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Research Article

DO TAPING AND ORTHOSIS AFFECT PAIN, GAIT, OR FUNCTIONALITY IN MILD KNEE OSTEOARTHRITIS? A RANDOMIZED CLINICAL TRIAL

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Keywords

Athletic tape,
Braces,
Gait,
Kinesiotape,
Knee osteoarthritis.

ABSTRACT

Purpose: Taping or brace were found to be effective in the treatment of knee osteoarthritis. There is a lack about comparison of taping techniques and brace immediately after application in knee osteoarthritis. The aim of this study was to compare the effects of elastic, rigid taping, and braces applied to women with mild knee osteoarthritis on pain, gait, and knee functionality.

Methods: This study included 21 female patients with bilateral grade 2 knee osteoarthritis. Pain was evaluated with visual analog scale, functionality was evaluated with Western Ontario McMaster Osteoarthritis Index, and gait parameters were evaluated using gait analysis system at baseline and immediately after the applications. The variables were measured after 45 minute the applications on each participant with 1-day intervals.

Results: The pain, functionality, and adductor moment of the participants showed statistically significant differences between the groups before and after the applications ($p<0.05$). The difference was found in the the intragroup evaluation results of the no application assessment ($p<0.05$). Spatiotemporal parameters and the maximum-minimum knee flexion angles of the left-right difference were not statistically significant ($p>0.05$).

Conclusion: Braces had the most immediate effect on pain and functionality and elastic taping had the most immediate effect on gait in mild knee osteoartritis.

INTRODUCTION

Osteoarthritis (OA) is a complex disease that occurs due to many factors like joint structure, genetic factors, local inflammation, mechanic loads, and the cellular/biochemical process, which results in joint destruction (1-3). Gait analysis, which is conducted during the evaluation of participants with knee OA, makes it easy to determine the abnormalities of gait, to select the treatment program, to detect treatment effects, and to select the correct orthosis (4, 5).

Physical therapy applications like exercises (6-8), taping (9, 10), using orthosis (11), and manual therapy (6, 7) have an important role in the treatment of participants with knee OA.

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Positive effects of these applications were reported including decreasing pain, increasing range of motion, muscle strength, and functionality in daily activities, and improving gait, which is affected secondarily after knee OA (9, 11-13). Elastic taping decreases pain and edema and increases elasticity, muscle strength, and range of motion. It also activates the power of intrinsic improvement by stimulating muscle structure with the full range of motion and it does not cause any circulation problems in the (6, 12, 14). The therapeutic effects of rigid taping are correcting the patella's position, decreasing the load on the soft tissue, and improving the connection between the patella and trochlea. It also decreases pain by increasing muscle contraction (3, 15, 16). Some research has focused on neutral, medial, and lateral calcaneal wedges and braces that apply forces on the knee to the varus/valgus (17, 18). Mange et al. (9) investigated whether elastic or rigid taping had better immediate effects on knee OA and concluded that elastic taping was better than rigid taping in increasing knee range of motion and in decreasing pain during activity. Park et al. (19) stated that elastic taping had positive immediate effects on pain, balance, and gait in older adults.

From the study's findings, there is a lack of comparisons of the acute effects of taping and knee orthoses in women with mild knee OA and comparisons on all three applications together in the literature. This study aimed to compare the effects of elastic taping, rigid taping, and braces on pain, gait, and functionality in women with mild knee OA. The hypothesis of this study was to determine the acute effects of the elastic, rigid taping, and braces on pain, gait, and functionality for women with mild knee OA.

METHODS

This four-session, experimental, randomized study compared the effects of elastic taping, rigid taping, and knee braces. The study was carried out at the Physiotherapy and Rehabilitation Department. The study was approved by the regional review board and was conducted according to the Declaration of Helsinki. The study was conducted after permission was obtained (with the number of KA-120110) from the Non-Interventional Clinical Research Ethics Board of Hacettepe University. All the study participants were informed about the aims of the study prior to commencing the study and signed the consent form provided by the Non-Interventional Clinical Research Ethics Board of Hacettepe University. This trial was registered with clinicaltrials.gov (registration no: NCT05741996).

The order of the elastic taping, rigid taping, and braces was randomized using a computer-generated random sequence created before the research (Random.org). Both knees of

each participant were taped and braced. All tapings were performed by a certified physical therapist with 5 years of experience. The participants were allowed to become accustomed to the applied elastic taping, rigid taping, and braces before the gait analysis and evaluations. All the taping techniques and braces were similar for all the participants. The participants performed four evaluation condition trials at baseline and with the elastic taping, rigid taping, and braces after 45 minutes.

