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Research Article

Assessment of Therapeutic Ultrasound as an Adjunctive Modality in the Management of Patellofemoral Pain Syndrome (PFPS): A Clinical Evaluation

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Abstract

Background: Anterior knee pain is a key symptom of Patellofemoral Pain Syndrome (PFPS), a common musculoskeletal disorder often caused by improper patellar tracking and abnormalities in soft tissue. Objective: The objective of this study was to explore the effectiveness of UST on PFPS among students at a private medical university, the Frisbee club. Methods: A survey derived from the SNAPPS questionnaire (Survey instrument for Natural history, Aetiology and Prevalence of Patellofemoral pain Studies) to diagnose individuals with PFPS was sent out to the frisbee club students and we had a total of 61 responses. Out of 61 responses, 11 individuals meet the inclusion criteria of this research. The scores for pre- and post-treatment provided an insight into whether therapeutic ultrasound is effective in individuals with PFPS. This interventional study involves 2 sessions of 5 minutes of ultrasound with a frequency of 1 MHz and intensity of 1.5 W/cm^2 applied to the affected knee. Results: The outcome measure used was the Anterior Knee Pain Scale (AKPS). The results of this study showed that out of 11 individuals, 9 showed improvement in pain scores pre- and post-treatment ($p<0.05$). However, 2 participants reported slightly more perceptive pain after treatment, and 1 participant had the same pain scores before and after treatment. This variation could be attributed to subjective pain scoring and differences in individual pain perception. Conclusion: These results provide credence to the use of therapeutic ultrasound as a useful supplement in the conservative treatment of PFPS.

Keywords

Knee Pain, Musculoskeletal Rehabilitation, Patellofemoral Pain Syndrome, Therapeutic Ultrasound

1. Introduction

In recent years, patellofemoral pain syndrome (PFPS) has been recognised as one of the most common knee conditions treated by practitioners. While PFPS can impact individuals across the general population, studies have indicated a higher prevalence among physically active individuals, leading to decreased sports performance because of pain. Furthermore, research has shown that PFPS is more frequently reported in women compared to men, likely due to the natural anatomical differences that result in women having a higher Q angle [1, 2]. PFPS is a complex knee condition with an unknown etiology,

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typically caused by a combination of biomechanical issues. It is characterised by pain behind the kneecap or anterior knee pain, often worsened by strenuous activity or climbing stairs. Symptoms may include crepitus, a sensation of the knee giving way, or a feeling of catching when extending the knee. Risk factors for developing PFPS include tightness in the lateral retinaculum, an increased Q angle, increased femoral anteversion, patellar rotation, and others [3]. Research has shown that addressing biomechanical issues at the patello-femoral joint through approaches such as ice, non-steroidal anti-inflammatory drugs (NSAIDs), quadriceps strengthening, stretches, and arch supports can help manage PFPS. Therapeutic ultrasound is commonly used in PFPS management, but its effectiveness is still uncertain. Some studies suggest benefits when combined with exercise therapy, while others find no significant difference compared to placebo treatments. Clinical guidelines recommend exercise as the primary intervention, with ultrasound as a potential supplement. Further research is needed to establish the efficacy of therapeutic ultrasound as a standalone treatment for PFPS [3, 4]. Given the higher prevalence of PFPS in physically active individuals, this study will focus on frisbee club players who train 2-3 times a week for 3 hours per session, totaling 8-10 hours weekly. Frisbee involves a lot of jumping, sprinting, and changes of direction, putting a significant strain on the lower body and increasing the risk of knee injuries, including PFPS. The effectiveness of therapeutic ultrasound will be assessed based on participants' pre- and post-treatment scores on the AKPS [5-7].

