Effects of an Ultrasound-assisted Palpation Training Program on Physical therapy Student's Palpation Skills

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Objective: This study aimed to explore the effects of a novel training program that integrates ultrasound technology to enhance the palpation skills of physical therapy students. The program was designed to support students in developing more precise palpation techniques by using ultrasound as a supplementary tool for anatomical identification.

Design: A randomized controlled trial.

Methods: A total of twenty students, all enrolled in the physical therapy department at S University, who met the specified selection criteria, were randomly assigned to one of two groups: the experimental group (EG, n=10) or the control group (CG, n=10). The experimental group participated in an ultrasound-assisted palpation training program, while the control group did not receive this intervention.

Results: The experimental group demonstrated significant improvements in their ability to accurately palpate anatomical landmarks, specifically the long head of the biceps brachii (LHBT) and the lateral joint line of the knee (LJLK), as well as an increased level of confidence in their palpation skills ($p<0.05$). A comparative analysis of changes from pre- to post-training revealed statistically significant differences between the two groups ($p<0.05$).

Conclusions: The findings of this study suggest that the ultrasound-assisted training program can provide valuable educational benefits, offering foundational data to enhance the development of palpation skills in physical therapy students and making a meaningful contribution to educational research within the field.

Key Words: Palpation, Accuracy, Confidence, Education, Ultrasound

Introduction

The diagnostic process in physical therapy is critical for evaluating patients and creating personalized treatment plans [1]. Through assessments of physical function, pain, and mobility, therapists utilize tools such as MRI and ultrasound to increase diagnostic precision [2]. Palpation, a core component of these evaluations, enables physical therapists to assess tissue and joint conditions, providing essential information for treatment decisions[3]. However, several studies have highlighted issues with the accuracy and inter-rater reliability of palpation techniques, often linked to the practitioner's experience and patient variability [4, 5]. Inaccurate palpation can lead to misdiagnosis and ineffective treatment [6].

Efforts to improve palpation accuracy have involved various training approaches. Traditional teaching methods in osteopathy and physical therapy have faced challenges in delivering objective feedback, limiting students' ability to refine their skills [7]. Recent research has proposed ultrasound-assisted training programs as a solution, offering a more effective method for enhancing palpation skills in students [8]. While the use of ultrasound as a diagnostic tool is increasing, its potential to improve palpation education remains underexplored. This study examines the impact of an ultrasound-assisted training program on the

accuracy of palpation skills in physical therapy students, comparing it to traditional educational approaches.

Materials and Methods

Subjects

The subjects of this study were 20 physical therapy students from S University in Seoul, Korea. Recruitment was conducted among second-, third-, and fourth-year students in the physical therapy program. The inclusion criteria were 1) students who had completed anatomy courses, and 2) healthy individuals without any abnormalities in finger sensation. The exclusion criteria were 1) students who had participated in other palpation training programs, and 2) those who did not consent to participate in the study.

All measurement and assessment methods were thoroughly explained to ensure that subjects understood the procedures. Participants were informed about the study's purpose, process, benefits, and risks, and all subjects provided informed consent after the study received approval from the Institutional Review Board of Sahmyook University (2023-10-012-002).