Twenty-one female participants, who were aged between 40-65 years, were diagnosed with bilateral knee OA according to the criteria of the American College of Rheumatology, had radiographically phase 2 based on the criteria identified by Kellgren & Lawrence, had active knee pain, did not receive any knee treatment in the last year, and who could understand test and evaluations, were included in the study (Figure 1)(20).

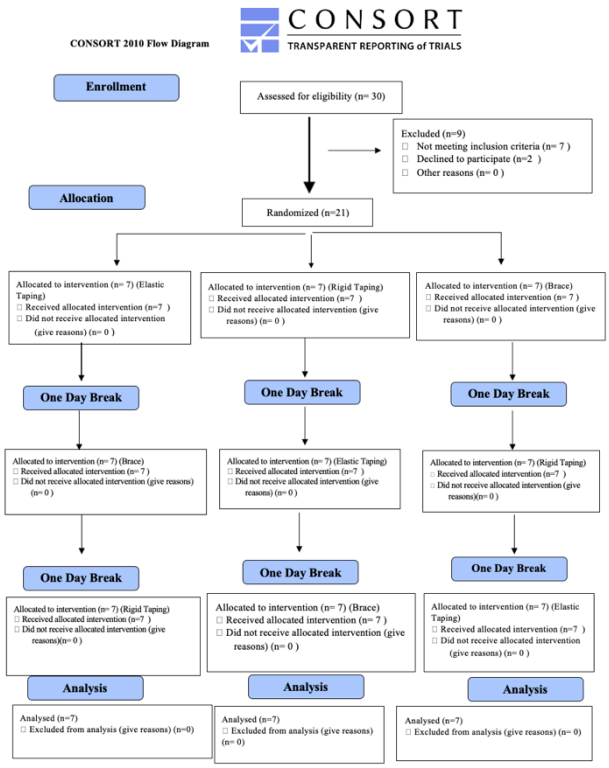

Figure 1. Flow Diagram of This Study

Participants who experienced lower extremity trauma or underwent surgery, had phase 3-4 OA severity, had any orthopedic or neurologic problem affecting walking, were allergic to taping, or did not walk independently on their own were excluded from the study.

Measurements

Each participant's knee pain was measured with a visual analog scale (VAS) that ranged from 0 (no pain) to 10 (worst pain imaginable). Four different VAS scores were recorded at first evaluation, after elastic taping, after rigid taping, and after brace application (21).

The Western Ontario and McMaster Universities Turkish Version 3.1 (WOMAC) index is a self-administered questionnaire that assesses three aspects of a patient's health status — pain, stiffness, and physical function — in those with lower limb OA. With 24 items (five about pain, two about stiffness, and 17 about difficulty with bodily functions) and a Likert scale (0–4), it was designed for people with osteoarthritis of the knee. Each subscale represents a figure and finally, a score can be obtained. Lower points represent a better health profile (22).

Gait analysis was conducted using a 3-dimensional VICON gait analysis system (Workstation Version 4.0, Oxford, UK). Each participant was assessed four times before and after the applications. The data was gathered at six high speed 50 Hz. JAI (Java Advanced Imaging) infrared digital cameras and two force plates (Bertec Force Plate, USA) in a gait analysis laboratory, which had an 8x4 gait road. Reflective indicators were placed on the patients' bodies using a standardized system called Helen Hayes Marker System. Daily walking rhythm was intended for each participant. Knee adductor–abductor moment maximum (max) and minimum (min) scores and max-min knee flexion angles were gathered for all gait cycles. Changes in spatiotemporal parameters (double support time, single support time, gait velocity, step length, step wide, and cadence) were calculated. The results were averaged from the four trials for each gait condition (23).

Intervention Protocols

The participants were evaluated for pain, gait, and functionality adaptations. For each patient, elastic taping, rigid taping, and braces were randomly applied. Between the applications, a break of at least one day was given not to affect the other participants. The participants were evaluated four times (at baseline, after elastic taping, after rigid taping, and after brace application). Measurements were taken before and 45 minutes after the application.

All tapings were applied by the same trained physiotherapist. Rigid taping was applied with hypoallergenic tape to prevent skin irritations. The hypoallergenic tape was laid over the same areas of the skin as the rigid tape. Rigid tape provided medial gliding, medial tilt, and anteroposterior tilt to the patella (Figure 2a) (3, 14).

