

Upon review, the data of three participants was excluded. One participant was excluded because their age was outside of our inclusion/exclusion criteria and this was not noticed until after the test was done. One participant revealed that they had a burn on

their leg only at the time of intervention and was therefore unable to participate in the treatment. And the last participant was excluded after baseline information was collected because they could not reach the SRT box and therefore their data was not recordable.

Normality of data

Before hypothesis testing, our first step was to check for normality of all the baseline characteristics and the SRTpost scores split for each intervention group. For the continuous data we checked if the mean and median were similar, we eyeballed the histograms and box-plots, and finally we looked at the value of the Shapiro-Wilk statistic. For the variable of gender we checked frequencies. Baseline characteristics can be found in Table 1. and

normality reports can be found in Table 2.

Once normality was known, we compared means for each variable to compare baseline characteristics between the TM and OM groups. If the variables were normally distributed, we used independent samples t-tests and if the variables were not normally distributed, we used a Mann-Whitney U test. The p values are reported and can be found in Table 2. As expected, there was no significant difference in the baseline characteristics of our two groups.

Comparison within groups

We found that there was a significant difference in the outcomes SRTpre vs.

Table 1. Baseline Characteristics

	Group 1 (n = 48)	Group 2 (n = 49)	*P* value
Intervention	PNF TM	PNF OM	
Age	22.92 ± 4.39	23.65 ± 4.45	0.385
Gender	Male = 20 (41.7%) Female = 28 (58.3%)	Male = 18 (36.7%) Female = 31 (63.3%)	0.619
Height	171.45 ± 9.04	171.09 ± 10.25	0.856
Weight	68.30 ± 9.98	68.86 ± 11.83	0.544
SRTpre	29.98 ± (9.62)	28.14 ± (10.76)	0.378

Table 2. Normality Analysis

	Height		*Weight*		*Age*		*Gender*		*SRTpre*	
Group	1	2	1	2	1	2	1	2	1	2
Mean	171.45	171.09	68.30	68.86	22.92	23.65	n/a	n/a	29.98	28.14
Median	170.50	173.00	66.00	69.00	22.00	23.00			32.08	28.67
Shapiro-Wilk	0.284	0.141	0.001*	0.683	0.002*	0.011*	n/a	n/a	0.087	0.123
Levene's Test	0.177		n/a		n/a		n/a		0.393	
Independent samples *t*-test	0.856		n/a		n/a		n/a		0.378	
Mann-Whitney *U*-test	n/a		0.544		0.385		n/a		n/a	

*Non-parametric

SRTpost ($t(47)$ = -6.717, p= 0.000). Next, we compared the means within the group OM. We found that there was a significant difference in SRTpre vs. SRTpost ($t(48)$ =-5.905 p = 0.000).

The p values are reported and can be found in Table 3. Therefore, both the interventions, PNF TM and PNF OM, were successful at providing a difference in SRT measurements.

Comparison between groups

We compared the means of the SRTpost between group TM and group OM. We found there was no significant difference in the outcome SRTpost between the intervention groups TM and OM ($t(95)$ =0.915, p = 0.364). Therefore, neither PNF TM nor the PNF OM techniques provided a better outcome over the other.

Table 3. *Results*

	SRTpre (Baseline)	SRTpost (Post intervention)	*P value*
Group 1 (PNF TM)	29.98 ± (9.62)	31.51 ± (10.03)	0.000
Group 2 (PNF OM)	28.14 ± (10.76)	29.55 ± (11.13)	0.000
P value	0.378	0.364	

Anthropometric analysis

Once our main question was answered, further analysis was carried out to determine if height, BMI, or gender had any influence on the improvement experienced in the SRT. Normality was checked for the new variables

of: BMI, BMIcategory, improvement and heightsplit. Results can be found in Table 4.

To compare *improvement* of female vs. male, we used the variable *gender*. A Mann-Whitney *U*-test was used and we found *p*=0.073. Therefore, there was no significant difference in the improvement of the SRT between the male and female gender.

To compare *improvement* in the *heightsplit* variable a Mann-Whitney *U*-test was used. When comparing the improvement in short vs. tall people, we found *p*=0.156. Therefore, there was no significant difference between improvements on the SRT of shorter participants vs. taller participants.

To compare *improvement* in the variable *BMIcategory*, we used a Mann-Whitney *U*-test. In this analysis we only used category 1 (normal) and 2 (overweight) since there was only one person in each of the other two categories (underweight and obese). When we compared the improvement of these two groups, we found *p=0.734*. Therefore, there is no significant difference in the improvement on the SRT of participants who had a normal weight vs. participants who were overweight.

