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Original Research

Reduction of Knee Q Angle Using Custom Foot Orthoses in Flat Foot Patients

Prasetyo Catur Utomo[1], Atika Febri Anggriani[1*]

[1] Department of Orthotic Prosthetic Poltekkes Kemenkes Surakarta, Indonesia

ABSTRACT

Background: *Flat foot is the most prevalent musculoskeletal condition. Research indicates that between 20 and 30 % of youngsters worldwide suffer from flat feet. In addition to being a static alignment issue of the ankle and foot, flat foot is progressive and can contribute to aberrant dynamic function of other lower limbs. This condition directly affected the degree of q angle. The purpose of this study was to compare the degree of q angel knee joint, before and after the use of custom foot othosis in the study sample*

Methods: *This is a quasi-experimental study with one group pre and post test design to determine the effect of using custom foot orthoses on reducing the degree of Q angle in flat foot. The total number of research samples is 26. The Wilcoxon test was used in this study to analyze the impact of the orthosi.*

Results: *Based on the results of wilcoxon tests show that the p value is < 0.001 (p-value < 0.05), there was a significant difference in the use of custom foot orthoses before the intervention and after the intervention by $5.8^{0.}$ As a result. There was a significant difference in the use of custom foot orthoses before the intervention and after the intervention in reducing the degree of Q angle knee joint.*

Conclusion: *The use of custom foot orthoses can significantly reduce the degree of Q angle knee joint of the study subjects. It is recommended to use orthosis to improve the degree of the Q angle.*

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CONTACT
Atika Febri Anggriani
atikaanggriani07@gmail.com
Department of Orthotic Prosthetic Poltekkes Kemenkes Surakarta. Jl. Captain Adisumarmo, Tohudan, Colomadu, Karanganyar, Indonesia.

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INTRODUCTION

As time goes by and the development of the times that are increasingly advanced, many problems are also encountered, one of which is problems in the health sector. One of the most common health problems is musculoskeletal disorders. The most common musculoskeletal disorder is flat foot or what is commonly called flat foot. Pes planus (flat foot) is a condition where the arch of the foot not present at birth and is buried in soft tissue (Zaidah , 2019). According to Evans, around 20-30% of all children in the world experience flat foot and there are around 129 (40%) children who have a flat foot tendency, which results are obtained from the results of examinations conducted in Sukajadi District, Bandung (Latifah, Naufal, Nafi'ah, & Astari, 2021).

Flat foot is a condition when part or all of the sole of the *foot* comes into contact with the ground. Individuals with flat feet usually experience impaired proprioception due to weak ligaments and tendon disorders, which can result in poor balance (Chinpeerasathian, 2024). This *flat foot* condition can indirectly increase other problems in the lower exterimity (knee joint), one of which is the degree of *q angle knee joint.*

Q angle is an important factor that needs to be considered in assessing the function of the knee joint. The value of the degree of q angle in a person is said to be normal if it is in the range of 10-150. However, a person is said to be at risk of injury if they have a q angle degree value of more than 15 (Anniza & Mayangsari, 2020). The increase in the value of the degree q angle that is outside the normal range is an indication of malalignment in the inferior extremities (Kurniawan, Husni, & Edward, 2019).

In addition to affecting the structure of the feet and the function of the lower extremities, flat feet also need to be considered because they can cause excessive biomechanical stress on the proximal joints. Changes in pressure distribution, decreased medial-lateral stability, and increased internal rotation of the tibia can affect functional movement patterns, especially when performing activities such as walking, running, and climbing stairs. This imbalance has the potential to trigger inefficient movement compensation, thereby increasing the risk of recurrent injuries and chronic knee pain. Therefore, understanding the relationship between flat feet and changes in the Q angle is important as part of broader efforts to prevent musculoskeletal disorders (Anniza & Mayangsari, 2020).

On the other hand, intervention in the form of custom foot orthoses has been widely reported as an effective approach in improving biomechanical alignment, increasing postural stability, and optimising load distribution on the feet and knees. Orthoses designed according to individual anatomical structures can correct foot arches, reduce excessive pronation, and help restore the knees to a more physiological position. The degree of Q angle in individuals with flat feet is expected to improve with the use of orthoses (Kurniawan, Husni, & Edward, 2019).