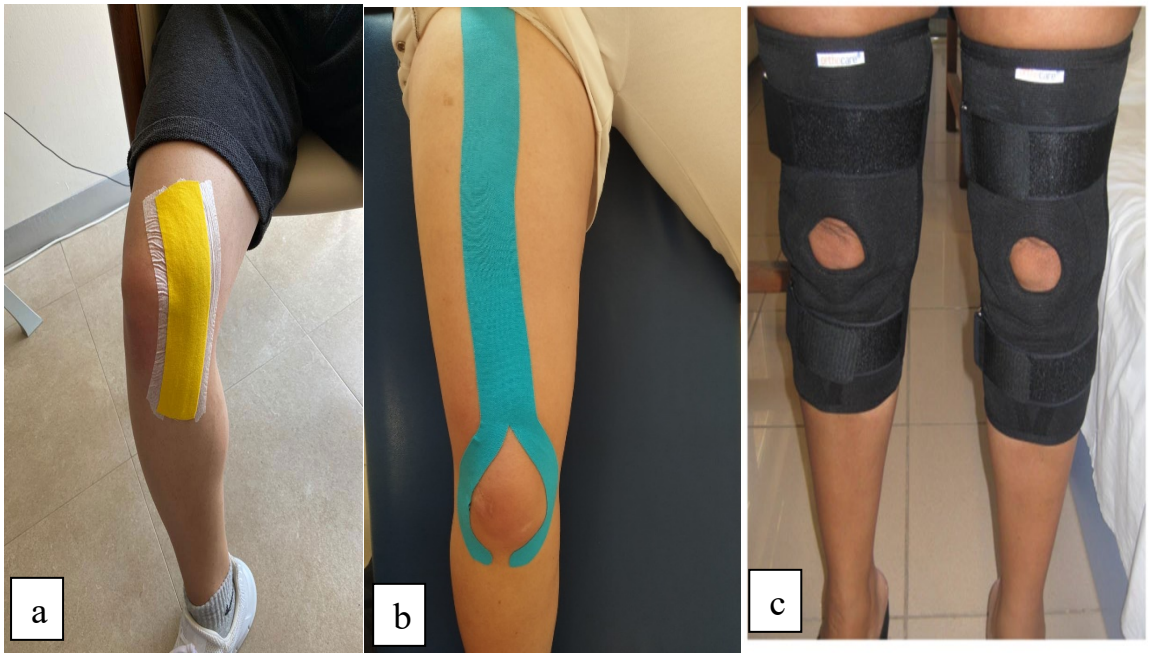

Figure 2. Rigid taping with McConnell Techique (a), Elastic Taping (b), Genucare AirX Brace (c)

The participants were taped with a Y-shaped elastic tape at the quadriceps. The patella was circled, and the tape was placed from a location 10 cm inferior to the anterior superior iliac spine, bisected at the quadriceps femoris tendon and patella junction, and finished at the inferior side of the patella. The first five centimeters of tape was not stretched and acted as the anchor. The area was expanded to 120% between the anchor and superior patella. The patella's remaining bandage was not stretched (Figure 2b) (12).

All the patients had been routinely prescribed a knee brace (Genucare Airx) by their treating physiotherapist to be used for the treatment of their OA. The brace was a fabricated system that was individually adjusted to each patient’s body measurements. This brace was a neoprene knee brace weighing less than 500 grams and did not affect the patient’s range of motion (Figure 2c) (18).

Statistical analysis

The sample size was determined using the G*power (version 3.1.9.4) program with an alpha level of 0.05, a correlation coefficient of 0.50, and a desired power (β) of 80%. The primary outcome of the randomized study was gait analysis. The estimated sample size was calculated to be at least 18 participants with at least six subjects in each group.

The statistical analyses were performed using the SPSS (version 18.0) software program. The variables were investigated using visual (histograms and probability plots) and analytical methods (Kolmogorov- Smirnov/Shapiro-Wilk's test) to determine whether they were normally distributed. Descriptive analyses were made using the median and interquartile range for the non-normally distributed and ordinal variables. To determine whether there had been a substantial change in pain, functionality, or gait analysis, Friedman tests were performed. The Bonferroni correction was used to account for multiple comparisons and to examine the significance of pairwise differences in the Wilcoxon test. An overall 5% Type-I error level was used to infer statistical significance (24).

RESULTS

Of the 30 people screened for eligibility, 21 female knee OA participants were included in this study (Figure 3). The demographic characteristics of the participants were 53.81±6.20 years for age, 158.90±7.02cm for length, 75.47±12.89 kg for weight, and 29.94±5.27 kg/m² for body mass index (Table 1).