Power Analysis & Sample Size

After the trial, a power analysis and sample size calculation was performed. We based the analysis on a p-value of 0.05 and an MCID of 4cm.

Assuming a p-level of 0.05, a sample size of 46 and 57 for the groups PNF TM and OM

Table 4. *Anthropometric Measures & SRTpost: Statistical Analysis*

	Height	Improvement		BMI	Improvement		Gender	Improvement		SRTpost	
Group	**All**	**Short**	**Tall**	**All**	**Normal**	**Overweight**	**Male (n=38) Female (n=59) Total = 97**	**Male**	**Female**	**1**	**2**
Mean **Median**	171.27 171.00	1.56 1.5	1.38 0.833	23.32 22.80	1.46 1.17	1.46 1.17	n/a	1.29 0.83	1.59 1.5	31.51 34.25	29.55 29.00
Shapiro-Wilk	n/a	0.502	0.001*	0.000*	0.004*	0.594	n/a	0.003*	0.593	0.064	0.063
Levene's Test	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.356	n/a
Mann-Whitney *U* Test	n/a	0.156	n/a	n/a	0.734	n/a	n/a	0.073	n/a	n/a	n/a

respectively would have been necessary to provide a power 0.80

With our sample size of 48, the power for the PNF TM group was 0.82.

With our sample size of 49, the power for the PNF OM group was 0.74.

Discussion

Our trial shows that just three bouts of PNF TM or PNF OM stretching is sufficient to significantly increase hamstring extensibility though as mentioned before, PNF OM techniques in isolation have been neglected in the research (Lucas et al, 1984).

Seeing that both of the techniques in our research led to improvements, one has to ask what are the mechanisms allowing for change in muscle length to occur.

The literature describes two mechanisms that directly or indirectly influence a muscle's ability to elongate upon stretch: Autogenic inhibition and reciprocal inhibition (Sharman et al, 2006).

The theory behind the mechanism for TM elongation is autogenic inhibition. It describes a reduction of excitability in the muscle to be stretched through afferent inhibitory signals from the Golgi tendon organs to the efferent motor neuron. The resulting inhibition facilitates the stretch of the TM.

Reciprocal inhibition on the other hand follows a different pathway. If a voluntary contraction of the OM is induced, the descending commands to the OM motor neuron can excite inhibitory interneurons at the TM resulting in its relaxation and consequent increased affinity to stretch.

From a physiological standpoint there is support for both PNF techniques to have an effect on increasing muscle length.

Although our statistical analyses of SRTpre and SRTpost for the TM and OM groups show a significant difference, the difference is below the suggested MCID of 4cm (Lopez-Miñarro et al. 2010). This could be due to the characteristics of our intervention as we only applied one set of three stretching bouts. Perhaps, if the intervention goal had been to induce structural change (i.e. more stretching

sets or multiple treatments over a longer period of time) this change could have been achieved. Some authors criticize the SRT's ability to measure hamstring extensibility in isolation since movement of the lumbar spine and hip joint ROM might play a role, while others vote in favor for it (Baltaci et al, 2002. Yuktasir et al, 2009). Cost-effectiveness and easy applicability of the SRT were reasons why it was chosen for our study.

Strengths

As we created SOPs for the interventions we could ensure that the interventions were performed to a set standard.

The randomization process ensured as little bias as possible during the trial of both the researchers and participating volunteers.

The relatively big sample size more accurately describes the population we wanted to study and therefore increases the power of our study.

There have not been many studies investigating our exact research question in the field of stretching, which underlines the value of our study.

Limitations

Furthermore, two researchers performed the interventions, which could have influenced the post-intervention measurements, as the resistance each researcher applied is hard to quantify even with a SOP.
Additionally, we could not control if participants followed our recommendation not to workout

hard before the trial. Resulting DOMS could alter the muscles response to stretch.
Lastly, our trial only assesses the hamstrings of healthy individuals. Further studies should examine if our findings can be confirmed with other muscles and different populations.

Conclusion

To our knowledge, this is the first study comparing PNF OM and PNF TM.
From our findings we can conclude that PNF OM is a valuable and equally effective stretching method to PNF TM, which can be added to physiotherapists' repertoire. However, further studies should validate these findings and carefully describe in detail how PNF was administered, which was a shortcoming in previous trials.

Acknowledgement

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Appendix

Informed Consent

I hereby declare to have been informed about the specifics of this research and agree:

- That I willingly agreed to take part in this research project within the EBP3 course conducted by the students of the European School of Physiotherapy
- That I understood that my participation is entirely voluntary and that I have the right to opt out at any given moment without any consequences
- That I know that all the data recorded, as well as my personal information will be used in the analysis but stays anonymous throughout the trial
- That I will receive a physical intervention and the students conducting the project are not responsible for any possible injuries that may occur during the trial

I agree on participating in this research project.