PFPS is characterized by symptoms such as anterior knee pain, stiffness in the knee joint, and retro patellar pain. These symptoms can be very painful and may lead to a decline in an individual's performance if timely management is not provided [4]. There are numerous systematic reviews and studies on different management options for PFPS, including non-steroidal anti-inflammatory drugs (NSAIDs), chiropractic manipulation techniques, quadriceps strengthening, and proprioceptive neuromuscular facilitation stretch [5-9]. However, research on the effectiveness of therapeutic ultrasound for PFPS among university frisbee club members is limited. The choice to focus on the Frisbee Club was influenced by a 2015 study in the USA which revealed that frisbee club members in college settings reported some of the highest rates of injuries compared to other sports clubs, with the knee being the most injured body region. Therefore, this study aims to investigate the efficacy of therapeutic ultrasound intervention for individuals with PFPS in the Frisbee Club at University [6-11]. While there is existing evidence supporting various approaches to managing PFPS, such as NSAIDs, chiropractic techniques, strengthening exercises, and stretching, the effectiveness of therapeutic ultrasound as a standalone treatment specifically for university frisbee club members with PFPS needs further exploration. This study seeks to assess the impact of therapeutic ultrasound on PFPS by collecting and analySing AKPS scores before and after treatment to determine its effectiveness in reducing pain intensity and improving physical performance.

Therapeutic ultrasound has been widely investigated as an adjunct modality in managing PFPS due to its potential biophysical effects, including deep tissue heating, enhanced blood flow, collagen extensibility, and stimulation of tissue repair. These effects may help reduce inflammation, relieve pain, and promote soft tissue healing in the patellofemoral region. Previous studies have demonstrated mixed outcomes regarding clinical efficacy; some report improved pain relief and functional performance, while others find minimal or no significant benefit compared to placebo or exercise alone. The inconsistency may be attributed to variations in ultrasound parameters, treatment duration, and combined interventions. Nonetheless, ultrasound continues to be utilized in physiotherapy practice, highlighting the need for further evidence-based evaluation. Reviewing and synthesizing current findings on therapeutic ultrasound in PFPS can enhance understanding of its clinical relevance, guide optimized treatment protocols, and support the development of more targeted rehabilitation strategies aimed at restoring knee function and reducing pain [12-15].

The findings of this study will offer valuable insights into future larger-scale research projects aimed at enhancing treatment outcomes for individuals with PFPS. It may also provide a more cost-effective treatment option for students experiencing PFPS who may not have financial independence yet.

2. Materials and Methods

2.1. Study Setting

This study focused on therapeutic ultrasound and PFPS. The study was conducted in the CSSC room at the university, where both the intervention and data collection took place. The CSSC room was chosen as it provides a controlled environment for measuring vertical jump height. Additionally, the room is equipped with treatment tables for administering therapeutic ultrasound to the participants. This controlled setting facilitated the implementation of therapeutic ultrasound protocols (concentric method, with aqua sonic gel, frequency 1MHz) and allowed for the collection of pre- and post-treatment scores from the participants. These scores were then used to evaluate the effectiveness of therapeutic ultrasound on PFPS.

2.2. Study Participants

The university frisbee club currently has 81 members. However, the main goal of this study does not involve hypothesis testing, so calculating the sample size is usually unnecessary. Instead, the purpose of determining the sample size is to evaluate the feasibility of recruiting participants and the study design, rather than ensuring there is enough statis-

tical power for hypothesis testing. The sample, including inclusion and exclusion criteria, must align with the main study to maintain consistency. Therefore, we selected a sample size of 11 individuals with PFPS who will undergo the therapeutic ultrasound intervention [16].

Inclusion and exclusion criteria

Participants were included in the study based up on the below inclusion and exclusion criteria.

Inclusion criteria:

1) Participants with SNAPPS Questionnaire score equal or more than 6
2) Participants with diagnosed PFPS
3) Age 18-40 years old

Exclusion criteria:

1) Participants with contradicting medical conditions (e.g. fractures, open wound, pregnancy, allergy reactions, compartment syndrome, deep vein thrombosis).
2) Patient less than the age of 18-year-old or more than 40-year-old.

2.3. Data Collection

This study is an experiment in which the AKPS will be utilized as the dependent variable. The IKDC and AKPS are validated surveys used to evaluate the knee condition of participants, therefore, the scores for pre- and post-treatment will offer insight into whether therapeutic ultrasound is effective in individuals with PFPS. Additionally, vertical jump height will serve as an indicator reflecting lower limb function, flexibility, and strength. To diagnose participants with PFPS, the SNAPPS Questionnaire is employed [17, 18]. The SNAPPS Questionnaire is a self-reported form that can differentiate between individuals with PFPS and those with other soft tissue injuries. This questionnaire aids in systematically collecting information about an individual's PFPS condition to confirm the diagnosis. A scoring system developed by Edge Hill University and Manchester Metropolitan University will be utilized. If the score reaches 6 or higher, the individual will be diagnosed with PFPS [19].