The mean pain scores significantly changed in the groups (p=0.001). For elastic taping, there was a statistically significant difference between the first evaluation score and the score after taping (p=0.005). For rigid taping, there was a statistically significant difference before and after taping (p=0.014). For braces, there was statistically significant difference before and after the brace application (p=0.003) (Table 1).

The WOMAC index pain scores were statistically significant in the groups (p=0.022). For elastic taping (p=0.014), rigid taping (p=0.0025), and braces (p=0.009), there were statistically significant differences before and after application. The WOMAC index stiffness scores had statistically significant differences in the groups (p=0.017). For elastic taping (p=0.017), rigid taping (p=0.019), and braces (p=0.029), there were statistically significant differences before and after the applications. The WOMAC index functionality scores had statistically significant differences in the groups (p=0.042). For elastic taping (p=0.022), rigid taping (p=0.023), and braces (p=0.039), there were statistically significant differences before and after the applications (Table 2).

Significant changes were found between the right knee max adductor moment, (p=0.019), right knee min adductor moment (p=0.007) and left knee min adductor moment (p=0.003) mean scores. Significant differences in the right knee maximum adductor moment (p=0.019) and left knee minimum adductor moment were observed in the brace application (p=0.003). Rigid tape application significantly changed for the left knee max adductor moment (p=0.007) (Table 2).

Maximum and minimum knee flexion angles of the participants while walking is given in Figure 3. There was no statistically significant difference in the maximum right knee flexion range mean scores (p=0.89), the minimum right knee flexion range mean scores (p=0.29), and the maximum left knee range mean scores (p=0.78). When the minimum left knee flexion range was compared with all evaluations, a statistically significant difference was found (p=0.01) (Table 2).

The spatiotemporal parameters of gait are given in Table 3. When walking at a normal self-selected speed, no other between-group statistically significant differences were detected for the spatiotemporal parameters of gait (p>0.05).

Table 1. Demographic Features and Pain Scores of Participants (n=21)

Demographic Features	**Median (Min-Max)**
Age (year)	53 (40-65)
Length (cm)	158 (146-173)
Weight (kg)	76 (48-102)
BMI (kg/m²)	30.90 (20.0-39.10)
Pain Scores	**Median (Min-Max)**
VAS -At Baseline	6 (0-10)
VAS-Elastic Taping	5 (0-10)
VAS-Rigid Taping	5 (0-10)
VAS-Brace	4 (0-10)
Friedman Test (χ^2/ p)	16.47 / **0.001***

Max: Maximum; Min: Minimum; cm: centimeter, kg: kilogram, BMI: Body Mass Index, VAS: Visual Analog Scale, * p<0.05

Table 2. Functionality, Adductor Moment, and Knee Flexion Angle Scores of Participants

Womac	**Pain Median (Min-Max)**	**Stiffness Median (Min-Max)**	**Physical Function Median (Min-Max)**	**Total Median (Min-Max)**
First Evaluation	7(0-17)	3(0-8)	32(5-50)	40(7-76)
Elastic Taping	4(0-13)	2(0-8)	24(5-56)	30(7-72)
Rigid Taping	3(0-13)	2(0-7)	27(5-44)	34(7-60)
Brace	2(0-13)	2(0-7)	27(5-41)	35(7-60)
Friedman (χ^2/p)	9.66/ **0.02***	10.25/ **0.01***	8.19/ **0.04***	7.87/ **0.04***
	Max Adductor Moment		**Min Adductor Moment**	
N/m²	**Right Knee**	**Left Knee**	**Right Knee**	**Left Knee**
First Evaluation	0.38(0.20-0.67)	0.34(0.10-0.66)	0.003(0.001-0.008)	0.003(0.002-0.008
Elastic Taping	0.38(0.20-0.48)	0.41(0.20-0.66)	0.000(-0.06-0.06)	0.000(0.00-0.06)
Rigid Taping	0.42(0.22-0.62)	0.35(0.00-0.60)	0.002(-0.02-0.05)	0.000(-0.06-1)
Brace	0.48(0.18-0.62)	0.32(0.15-0.62)	0.01(0.00-0.04)	0.02(0.01-0.04)
Friedman (χ^2/p)	9.98/ **0.019***	4.08/ 0.25	12.12/ **0.007***	8.77/ **0.003***
	Max Flexion Angle		**Minimum Flexion Angle**	
	Right Knee	**Left Knee**	**Right Knee**	**Left Knee**
First Evaluation	43(12-58)	38(6-54)	10(1-12)	8(1-10)
Elastic Taping	39(12-60)	37(13-59)	3(1-16)	2(1-12)
Rigid Taping	45(10-57)	40(12-60)	3(1-16)	2(1-12)
Brace	39(20-64)	40(13-60)	4(0-11)	5(0-12)
Friedman (χ^2/p)	0.62/ 0.89	1.05/ 0.78	3.70/ 0.29	11.27/ **0.01***