Study procedures

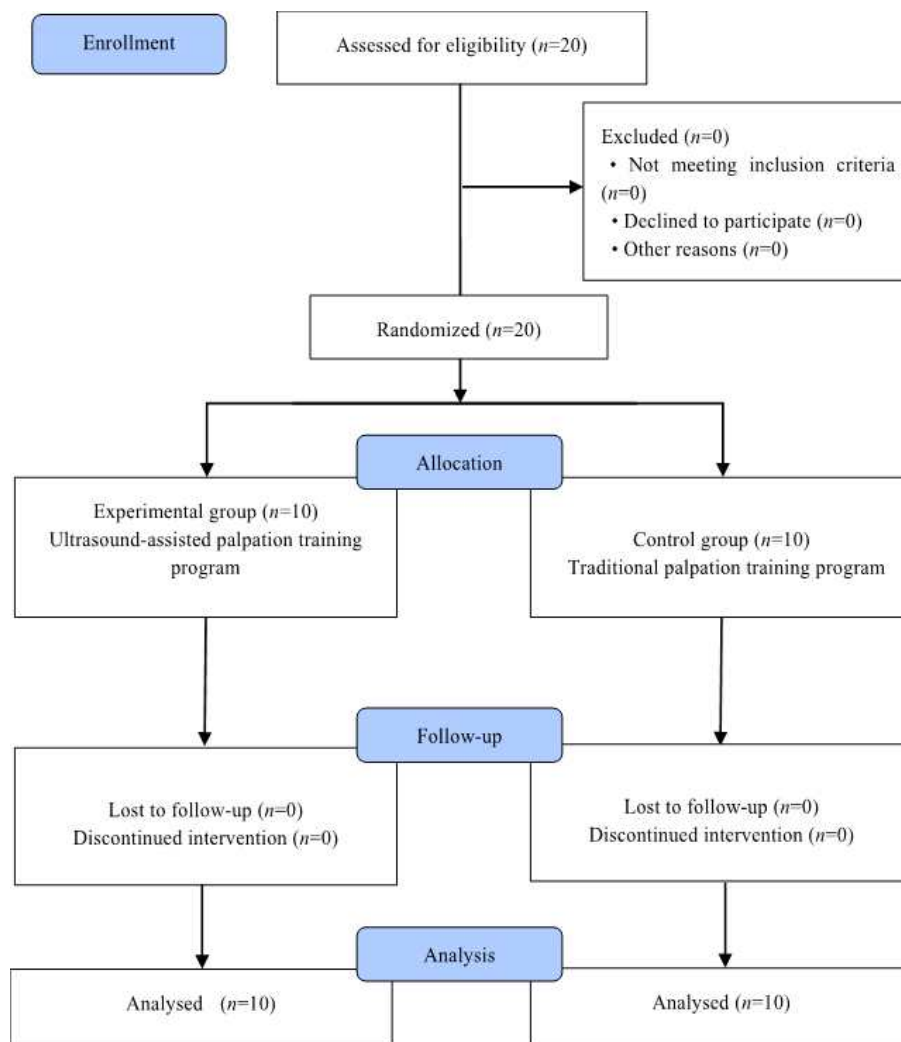This study was a single-blinded randomized controlled study. Twenty participants were randomly

Figure 1. Experimental diagram

assigned to either the ultrasound-assisted palpation training group (10 students) or the control group (10 students). Random allocation software was used to ensure unbiased group assignments [9]. Palpation accuracy and confidence were evaluated before and after the 90-minute training program. All assessments were conducted by a physical therapist who was blinded to the group allocations. Participants in the experimental group underwent an ultrasound-assisted palpation training program, while those in the control group received traditional palpation training (Figure 1).

Interventions

Ultrasound–assisted palpation training program

The palpation training program used in this study was adapted from previous research on ultrasound-based palpation training [8] and ultrasound-based shoulder joint palpation methods [10]. The program was modified into an ultrasound-assisted palpation training program to enhance palpation skills.

Participants underwent a 90-minute training session, divided into two parts. The first 45 minutes focused on the long head of the biceps brachii tendon (LHBT) and the acromioclavicular joint (AC), while the second 45 minutes concentrated on the lateral joint line of the knee joint (LJLK). Before starting the training, participants received a 5-minute introduction to the anatomical structure and characteristics of each area. This was followed by a 5-minute review of ultrasound images showing the anatomical structures. Participants then practiced palpation for 20 minutes with visual feedback provided via a medical ultrasound diagnostic device. They worked in groups of two or three, with each group receiving feedback from an arbitrator regarding the difference between the palpated area and the actual anatomical structure. Finally, participants practiced for 15 minutes without visual feedback from the ultrasound device.

Traditional palpation training program

The palpation training program utilized in this study was developed based on the principles outlined in a previous palpation training manual [11]. The program was modified and supplemented to form a comprehensive traditional palpation training program aimed at enhancing palpation proficiency. Participants engaged in a 90-minute training session, structured into two distinct segments. The first 45 minutes were allocated to training on the LHBT and the AC, while the subsequent 45 minutes focused on the LJLK. Prior to the practical component, participants were provided with a 5-minute theoretical overview detailing the anatomical structures and characteristics of the relevant regions. This was followed by a 5-minute instructional video demonstrating traditional palpation techniques for the targeted anatomical structures. A 20-minute practical session ensued, during which participants applied traditional palpation techniques. Working in groups of two to three, participants received feedback from an arbitrator who assessed the accuracy of their palpation in relation to the actual anatomical structures. The final 15 minutes were dedicated to independent practice, during which participants applied traditional palpation methods without further feedback.