Various studies have been conducted that examine the effect of using custom foot orthoses in reducing the degree of ankle valgus, so in this case the researcher aims to conduct further research on the effect of using custom foot orthoses on reducing the degree of Q angle in flatfoot sufferers. The use of orthoses in reducing the degree of Q angle of the knee joint is expected to be useful for the lives of people who experience flatfoot problems and can improve the quality of life of sufferers. The purpose of this study was to compare the degree of q angle knee joint, before and after the use of custom foot orthosis in the study sample.

MATERIALS AND METHOD

This type of research is a quasi-experiment with a research design of one group post test design with the effect of using custom foot orthoses on reducing the degree of Q angle in flat foot sufferers. The research's design is very capable of observing the effects both before and after orthosis use. The population in this study was students in grades 3–5 at SD Negeri 1 Malangjiwan, Colomadu, Karanganyar from May to October 2022.

Purposive sampling was used to collect data for this research. The inclusion criteria were that the subject had flat feet and that the subject had given consent to be included in the study. Exclusion criteria were that the subject was in pain and that the subject had deformities other than pes planus or flat feet, such as pes cavus, scoliosis, or

metatarsalgia. Only students with flat feet participated as subjects. A foot wet print test was used to determine the sample. A total of 23 of the 60 students had flatfoot.

Then initial data collection was carried out through wet footprints test obtained data from 23 student feet indicated flat foot. Then the subject measured the degree of Q angle knee joint then given an intervention in the form of using a custom foot orthosis for 1 month and control will be carried out every two weeks. After 1 month, a re-measurement of the degree of Q angle knee joint will be carried out. A contact angle goniometer is a device used to measure the contact angle of a surface, typically coated with a nanomaterial.

Goniometers are essential tools in medicine and physical rehabilitation. In angle measurement, goniometers are used to obtain accurate information about a person's range of motion in joints, including the knee joint. They have three parts: an axis, a static stem, and a dynamic stem, and are calibrated before use. A flexible foot orthosis was made from this sample. The Q angle of the orthosis was measured after a month of use.

To ensure the validity and reliability of the data, the Q angle measurement procedure was performed by an experienced physiotherapist who was familiar with using a goniometer and did not know the previous measurement results in order to minimise observer bias. The validity and reliability of the goniometer measuring device has been widely reported in clinical studies, and all measurements were performed by the same measurer to improve consistency (intra-rater reliability). The Q angle measurement was performed in a standing position without shoes, with anatomical landmarks identified as the anterior superior iliac spine (ASIS), the centre of the patella, and the tibial tuberosity. Each subject was measured three times, and the average result was used as the final value for analysis.

The dependent variable in this study is the degree of Q angle in flatfoot patients. The independent variable is the custom foot orthosis. The normality test used Shapiro Wilk because the subjects were less than 50 and the hypothesis test used Wilcoxon.

This research was approved by the ethics team of the Surakarta Ministry of Health Polytechnic on October 4, 2022, with the number LB. 02.02/1.1/693.6/2022. This study adhered to health research ethics principles, including respect for participant autonomy, confidentiality, and safety. All research procedures were conducted in accordance with applicable ethical standards.

RESULTS

Table 1. Distribution of Frequency of Gender, Classes, And Flat Foot Conditions (n = 23)

Variable	n	%
Gender		
Man	13	56
Woman	10	44
Total	**23**	**100**
Class		
3	10	43
4	5	22
5	8	35
Total	**23**	**100**
Flat Foot Condition		
Bilateral	23	100
Total	**23**	**100**

Variable	n	%
Degree Flat Foot		
2nd degree	8	35
3rd degree	15	65
Total	**23**	**100**

Note: n = the number of obeservation; % = percentage

Table 1 explains that the gender of the study subjects, it was found that the male (56%) was more than the female (46%). The subjects of the study were taken equally from grades 3, 4, and 5. Then in accordance with the purpose of the study, namely regarding the effectiveness of the use of custom foot orthoses in reducing the degree of Q angle knee joint in flat foot sufferers, all subjects who experienced bilateral flat foot were used in the study. It was found that 8 (35%) subjects experienced flat foot with grade 2, and 15 (65%) subjects experienced flat foot grade 3. It can be concluded that the subjects of the study mostly had a category 3 flat foot condition.