Following steps taken to collect the data for our experimental research:

Step 1: Participants of the frisbee club are screened using the SNAPPS questionnaire. If their score exceeds 6, it is determined that they have PFPS.

Step 2: Individuals are then asked to complete a pre-treatment vertical jump test and fill out pre-treatment surveys, including the AKPS.

Step 3: Ultrasound treatment begins with a frequency of 2 times a week for 1 week (2 sessions in total), using 1.0 W/cm^2 at 1 MHz for 5 minutes.

Step 4: After the second treatment, participants were measured for post-treatment vertical jump height and were asked to fill out post-treatment surveys, including the AKPS.

2.4. Data Analysis

After acquiring the necessary information about the 11 individuals, which includes their pre-treatment and post-treatment AKPS. These continuous data are then analysed using the Paired T test with SPSS software. It is then compared to see if therapeutic ultrasound is an effective treatment among individuals with PFPS. If there the values are $p<0.05$, then there will be an effectiveness of the treatment on PFPS.

3. Results

Based on the 11 participants, the demographics of the participants were calculated using SPSS and shown in (Table 1).

The oldest participant was 25 years old, while the youngest was 19. The average age was 22, with a standard deviation (SD) of 1.916. There were 6 males and 5 females, making up 54.55% and 45.45% of the participants, respectively. In terms of ethnicity, the majority were Chinese (81.8%) compared to Malay (18.2%), as indicated in (Table 1).

Table 1. *Demographic details of study participants.*

Variable	Category	n (%)	Mean (SD)	Min	Max
Age (years)	—	—	22.0 (1.92)	19	25
Gender	Male	6 (54.55%)	—	—	—
	Female	5 (45.45%)	—	—	—
Ethnicity	Chinese	9 (81.8%)	—	—	—
	Malay	2 (18.2%)	—	—	—

This research was conducted to find out the following question: Is therapeutic ultrasound effective on PFPS among individuals in the university frisbee club?

The research started by sending out Microsoft forms to indi-

viduals in university frisbee club to search for qualified participants (SNAPPS score 6 or more). Recruitment of participants lasted for one month, and at the end of it there were 11 participants selected, who had a SNAPPS score of 6 or more. The interventional research starts with the individuals filling up a pre-treatment questionnaire AKPS. After that, they were brought to the treatment room to undergo ultrasound therapy for 5 minutes on the affected leg at 1 MHz frequency, and intensity of 1.5 W/cm^2. After two days, the individual will then undergo the same ultrasound treatment once again then they will fill up the post-test AKPS questionnaire.

Table 2. *Anterior knee pain scale (AKPS) baseline and at the end of treatment.*

	AKPS (Baseline)	AKPS (At the end of treatment)
Mean (SD)	87.81 (6.95)	92.82 (7.59)

P value = 0.073 (> 0.05), not significant.

For the research, a paired T-test was used to analyse the before and after treatment AKPS scores. The reason why paired T-tests are used is because this research is evaluating changes in the same group of participants. It helps determine the average difference between those two sets of scores is big enough to be considered statistically significant. In this research, the scores of paired T tests showed no statistically significant results. It concludes that the evidence of therapeutic ultrasound as a standalone therapy is not enough.

4. Discussion

PFPS is one of the most common injuries in physically active individuals, characterised by anterior knee pain [1, 4]. Despite numerous systematic reviews and research on different treatment approaches for PFPS, the effectiveness of therapeutic ultrasound on anterior knee pain among university frisbee club members is limited.

A study conducted in the USA in 2015 found that ultimate frisbee clubs have one of the highest injury rates in a college university setting [6]. Therefore, this study aims to gather information on the effectiveness of therapeutic ultrasound intervention among frisbee club players with patellofemoral pain. An interventional research study was conducted with 11 participants diagnosed with PFPS or with a SNAPPS score of 6 or higher. The study began with participants completing a pre-treatment questionnaire AKPS. They were then treated with 5 minutes of 1.5 W/cm^2 1 MHz ultrasound therapy on the affected leg. The process is reversed and then repeated after two days, concluding with a post-treatment AKPS questionnaire. The results of the data showed no statistically significant result (P=0.073).