Outcome Measurements

Accuracy of Palpation

To assess the accuracy of palpation, a medical ultrasound diagnostic device (X-CUBE 60; ALPINION, Korea, 2022) was utilized. This device has been validated as an effective tool for identifying pain sources and functional impairments [12]. The participants performed palpation on various anatomical regions, including the LHBT, the AC, and the LJLK. To ensure measurement accuracy, previous studies by Gazzillo et al. [13] and Rho et al. [5] were referenced. These studies demonstrated the proper angle and posture for accurately attaching the catheter to each joint. Following the palpation, an 18-gauge catheter was affixed to the identified site using cellophane tape (Figure 2). The distance between the palpated location and the actual anatomical structure, as determined by the ultrasound device, was measured to evaluate the accuracy of palpation (Figure 3).

Confidence in Palpation

As part of the study, a survey was administered to evaluate participants' confidence levels before and after
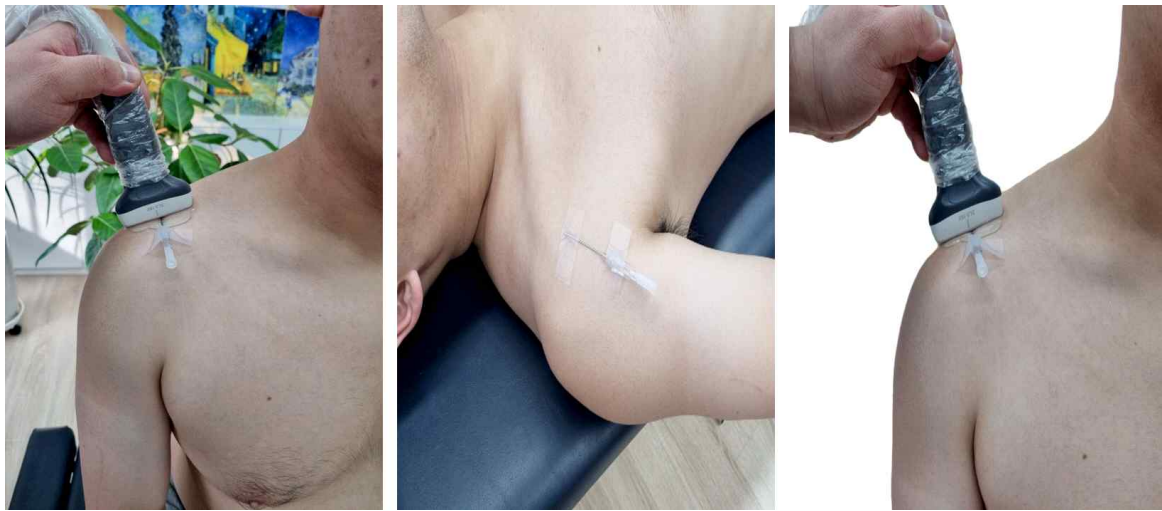
Figure 2. Assessment of the accuracy of palpation
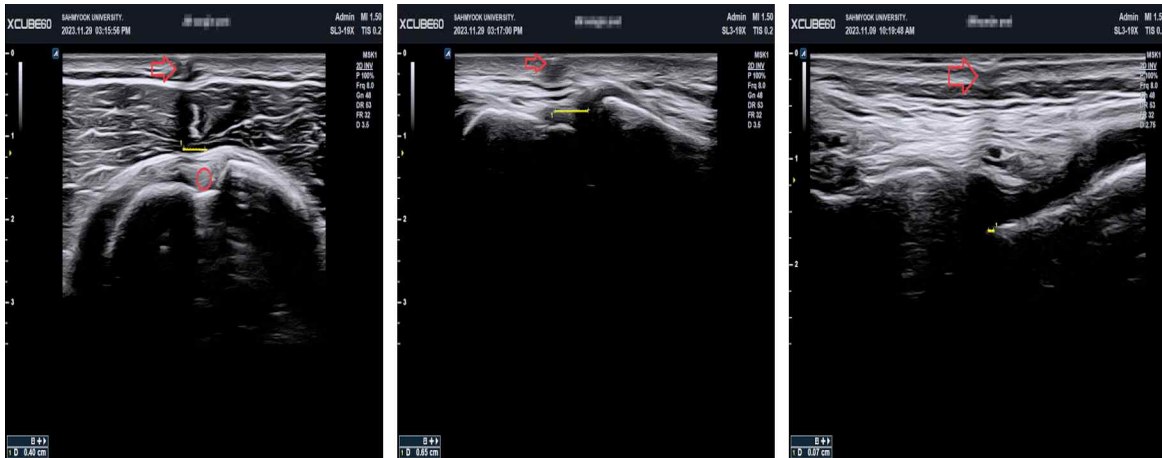
Figure 3. Medical Ultrasound Diagnostic Device Video (Distance between the catheter and anatomical structures)

the palpation training program. The survey employed a linear scale questionnaire, adapted from Sederberg et al. [14], ranging from 0 (indicating very low confidence) to 10 (indicating very high confidence).