Table 2. Distribution of Age, Weight, Height (n = 23)

Variable	Min	Max	Mean ± Standar Deviation
Age (year)	8	12	9.69 ± 0.876
Weight (kg)	19	54	31.17 ± 10.30
Height (cm)	119	151	131.65 ± 7.81

The average age of the subjects in this study is 9.69 years, with an age range of 8-12 years. The average weight is 31.17 kg, with a weight range of 19-54 kg; while the average height is 131.65 cm, with a height range of 119-151 cm. From the normality test with Shapiro wilk, the results of the Q angle knee joint degree reduction test using shapiro-wilk using custom foot orthosis before intervention (pretest) obtained results with a value of p value < 0.001 where the p-value < 0.05, so that the data were abnormally distributed.

The normality test for the knee joint Q-angle after the intervention using custom foot orthoses showed a p-value of less than 0.001 ($p < 0.05$). This result indicates that the post-test data were not normally distributed. Therefore, both datasets were considered non-normally distributed.

Table 4. Degree Q Angle Knee Joint Pre and Post Intervention (n =23)

Variable	Min	Max	Mean ± Standard Deviation	p-value*
Degree Q angle knee joint				
Pre-intervention	10	20	13.37 ± 2.92	**< 0.001**
Post-intervention	5	10	7.59 ± 1.81	

Note: **Wilcoxon test*

From the results of the study conducted, it is known that the degree of Q angle knee joint of the patient is greater at the time of pre-intervention or when the subject has not been given custom foot orthosis compared to post intervention, namely after the study subject is given an intervention in the form of using custom foot orthosis for 1 month. Before being given a custom foot orthosis, the average magnitude of the Q angle knee joint was 13.3 0 while after being given the intervention the angle dropped to an

average of 7.5^0. So, it can be concluded that there is a difference in the difference between the average before being given the intervention and after being given the intervention, which is 5.8^0.

The Wilcoxon test was used to analyze the effect of custom foot orthoses on the Q-angle of the knee joint. The results showed a p-value of less than 0.001, which was statistically significant ($p < 0.05$). These findings indicate a significant difference in the Q-angle of the knee joint before and after the use of custom foot orthoses.

DISCUSSION

The results of this study indicate that the use of custom foot orthoses can significantly reduce the degree of Q angle of the knee joint after one month of use. These findings indicate that others provide effective biomechanical correction by increasing medial arch support and reducing excessive pronation in patients with flat feet. These changes illustrate that orthotic intervention can contribute to improving lower limb alignment in populations with this postural disorder.

The data resulting from research subject criteria is data obtained from direct measurement results of research subjects. The subjects used in this research were elementary school (SD) students aged 8 to 12 years which has enormous potential in optimizing all aspects of body development, including motor development. At the age range of 7 to 12 years, children's motor skills have reached a special skill stage, children begin to master their motor skills better and begin to achieve the most optimal motor development. During the growth and development of children.

Most of the soles of children's feet will experience thickening of the soft tissue on the inside (medial), then this condition will decrease as they grow. The musculoskeletal disorder that most often occurs during the growth period is flat feet (Anggriani, 2023). In research conducted subjects with flat foot deformity then given intervention using custom foot orthosis for 1 month and then observed the condition of the Q degree angle knee joint of each group of study subjects after being given an intervention. This intervention is given because according to what was conveyed by (Hajizadeh, Desmyttere, Carmona, Bleau, & Begon, 2020) that foot orthoses (FOs) are one of the popular treatments used to alleviate some abnormalities in the lower extremities. This orthosis not only works on the principle of supporting the archus pedis, but also works by repairing the structure of the foot to prevent abnormalities in the bones, muscles, tendons and ligament fatigue (Putri, Sabita, & Nurseptiani, 2019).

The detection of flat foot using the foot print test is in accordance with that carried out by (Antar, Nugraha, & Dewi, 2019) in his research entitled "Physiotherapy Services for Arkus Pedis Form Examination (Normal Foot, Flat Foot, And Cavus Foot) and Walking Pattern Examination (Stride Length, Step Length, Cadence, And Speed) in Children at SDN 8 Dauh Puri Denpasar". This method is then used as the basic formula for determining flat foot conditions in this study. Then the study subjects who experienced flat foot were measured by the degree of Q angle knee joint using a goniometer before being given a custom foot orthosis and after being given a custom foot orthosis.

From the results of the research conducted, it is known that the patient's Q angle knee joint degree is greater at the time of pre-intervention or when the subject has not been given a custom foot orthosis compared to post intervention, namely after the study subject is given an intervention in the form of using a custom foot orthosis for 1 month. Before being given a custom foot orthosis, the average magnitude of the Q degree angle knee joint was 13.30 while after administration the intervention the angle dropped

to an average of 7.50. So, it can be concluded that there is a difference in the difference between the average before being given an intervention and after being given an intervention, which is 5.80.