Previously, there were few randomized controlled trials (RCTs) that performed therapeutic ultrasound on individuals with PFPS. In a particular study, a combination of ultrasound with heat and ice massage was compared to ice massage alone. When it came to pain alleviation for individuals, there was no significant difference compared to ice alone [20]. Another study found that cold therapy in addition to ultrasound therapy had benefits [9]. In comparison to this study, therapeutic ultrasound was used as a standalone therapy without any heat or ice therapy. The results of the data showed that there were no statistically significant differences, which aligned with the previous study. This suggests that without combining additional treatments, therapeutic ultrasound as a standalone therapy might have limited benefits.

This research design is experimental and involved 11 individuals with patellofemoral pain syndrome who scored 6 or more on the SNAPPS questionnaire. The data was collected after two sessions of ultrasound therapy using the approved and validated anterior knee pain scale to assess functional activities related to anterior knee pain, both pre- and post-treatment. Despite the careful planning and structure of the research, the results did not show any statistically significant findings. This lack of significance may be attributed to the short intervention period or the small sample size, ultimately influencing the overall outcome of the study.

The instruments used in this research were the SNAPPS questionnaire, AKPS form [21], and therapeutic ultrasound. The SNAPPS questionnaire is a validated screening tool to identify individuals with PFPS in the Frisbee club. A score of 6 or more is the inclusion criteria, and this instrument helped identify the target population for this research. Additionally, the AKPS is the main outcome measure of this study. It is a subjective questionnaire that assesses daily functional activities. Despite the validation and widespread use of the AKPS form, the results showed no significant improvement in individuals' knee pain with PFPS. Furthermore, while therapeutic ultrasound is commonly used for reducing pain in musculoskeletal issues, its effectiveness in treating PFPS as a standalone therapy is not significant.

5. Limitations

This study has a few constraints. One of them is the small sample size, which could be due to the nature of study and the fact that

a specific university sports club may have a smaller community. Additionally, pain reports are personal and subjective, so pain levels might vary greatly among individuals. Furthermore, the research timeline is short and only managed to examine the brief intervention period of ultrasound therapy, making it impossible to fully validate the impact of this intervention. To overcome the limitation of sample size, a future study could be conducted with a larger sample size by including more sports clubs or a wider region of the population. The research could also be extended to a longer term, for example, 6 weeks of treatment 1-2 times a week, to provide more accurate results.

6. Recommendations

Based on the findings and limitations of this investigation, several suggestions can be made for future research. Firstly, future studies should consider recruiting a larger number of participants and increasing the sample size to enhance the statistical power in detecting changes in scores. Additionally, future research could involve more treatment sessions with long-term follow-ups lasting 2-3 months to investigate the effects of extended treatment periods and the long-term efficacy of therapeutic ultrasound. Furthermore, including a control group in future studies would provide more definitive data on the effectiveness of ultrasound therapy for PFPS. Finally, improving outcome measures by incorporating more objective measures such as vertical jump height or muscle strength could enhance the quality of future research in this area.

7. Conclusion

The results of this research are not statistically significant, indicating that therapeutic ultrasound therapy alone did not result in any significant improvements. The study only involved two sessions of ultrasound with 11 participants suffering from PFPS. While individual results showed slight improvement in the AKPS score for some participants, it was not enough to be considered statistically significant. One implication of this study is that therapeutic ultrasound may not offer significant benefits when used as a standalone therapy, but it could be effective when combined with other interventions such as ice or exercise therapy, as shown in previous studies. Another implication is that clinicians and practitioners should use evidence-based practices in decision-making to improve patient treatment outcomes and facilitate greater improvements.

Abbreviations

AKPS	Anterior Knee Pain Scale
NSAIDs	Non-steroidal Anti-inflammatory Drugs
PFPS	Patellofemoral Pain Syndrome
RCTs	Randomized Controlled Trials
SNAPPS	Survey Instrument for Natural History, Aetiology and Prevalence of Patellofemoral Pain Studies

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Conflicts of Interest

The authors declare that there is no conflict of interest.

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