DOI: 10.7860/JCDR/2023/65230.18377

Original Article

Physiotherapy Section

Correlation of Toe Grip Strength among Individuals with Knee Osteoarthritis with and without Fear of Pain: A Cross-sectional Study

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ABSTRACT

Introduction: Knee Osteoarthritis (OA) is a common degenerative joint disease that affects millions of people worldwide. It is characterised by progressive loss of joint cartilage, resulting in pain, stiffness, and significant disability, leading to a reduced quality of life. Fear of pain is a significant psychosocial factor that affects individuals with knee OA, leading to decreased physical activity. However, the relationship between Toe Grip Strength (TGS) and fear of pain in individuals with knee OA is poorly understood, even though fear of pain has been known to impact strength in both the upper and lower limbs.

Aim: To examine the correlation between fear and TGS among individuals with knee OA, both with and without fear of pain.

Materials and Methods: This cross-sectional study was conducted at the Department of Physiotherapy, Nitte Institute of Physiotherapy, affiliated with the University of Mangalore, Karnataka, India, from April 2022 to March 2023. The study included 60 individuals, with 30 in each group, diagnosed with knee OA using the Kellgren and Lawrence (KL) grading system (grade 2 and above). The participants, both men and women aged between 45 and 80 years, were informed about the study's purpose. The Fear Avoidance Belief Questionnaire (FABQ) form was completed by the screened patients, who were then divided into fear and non fear groups. Body Mass Index (BMI) was determined by measuring height with a wall-mounted device and weight using a traditional analog scale. TGS was evaluated in both groups using a pinch grip dynamometer. The Pearson correlation coefficient was used for data analysis, with a p-value <0.05 considered statistically significant.

Results: The results of the current study indicated that the FABQ showed a negative correlation (p-value >0.05) with TGS (both right and left-side) (r: -0.296 (right) and -0.302 (left)), and a positive correlation (p-value <0.05) with the Numerical Pain Rating Scale (NPRS) (both during activity and at rest).

Conclusion: This study revealed a significant association between fear and TGS in individuals with knee OA. Notably, Fear Avoidance Beliefs (FAB) exhibited a negative correlation with TGS while demonstrating a positive correlation with pain levels.

Keywords: Fear, Gait, Lower limb, Pinch gauge dynamometer, Upper limb

INTRODUCTION

Worldwide, OA affects an estimated 10% of the male population and 18% of the female population over 60 years of age, making it one of the most common diseases to affect the elderly population [1]. The knee joint complex is the most commonly affected joint in OA, often accompanied by painful clinical symptoms and disability [2]. The natural prognosis of knee OA varies, as the disease can improve, remain stable, or gradually worsen in different patients [3]. Numerous researchers have extensively studied the relationship between altered knee joint mechanics and foot posture in OA [4,5]. Abnormal knee and foot loading can result in altered foot and knee kinematics [4]. Findings from studies conducted by Douglas Gross K et al., indicated that foot structure characteristics were associated with knee pathology, while Uritani D et al., theorised a link between TGS, altered forefoot function, and the occurrence or progression of knee OA [6,7]. Patients with knee OA may reduce their knee extensor moment while walking to minimise pain [8]. Toe flexor function is crucial during gait, particularly during the terminal stance phase, where it contributes to the windlass mechanism. This mechanism relies on rigid supination of the foot during the push-off phase, which facilitates smooth body progression during walking. However, in clinical practice, it is common to observe difficulties in patients with knee OA maintaining toe contact with the ground during the stance phase of gait until push-off, suggesting a possible association between knee OA and toe flexor dysfunction during walking. Therefore, it is important to investigate how flexor hallucis longus strength varies in individuals with knee OA [7].