Date: _____ / _____ / _____

Participant's Name: _____

Participant's Signature: _____

_____

Date: _____ / _____ / _____

Researcher's name: _____

Signature: _____

Standard Operating Procedure (SOP) for anthropometric measurements:

Age & Gender – Will be collected via questionnaire

Height – Participants will be instructed to remove hats and shoes. The tape measure will be taped to the wall with the 0cm end at the level of the floor. Participants will be asked to stand against the wall in front of the tape measure with heels and back against the wall. Participant will be asked to stand as tall as possible with weight distributed equally through both legs and shoulders relaxed. Researcher #1 will take the measurement of the participant by placing a hard flat board on top of the head and will the measurement to the nearest 0.5cm.

Weight – Participant will be instructed to take of shoes, hats, heavy jewelry or accessories, and to empty pockets. Participants will be instructed to step onto the scale. Participant will be asked to stand as tall as possible with weight distributed equally through both legs and shoulders relaxed. Researcher #1 will record the measure of the participant to the nearest 0.1kg.

Standard Operating Procedure (SOP) for SRT:

Subjects will take off their shoes and place both feet flat against the designated sit-and-reach box. The hips will be in a neutral position and fully adducted and.
Verbal instructions will be provided at the start of the SR test:

''Slowly reach forward towards your toes as far as possible while keeping your knees, arms, and fingers fully extended, keep your palms down and place one hand on top of the other and have your neck flexed comfortably. Hold this position (of maximal reach) for (approximately) 3 seconds.''

The greatest distance that the participant can push the metal slider while keeping both knees straight for the full three seconds, will be recorded in centimeters. This will be demonstrated by the final position of their fingertips on the ruler. The forward reach scores will be registered with an accuracy of up to 0.1 cm using the scale on the box.

If the knees bend at any point or the instructions are not executed properly, the participant will be asked to repeat the STR.

Standard operating Procedure Control-PNF TM group.
1. Purpose
This Standard Operating Procedure (SOP) describes the process for the Propioceptive Neuromuscular Facilitation for the Target Muscle (PNF TM) , in this case hamstrings, that wil be carry on during the clinical trial.
2. Scope
This SOP is a mandatory document and shall be implemented by all employees and contractors when engaging the PNF TM intervention in order to guarantee high reliability in the study.
3. Training
The team manager is responsible for ensuring that team members who follow this procedure understand the SOP's objectives and other inter-related activities. After the training team members must sign that they have read and understood this SOP before they are approved to execute the PNF TM.
4. Precautions
Team members are only approved to execute this SOP if the SOP trainer trains them. If during the intervention the patient suffers pain at any moment, the intervention will be suspended.
5. Responsibility
SOP (original) Author: Francisco Javier Alonso. SOP Trainer: Francisco Javier Alonso,
Team Leader:
Assessors:

6. Equipment

A mat for the patient to lay down over and a small pillow for patient´s head.

7. Procedure

1. The assesor explain the intervention to the patient: *"I am gonna perfom a PNF stretching in your hamstrings, you will be lying dow over your back, try to realx and do not move. I will grap your right leg and bending toward your chest without bending your knee untill you feel discomfort, Then i will ask you push against my hand toward the floor for 3 second at 20% of your maximal force. After this 3 seconds we are done. Then we will repeat the same proccess with the left leg"*

2. The Assesor asks to the patient take his/her shoes off and lay down over the back.

3. The assesor asks to the patient to relax *"Try to relax".* The assesor asks to the patient let him know when discomfort is felt *"Let me know when u feel discomfort".*

4. The patient indicates that it feels discomfort.

5. Inmediately after the assesor asks the patient to push against he is hand towards the floor: *"Now! Push!..1,2,3"*

6. Following the Assesor ask the patient to relax: *"Now relax, we are done"*

7. The procedure is repeated in the left leg.

8. The assessor work with the patient to the measurements room.

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Standard operating Procedure PNF OM group.

1. Purpose

This Standard Operating Procedure (SOP) describes the process for the Proprioceptive Neuromuscular Facilitation for the Target Muscle (PNF OM) , in this case rectus femoris and iliopsas, that will be carry on during the clinical trial.

2. Scope

This SOP is a mandatory document and shall be implemented by all employees and contractors when engaging the PNF OM intervention in order to guarantee high reliability in the study.