Statistical Analysis

The general characteristics of the subjects were expressed as means and standard deviations. Normality was assessed using the Shapiro-Wilk test. For group comparisons, the independent t-test and chi-square test were used to verify homogeneity between groups. Variables that did not meet the normality assumption were analyzed using the Wilcoxon signed-rank test to assess changes before and after training, while the Mann-Whitney U test was employed to compare differences between groups. The significance level for each analysis was set at 0.05, and statistics were computed using SPSS program (SPSS Statistics 23.0, IBM Corp, USA).

Result

A total of 20 students were randomized for study intervention. EG consisted of 10 students and participated the ultrasound-assisted palpation training

Table 1. General Characteristics of Participants (n=20)

Characteristics	EG (n=10)	CG (n=10)	χ^2/t(p)
Sex (male / female)	7 / 3	4 / 6	0.068(3.333)
Age (years)	23.30(1.88)	22.40(1.34)	1.226(0.236)
Grades(2/3/4)	(0/4/6)	(2/6/2)	0.568

The values are presented mean (SD)
EG: Experimental group, CG: Control group

Table 2. Comparison of Accuracy of palpation between EG and CG (n=20)

		EG (n=10)	CG (n=10)	U(p)
LHBT(mm)	Pre	8.81±6.43	8.94±3.36	32.000(0.173)
	Post	4.35±3.62	11.30±5.36	
	Pre-post	-4.46±7.85	2.36±3.68	17.000(0.013)
	Z(p)	-1.988(0.047)	-1.580(0.114)	
AC(mm)	Pre	4.82±2.79	5.58±2.38	45.500(0.571)
	Post	4.46±3.07	6.24±2.62	
	Pre-post	-0.36±2.76	0.66±1.83	42.000(0.545)
	Z(p)	-0.510(0.959)	-1.328(0.185)	
LJLK(mm)	Pre	8.62±2.92	9.43±2.48	41.000(0.495)
	Post	5.08±3.23	9.07±5.02	
	Pre-post	-3.55±3.16	-0.36±5.16	24.000(0.049)
	Z(p)	-2.293(0.022)	-0.510(0.959)	

The values are presented mean (SD)
EG: Experimental group, CG: Control group, LHBT: The long head of the biceps brachii, AC: The Acromioclavicular joint, LJLK: The Lateral joint Line of Knee

program. CG consisted of 10 students and participated the traditional palpation training program. In this study, there was no significant difference in the results of a homogeneity test on the measurement items of EG and CG (Table 1).

The table of changes in LHBT, AC, LJLK in the ultrasound-based palpation training program and the control group is as follows (Table 2).

In the EG, palpation accuracy for LHBT significantly improved from 8.81 mm before training to 4.35 mm after training ($p < 0.05$). No significant difference was observed in the CG before and after training. The EG demonstrated a statistically significant improvement in LHBT palpation accuracy compared to the CG ($p < 0.05$). In the EG, there was a slight, but not statistically significant, improvement from 4.82 mm before training to 4.46 mm after training. The CG showed no significant changes. Overall, the EG did not demonstrate a significant improvement in AC palpation accuracy compared to the CG. The EG showed a significant improvement in palpation accuracy for LJLK, with a reduction from 8.36 mm before training to 5.08 mm after training ($p < 0.05$). In contrast, the CG demonstrated no significant change. The EG exhibited a statistically significant effect on LJLK palpation accuracy compared to the CG ($p < 0.05$). Both the EG and CG showed significant increases in confidence levels. The experimental group

Table 3. Comparison of Confidence in palpation between EG and CG (n＝20)

		EG (n＝10)	CG (n＝10)	U(*p*)
Confidence in palpation(points)	Pre	3.90±0.99	3.90±2.55	
	Post	8.20±1.47	8.30±0.94	
	Pre-post	4.30±2.00	4.40±2.22	-2.499(0.021)
	Z(*p*)	-2.810(0.005)	-2.744(0.006)	

The values are presented mean (SD)
EG: Experimental group, CG: Control group

improved from 3.90 to 8.20 points (*p*＜0.05), and the control group increased from 3.90 to 8.30 points (*p*＜0.05) (Table 3).