This is in accordance with the theory presented by Kurniawan et al. (2019) who said that Q angle is an important factor that needs to be considered in assessing the function of knee joints. The value of the degree of q angle in a person is said to be normal if it is in the range of 10-150. However, a person is said to be at risk of injury if they have a degree value of more than 150. The increase in the value of the degree of q angle that is outside the normal range is an indication of malalignment in the inferior extremities (Kurniawan et al., 2019). Changes in the alignment of the body can cause disturbances in the bones and joints. The World Health Organization states that hundreds of millions of people are disturbed by joint disorders (Hartvigsen et al., 2018).

Based on the results of statistical analysis using the Wilcoxon test that has been given to research subjects was obtained, so it can answer that there is a significant difference in the use of custom foot orthoses before intervention and after intervention in reducing the degree of flat foot. This is in accordance with research conducted by Jafarnezhadgero et al. (2024) which explained that there is a significant effect of using foot orthosis on the knee adduction moment or knee Q angle when walking. Based on the results of a meta-analysis conducted, the peak knee adduction moment is greater when using a custom foot orthosis. In the medial part, an arch is formed which is used to support the arcus pedis.

The heel will dampen or reduce the compressive force on the heel. The pressure on the plantar area of the foot will be distributed to the arch support, metatarsals, heel, to the forefoot. When viewed from a biomechanical perspective, the medial wedge will support the load on the foot, especially the middle leg, which functions as a shock absorber, thereby preventing pronation which will have an impact on balance. Use in the case of flat foot to increase the medial arch longitudinal arch (Kurniawan et al., 2019).

The use of custom foot orthosis will restore shape of the arch in the medial longitudinal arch. The purpose of using a custom foot orthosis (medial arch support) is so that the longitudinal arch of the medial arch can be corrected and grow like a normal foot. If the medial longitudinal arcus is supported, it can reduce the degree of Q angle in the knee joint and can improve the alignment of the foot, ankle, and knee joint.

The subject said that he became more comfortable when walking or walking and felt that he did not fall as easily as he did before wear a custom foot orthosis. The observed gait alterations suggest that foot orthoses, aiming to support the foot and ankle joint, contributed to reduced overall foot rotation as measured by external foot progression, increased peak plantarflexion moment, and increased step length (Naili., 2024). The custom foot orthosis used by the researcher is a custom foot orthosis made of 2 mm PE plastic material and given EVA/sponge according to the height of the subject of the research.

The results of research that has been carried out by the author show that the use of custom foot orthoses made of PE plastic material has a greater effect in reducing the degree of flat foot. Custom foot orthoses are good to use to help transfer weight, stabilize flexible disability, and control abnormal movement. So that the use of custom foot orthoses with a more rigid material will help reduce the degree of flat foot better and help improve alignment in the knee joint area so as to reduce the degree of Q angle knee joint of the research subject.

The incapability of the researchers to track the orthosis's ideal usage over a one-month period is a study limitation. Additionally, the material's flexibility reduced its ability to support the foot's medial arch (Jafarnezhadgero et al,. 2024). The limitations of this study are that the researchers were unable to directly monitor the duration and consistency of orthosis use by subjects over a month, so there may be variations in compliance that affect the results.

In addition, the flexible nature of the orthosis material makes the medial arch support less than optimal, so the biomechanical correction achieved may not be maximal. Therefore, further research is recommended to use stiffer and more durable orthosis materials, implement stricter compliance monitoring, and involve a larger sample size to strengthen the evidence of the orthosis's effectiveness in improving the Q angle and make it more generalisable.

CONCLUSION

Based on the results of the study, the use of custom foot orthoses has been proven to significantly reduce the degree of the Q angle of the knee joint in subjects with flat feet. These findings indicate that orthoses are capable of providing biomechanical correction that improves knee joint alignment. Thus, the use of foot orthoses is recommended as a supportive intervention for individuals with flat feet to help improve lower extremity alignment and reduce the risk of related musculoskeletal problems.

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DECLARATION OF USE OF AI IN SCIENTIFIC WRITING

AI tools were used solely for grammar and language editing. The authors take full responsibility for the content and integrity of the manuscript.

CONFLICT OF INTERESTS

The authors declare no conflicts of interest.

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