3. Training

The team manager is responsible for ensuring that team members who follow this procedure understand the SOP's objectives and other inter-related activities. After the training team members must sign that they have read and understood this SOP before they are approved to execute the PNF OM.

4. Precautions

Team members are only approved to execute this SOP if the SOP trainer trains them. If during the intervention the patient suffer pain at any moment, the intervention will be suspended.

5. Responsibility

SOP (original) Author: Francisco Javier Alonso. SOP Trainer: Francisco Javier Alonso,

Team Leader:

Assessors:

6. Equipment

A mat for the patient to lay down over and a small pillow for patient´s head.

7. Procedure

1. The assesor explain the intervention to the patient: *"I am gonna perfom a PNF stretching in your hamstrings, you will be lying dow over your back, try to realx and do not move. I will grap your right leg and bending toward your chest without bending your knee untill you feel discomfort, Then i will ask you push against my hand toward your chest for 3 second at 20% of your maximal force. After this 3 seconds we are done. Then we will repeat the same proccess with the left leg"*

2. The Assesor asks to the patient take his/her shoes off and lay down over the back.

3. The assesor asks to the patient to relax *"Try to relax".* The assesor asks to the patient let him know when discomfort is felt *"Let me know when u feel discomfort".*

4. The patient indicates that it feels discomfort.

5. Inmediately after the assesor asks the patient to push against he is hand towards the patient´s chest: *"Now! Push!..1,2,3"*

6. Following the Assesor ask the patient to relax: *"Now relax, we are done"*

7. The procedure is repeated in the left leg.

8. The assessor work with the patient to the measurements room.

Application for ethical approval of research project within EBP3 at the European School of Physiotherapy

Supervisor:

Maarten van Egmond

Students:

Andreas Heck

Christine Petrides

Kai Sigel

Francisco Alonso

Title and details of Research Project:

Title:

What is the difference in reach distance in the sit-and-reach test for people who receive agonist-PNF stretching vs. antagonist-PNF stretching immediately after intervention?

Details:

Self conducted RCT between September 2015 and January 2016

We will conduct research on two PNF stretching techniques and their immediate effects on reach distance measured by a sit-and-reach test. The interventions and measurement details are outlined in their respective sections of the project plan.

The interventions chosen are non-invasive, minimally stressing, well researched and commonly used in practice and thus pose no threat to the participants' physical and/or mental health. For a detailed description of the intervention refer to the respective paragraph in the project plan.

We have chosen students from the English and Dutch Physiotherapy program between the ages of 17-40 as our study population. Choosing young and healthy individuals should result in low risk of harm for the participants. All participants will have to sign an informed consent form prior to participating in the research. Details on in- and exclusion criteria are outlined in the project plan.

Randomization and blinding of the participants, as well as, researchers will be ensured to minimize bias. For details see "Research Design" in the project plan.

The data that will be collected is going to be processed by the use of several statistical tests within the SPSS software v. 23. See "statistic analysis" in the project plan.

Date & Students Signatures: 23/9/2015 _____

Date & Signature Supervisor: 23/9/2015_____

Alonso et al. 2015 | The Immediate effects of agonist vs. antagonist PNF stretching in hamstring extensibility measured by sit-and-reach test . European school of Physiotherapy, Amsterdam Universtity of Applied Sciences. Hogeschool van Amsterdam.

Collection Datasheet

The blue datasheet contained the participant's name, PIN, baseline measurements and group assignment code. It was accessible to the researcher concerned with administration and to the researchers carrying out the intervention so that they know which participant received the intervention and which one the control. The researcher taking the measurements with the SRT had no access to this datasheet. He had access to the green data sheet, which did not contain info on the allocation.

The researcher who did the administration randomly allocated the participants to either the TM or OM group and assigned them their PIN. This was noted in the blue data sheet and visible to the researchers carrying out the intervention. The participants went to a separate room to have their pre- intervention SRT data recorded. Following this, they went to another room and told their PIN to the researchers in order to receive the appropriate intervention. Finally, they went back to the other room where the post intervention SRT was measured.

Due to this systematic process, the researchers, when the data was reviewed, could trace the measurements to either the control or intervention groups by using the PIN.

Spreadsheet for recording baseline data and randomly allocating patients

Name	PIN	Gender	Age	Weight (kg)	Height (cm)	Group
Jack Johnson	1	male	25	80	180	TM

Spreadsheet for recording measurements of the SRT prior and post intervention

Name	PIN	SRT: T0_1	SRT: T0_2	SRT: T0_3	SRT: T0 Ø	SRT: T1_1	SRT: T1_2	SRT: T1_3	SRT: T1 Ø
Jack Johnson	1	30	31	31	30,7	31	31	32	31,3