Discussion

This study aimed to investigate the effects of an ultrasound-assisted palpation training program on the palpation accuracy and confidence of physical therapy students. The results demonstrated a statistically significant improvement in palpation accuracy for the LHBT and the LJLK (*p*＜0.05), as well as increased confidence in palpation following the ultrasound-assisted training program (*p*＜0.05).

A. Changes in Palpation Accuracy of the LHBT According to Training Methods

Analysis of the mean differences between the two groups revealed a statistically significant improvement in LHBT palpation accuracy. The experimental group showed a mean difference of -4.46 ± 7.84 mm before and after training, while the control group exhibited a difference of 2.36 ± 3.68 mm (*p*＜0.05).

Previous research has reported low accuracy rates in LHBT palpation. For instance, Gazzillo et al. [13] found that only 5.3% of the 23 participants correctly identified the LHBT, and McDevitt et al. [15] reported an average accuracy rate of just 45.7% in their sample of 32 participants. Woods et al. [10] also highlighted the impact of ultrasound-based education, noting an increase in palpation accuracy from 16% to 51.7% after training (*p*＜0.05).

This study supports these findings, demonstrating that the ultrasound-assisted palpation training program significantly improved the accuracy of LHBT palpation compared to the control group. The results underscore the potential of ultrasound-assisted training in enhancing palpation skills for this anatomical region.

B. Changes in Palpation Accuracy of the AC According to Training Methods

The analysis showed no statistically significant difference in AC palpation accuracy between the EG and CG. The EG demonstrated a mean difference of -0.36 ± 2.76 mm before and after training, while the CG exhibited a difference of 0.66 ± 1.83 mm.

Previous studies have similarly reported low accuracy rates for AC palpation [16, 17], and clinicians have advocated for injections as a diagnostic aid due to these limitations.

In this study, the ultrasound-assisted training did not yield a statistically significant improvement in AC palpation accuracy. This may be attributed to the inherent difficulty of palpating the AC joint and the insufficient duration of the training program. Further research is necessary to explore extended training sessions or alternative methods for improving palpation accuracy in this area.

C. Changes in Palpation Accuracy of the LJLK According to Training Methods

The results indicated a statistically significant difference in the palpation accuracy of the LJLK. The EG exhibited a mean difference of -3.55 ± 3.16 mm,

while the CG showed a difference of -0.36 ± 5.16 mm ($p < 0.05$).

Previous research has highlighted the challenges of accurately palpating the knee joint line. Rho et al. [5] found no significant differences in palpation accuracy across different education levels, suggesting a need for improved training methodologies.

In this study, the ultrasound-assisted palpation training program demonstrated a significant improvement in LJLK palpation accuracy, supporting its effectiveness as an educational tool for enhancing palpation skills in this anatomical region.

D. Changes in Confidence in Palpation According to Training Methods

The analysis of confidence levels revealed a statistically significant improvement in the EG. Participants in the EG reported an increase of 4.30 ± 2.00 points, while the CG showed an increase of 4.40 ± 2.22 points ($p < 0.05$).

Sederberg et al. [14] similarly reported a marked increase in confidence, from 4.30 to 8.15 points, following a brief ultrasound-assisted palpation training program.

The findings of this study suggest that ultrasound-assisted palpation training can significantly enhance participants' confidence in their palpation skills, further emphasizing the value of integrating ultrasound-based feedback in physical therapy education.

Conclusion

The purpose of this study was to examine the effect of an ultrasound-assisted palpation training program on the palpation skills of physical therapy students. The study involved two groups: the ultrasound-assisted palpation training program group and the control group. The experimental group used a medical ultrasound diagnostic device while the control group used a traditional palpation training program without the medical ultrasound diagnostic device during the palpation training program. The accuracy of palpation and confidence in palpation were evaluated for both groups. The results showed that the experimental group had significant improvement in accuracy of palpation on LHBT, LJLK and confidence in palpation ($p < 0.05$) as compared to the control group. The study confirms that ultrasound-assisted palpation training programs are effective in improving the palpation skills of physical therapy students. This study can be used as basic material for future education to improve physical therapy students' palpation skills.

Acknowledgement

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