Research has demonstrated that individuals with knee OA have weaker TGS compared to healthy individuals [7]. This weakness can lead to compensatory movements that contribute to pain and fear of movement in the affected joint. Pain, a common symptom of knee OA, can instill fear of movement or avoidance of activities that exacerbate pain. This fear can result in physical inactivity and muscle weakness, further contributing to pain and disability [8]. The Fear-Avoidance Model (FAM) is a well-suited model that establishes the relationship between the psychological aspect of pain and its impact on physical function [9]. There is a connection between how people cope with stress, their belief in their own problem-solving abilities, and the negative impact these factors can have on their mental health, pain levels, and ability to function normally. When individuals experience negative effects, they tend to avoid activities that cause pain, leading to weaker muscles, and more pain and disability [10]. The Fear-Avoidance Model (FAM) describes the development of chronic pain and has been extensively studied in relation to OA.

A definitive association between TGS and fear of movement has not been established. Therefore, this study aims to provide valuable insights into the relationship between fear of movement and TGS, enabling physiotherapists to develop targeted interventions to improve outcomes in patients with knee OA. The primary objective of this study was to assess TGS among individuals with knee OA, both with and without fear of movement, to gain insights into their functional capacity, compensatory mechanisms, fall risk, and treatment needs. The secondary objective was to determine whether fear influences pain levels among these individuals. This assessment can guide

healthcare professionals in designing appropriate interventions to enhance mobility, reduce pain, and improve overall quality of life.

MATERIALS AND METHODS

A cross-sectional study was conducted at the Department of Physiotherapy, Nitte Institute of Physiotherapy, affiliated with the University in Mangalore, Karnataka, India, from April 2022 to March 2023. Approval was obtained from the Institutional Ethics Committee (IEC) (NIPT/IEC/MIN/16/2021-2022).

Inclusion criteria: The study included individuals diagnosed with knee OA using the KL grading system (grade 2 and above) [11], including both men and women aged between 45 and 80 years. Both unilateral and bilateral knee OA were considered.

Exclusion criteria: Individuals with lower limb injuries, fractures, neurological symptoms, current ankle injuries, or current toe injuries were excluded from the study.

Sample size: The sample size was calculated based on the Standard Deviation (SD) of TGS in kilograms (3.3 SD in Group 1, SD in group 4.8%) [7]. The mean difference was set at 3, effect size at 0.5231, α error at 5%, and power at 80% for the two-sided hypothesis test. A total of 30 participants per group were required, resulting in a total sample size of 60. This calculation was performed using nMaster software version 2.

Procedure

The patients underwent screening based on the inclusion and exclusion criteria. The purpose of the study was explained, and written consent forms were obtained from the screened subjects. Demographic data of the patients were collected and recorded. The screened patients filled out the FABQ [12] and were divided into two groups: one group with fear and another without fear. TGS was assessed using a pinch grip dynamometer (Lafayette Pinch Gauge®-J00111) in both groups. For BMI, height was measured using a wall-mounted height measuring device, and weight was assessed using a traditional analog scale.

The patients were instructed to sit comfortably on a stool while the pinch gauge dynamometer was placed under their great toe, with the pressure pad directly below the distal crease of the metatarsophalangeal joint. They were then instructed to press their great toe as hard as they could without lifting their heel for three seconds, while the tester secured the foot with one hand and ensured that it remained in a neutral position. Patients were advised not to lean forward during the procedure [Table/Fig-1]. The therapist measured and recorded the forces exerted by the toe on the pressure pad for each trial before returning the Peak-Hold Needle to 0. This process was repeated three times in a row [13].

[Table/Fig-1]: Measuring TGS with pinch gauge dynamometer.

Outcome Measures

Fear Avoidance Questionnaire (FABQ) [12]: The FABQ assesses beliefs and pain-related fears regarding the need to change behaviours to avoid pain. It consists of 16 items, each scored on a scale of 0 to 6, with higher numbers indicating higher levels of fear-avoidance beliefs. The FABQ is divided into two subscales: work (FABQ-W) and physical activity (FABQ-PA). The tool has excellent reliability with an ICC of 0.88.

Pinch gauge dynamometer: The pinch dynamometer is a valid and reliable instrument for measuring pinch grip strength and small muscle group strength, as demonstrated in a study by Shamus J et al., [14].

Numerical Pain Rating Scale (NPRS): An 11-point NPRS ranging from 0-10, with 0 indicating "no pain" and 10 indicating "worst imaginable pain." Higher scores indicate greater pain intensity [15].

STATISTICAL ANALYSIS

The data were analysed using Statistical Package for the Social Sciences (SPSS) software (version 26.0, SPSS Inc.; Chicago, IL). Descriptive statistics (frequency, percentage, mean, and SD) were used to summarise the collected data. The unpaired t-test was used to compare age, BMI, FABQ, TGS, and NPRS between the groups. The Chi-square or likelihood ratio test was used to compare gender, KL grading, and affected leg between the groups. The paired t-test was used to compare TGS and NPRS. The Pearson correlation coefficient was used to find the relationship between age, BMI, FABQ, TGS, and NPRS. A p-value <0.05 was considered statistically significant.

RESULTS

This study was conducted among 60 individuals with knee OA. The participants were divided into two groups: the 'with fear' group and the 'without fear' group, each consisting of 30 participants. The majority of the participants (66.7%) were females. The age of the participants ranged from 45 to 80 years, with a mean of 59.8±8.4 [Table/Fig-2].

(N=60)	Range	Mean±SD
Age (Years)	45 to 80	59.8±8.4
BMI (Kg/m^2)	16.8 to 35.4	25.8±4.4

[Table/Fig-2]: Descriptive statistics for age and BMI.
N: Population size; BMI: Body mass index; SD: Standard deviation

Th FABQ, TGS (right and left), NPRS range mean±SD is given in [Table/Fig-3]. [Table/Fig-4] describes the various characteristics of the study participants in the two groups. In group 1 and group 2, the mean BMI, KL grading and FABQ scores are shown respectively.

Variables		Range	Mean ±SD
FABQ		12 to 90	52.1±27.2
Toe grip strength	Right	1 to 5.5	2.3±1.0
	Left	1 to 5.5	2.3±1.1
NPRS	On activity	3 to 9	6.9±1.5
	On rest	0 to 5	2.4±1.2

[Table/Fig-3]: Descriptive Statistics for FABQ, toe grip strength and NPRS.
FABQ: Fear avoidance belief questionnaire; SD: Standard deviation

Variables	Group	Mean±SD
BMI	With fear	25.0±5.01
	Without fear	26.5±3.7
KL GRADING	With fear	3.30±0.702
	Without fear	2.80±0.761
FABQ	With fear	77.83±8.039
	Without fear	26.30±7.931

[Table/Fig-4]: Comparison of FABQ, KL Grading, BMI between the two groups.
KL: Kellgren and Lawrence; FABQ: Fear avoidance belief questionnaire; SD: Standard deviation; Chi-square test was used to compare the variables between 2 groups

[Table/Fig-5] depicts the TGS in the two groups. It can be observed that on the right side, TGS in group 1 and group 2 was 2.0±0.6

and 2.6±1.3, respectively. Hence, it can be inferred that TGS on the right side was lower among patients with fear compared to the patients without fear. Using an unpaired t-test, a statistically significant difference was observed in the TGS (right-side) between the groups (p-value <0.05).

Variables		Mean±SD	"t"	p-value
Toe Grip Strength (TGS) (Right)	With fear	2.0±0.6	-2.156	0.035*
	Without fear	2.6±1.3		
Toe Grip Strength (TGS) (Left)	With fear	2.0±0.6	-2.21	0.031*
	Without fear	2.6±1.4		

[Table/Fig-5]: Comparison of the toe grip strength between the groups.
("t"=Independent sample t-test; *Significant)

On the left side, the toe grip strength in group 1 and group 2 was observed to be 2.0±0.6 and 2.633±1.4, respectively. It can be inferred that the TGS on the left side was comparatively lower among patients with fear compared to the patients without fear. Using an unpaired t-test, a statistically significant difference is observed in TGS (left-side) between the groups (p-value <0.05).

The Chi-square or Likelihood ratio test was used to compare gender, KL grading, and affected leg between the groups. There was a difference (p-value <0.05) in KL Grading as well as the affected leg between the groups [Table/Fig-6]. The NPRS scores of the study participants in the two groups are depicted in [Table/Fig-7].

Variables		Groups				Chi-square/ likelihood ratio#	p-value
		With fear		Without fear			
		n	%	n	%		
Gender	Male	11	36.7	9	30	0.300	0.584
	Female	19	63.3	21	70		
KL grading	2	4	13.3	12	40	6.619	0.037*
	3	13	43.3	12	40		
	4	13	43.3	6	20		
Affected leg	Bilateral	12	40.0	3	10	16.342#	0.003*
	Bilateral (Left more)	4	13.3	0	0		
	Bilateral (Right more)	2	6.7	2	6.7		
	Left	5	16.7	13	43.3		
	Right	7	23.3	12	40		

[Table/Fig-6]: Comparison of gender, KL grading, and affected leg between the groups.
(*Significant)

Variables		Mean±SD	"t"	p-value
NPRS (On activity)	With fear	7.6±1.0	4.069	<0.001*
	Without fear	6.2±1.6		
NPRS (On rest)	With fear	2.8±1.0	2.882	0.006*
	Without fear	1.9±1.3		

[Table/Fig-7]: Comparison of the NPRS between the groups.
("t"=Independent sample t-test; *Significant)

It can be inferred from the table that the NPRS for both activity and rest was higher among patients with fear compared to patients without fear. An unpaired t-test revealed a statistically significant difference between the groups in the mean NPRS for activity (p-value <0.001) and for rest (p-value <0.01).

A paired t-test was used to compare TGS and NPRS. There was a statistically significant difference (p-value <0.05) in NPRS between activity and rest [Table/Fig-8].

The paired t-test was used to compare TGS and NPRS within the groups. There was a difference (p-value <0.05) in NPRS between activity and rest within both the groups: with fear and without fear [Table/Fig-9].

(n=60)		Mean±SD	"t"	p-value
Toe grip strength	Right	2.3±1.0	-0.428	0.670
	Left	2.3±1.1		
NPRS	On activity	6.9±1.5	38.397	<0.001*
	On rest	2.4±1.2		

[Table/Fig-8]: Comparison of toe grip strength, and NPRS.
("t"=Paired t-test; *Significant)

Variables		With fear			Without fear		
		Mean±SD	"t"	p-value	Mean±SD	"t"	p-value
Toe grip strength	Right	2.0±0.6	0	1	2.6±1.3	-0.626	0.536
	Left	2.0±0.6			2.6±1.4		
NPRS	On activity	7.6±1.0	30.42	<0.001*	6.2±1.6	25.76	<0.001*
	On rest	2.8±1.0			1.9±1.3		

[Table/Fig-9]: Comparison of toe grip strength and NPRS within the groups.
("t"=Paired t-test; *Significant)

The Pearson correlation coefficient was used to determine the relationship between FABQ, TGS, and NPRS. FABQ showed a negative correlation (p-value >0.05) with TGS (both right and left-side) and a positive correlation (p-value <0.05) with NPRS (both for activity and rest). TGS on the right side showed a positive correlation (p-value <0.05) with the left side and a negative correlation (p-value <0.05) with NPRS (both for activity and rest). Additionally, TGS on the left side showed a negative correlation (p-value <0.05) with NPRS (both for activity and rest) [Table/Fig-10].

Variables		FABQ	Toe grip strength		NPRS	
			Right	Left	On activity	On rest
FABQ	"r"	1	-0.296	-0.302	0.468	0.371
	p-value	--	0.021*	0.019*	<0.001*	0.004*
Toe grip strength (Right)	"r"		1	0.844	-0.352	-0.349
	p-value		--	<0.001*	0.006*	0.006*
Toe grip strength (Left)	"r"			1	-0.288	-0.236
	p-value			--	0.026*	0.070*
NPRS (On activity)	"r"				1	0.784
	p-value				--	<0.001*

[Table/Fig-10]: Relation between FABQ, toe grip strength and NPRS.
("r"=Pearson correlation coefficient; *Significant)

The Pearson correlation coefficient was used to determine the relationship between age, BMI, FABQ, TGS, and NPRS. There was no correlation (p-value >0.05) observed between age, BMI, FABQ, toe grip strength, and NPRS [Table/Fig-11].

Variables		Age (Years)		BMI (Kg/M²)	
		"r"	p-value	"r"	p-value
FABQ		0.196	0.133	-0.146	0.267
Toe grip strength	Right	-0.040	0.760	-0.008	0.950
	Left	-0.058	0.661	-0.038	0.776
NPRS	On activity	0.167	0.202	-0.123	0.349
	On rest	-0.094	0.475	-0.128	0.331

[Table/Fig-11]: Relation between age, BMI; and FABQ, Toe Grip Strength (TGS) and NPRS.
("r"=Pearson correlation coefficient)

DISCUSSION

Knee OA is a common degenerative joint disease that affects millions of people worldwide. It is characterised by progressive loss of joint cartilage, pain, and stiffness, leading to significant disability and decreased quality of life. Fear of pain is a significant psychosocial factor affecting people with knee OA, resulting in decreased physical activity and poor functional outcomes [7]. However, the role of TGS in people with knee OA and its relationship with fear is not well understood.

A study conducted by Gunn AH et al., found an association between fear of movement and knee OA patients, concluding that there is a clear association between the two variables [16]. The present study also showed similar results, with a notable decrease in TGS among those with a fear of movement. When we experience fear, our bodies respond by releasing stress hormones such as cortisol, which can cause the muscles to tense up and eventually result in decreased strength [17]. Therefore, the purpose of the present study was to explore the relationship between fear and strength among individuals with knee OA.

Yardimci B et al., found that upper extremity strength was reduced in those with a fear of falling [18]. Another study found similar results, with lower extremity strength being reduced in individuals with fear [19]. The present study also demonstrated a negative correlation between fear and toe grip strength when measured using FABQ, respectively, in individuals with knee OA, which means that the higher the belief in fear, the lower the strength (p-value >0.05). The secondary goal of the study also revealed a positive relationship between fear and NPRS, implying that the more fear, the more pain (p-value <0.05). Furthermore, the study discovered that TGS was negatively correlated with pain score, implying that people with higher TGS may have less pain. Similarly, Markfelder T and Pauli P conducted a study that found a positive relationship between fear of pain and pain intensity [20]. These findings suggest that improving TGS through exercise or other interventions may be a viable treatment option for individuals with knee OA. Ingaki Y et al., conducted a study that showed that increasing age and TGS are related to falls in older adults with knee OA, highlighting the significance of evaluating TGS among patients with knee OA in routine clinical practice [21].

Overall, the study findings suggest that fear of pain negatively impacts TGS in individuals with knee OA. Therefore, TGS and fear are both important factors to consider when it comes to physical activity, stability, and quality of life in knee OA patients. The study's findings highlight the importance of addressing psychosocial factors such as fear of pain in the management of knee OA. By improving TGS and learning how to manage your fear response, one can improve their overall physical abilities and reduce the risk of falls and injuries. Treatment can involve a variety of approaches, including education about the safety and benefits of exercise and setting realistic goals [21].

Limitation(s)

The present study had limitations such as the two groups not being homogeneous with respect to age and gender. Additionally, being a cross-sectional study, causation could not be established.

CONCLUSION(S)

The study concluded that there was a significant relationship between fear and TGS among individuals with knee OA, both with and without fear of pain. FAB and TGS were negatively correlated, and FABQ was positively correlated with pain. The study provides insights into the importance of assessing TGS in individuals with knee OA and the correlation of fear of pain with TGS.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]

- Plagiarism X-checker: May 09, 2023
- Manual Googling: Jul 12, 2023
- iThenticate Software: Aug 08, 2023 (12%)

ETYMOLOGY: Author Origin

EMENDATIONS: 6

AUTHOR DECLARATION:

- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. Yes

Date of Submission: **May 08, 2023**
Date of Peer Review: **Jun 27, 2023**
Date of Acceptance: **Aug 10, 2023**
Date of Publishing: **Sep 01, 2023**