WOMAC: Western Ontario McMaster Osteoarthrithis, N/m^2: Newton/ meter square; Max: Maximum; Min: Minimum; * p<0.05; χ^2: $Chi-square$

Table 3. Gait Parameters of Participants

Gait Parameters	First Evaluations Median (Min-Max)	Elastic Taping Median (Min-Max)	Rigid Taping Median (Min-Max)	Brace Median (Min-Max)	Friedman (χ^2/p)
Double Leg Stance (sn) (Left)	0.30(0.19-0.50)	0.30(0.26-0.48)	0.32(0.18-0.50)	0.31(0.20-0.50)	1.492/ 0.68
Double Leg Stance (sn) (Right)	0.28(0.19-0.48)	0.30(0.22-0.48)	0.30(0.18-0.50)	0.30(0.19-0.54)	3.846/0.27
Single Leg Stance (sn) (Left)	0.44(0.35-0.52)	0.44(0.32-0.50)	0.44(0.38-0.51)	0.43(0.34-0.50)	3.703/ 0.29
Single Leg Stance (sn) (Right)	0.43(0.33-0.58)	0.43(0.32-0.58)	0.42(0.36-0.52)	0.42(0.37-0.54)	0.665/0.88
Double Step Length (m)	1.05(0.85-1.030)	1.08(0.86-1.37)	1.04(0.83-1.28)	1.01(0.82-1.30)	4.00/ 0.26
Step Length (Left) (m)	0.51(0.41-0.65)	0.52(0.42-0.69)	0.51(0.41-0.65)	0.50(0.38-0.62)	2.505/ 0.47
Step Length (Right) (m)	0.54(0.44-0.65)	0.56(0.40-0.68)	0.55(0.41-0.63)	0.53(0.44-0.69)	0.81/ 0.84
Gait Speed (m/sn)	0.90(0.62-1.35)	0.90(0.64-1.52)	0.93(0.59-1.30)	0.92(0.52-1.40)	2.32/ 0.50
Gait Width (m)	0.18(0.13-0.23)	0.18(0.12-0.24)	0.18(0.12-0.24)	0.19(0.12-0.24)	2.42/ 0.48
Cadans (step/minute)	102(82-127)	104.0(84.6-131.5)	105.5(79.45-126.0)	105.5(84.20-124)	3.97/ 0.26

χ^2: $Chi-square$;; sn: second, m: meter, Max: Maximum; Min: Minimum, p>0.05

DISCUSSION

This study aimed to compare the effects of elastic taping, rigid taping, and braces on pain, gait, and functionality in women with mild knee OA. According to this study, rigid taping, elastic taping, and braces all showed improvements on pain, functionality, and gait immediately after the applications to the participants with mild knee OA. Pain and functionality improved more after the brace application. Gait improved more after the elastic taping application. This study is one of the few studies that have demonstrated that elastic taping, rigid taping, and braces are immediately effective on mild knee OA and can be a part of physical therapy applications.

Knee OA stems from loss of cartilage, and therefore, knee pain is inevitable. There are various treatment techniques available for reducing pain in individuals with knee OA (25). Elastic taping, rigid taping, and braces can be used for pain relief in literature (3, 9). Mange et al. (9) found that kinesiotape had immediate effects of pain relief, but rigid taping did not. Lu et al. (3) found that the mean VAS scores decreased in their rigid taping group compared to their no taping group. This study's results showed that all three interventions can be useful for immediate pain relief.

Functionality is the most important factor in the treatment of knee OA. A popular, dependable, and responsive indicator of the outcome for people with knee OA is the WOMAC index. Mutlu et al. (12) compared WOMAC scores in participants with knee OA using kinesiotape and placebo tape groups. Significant differences were found before and after a one-month treatment on pain, muscle strength, range of motion, and functionality. It was found that the kinesiotape group had higher scores than the placebo group. Like this study results, the first evaluations at the beginning of the study had the lowest WOMAC values. It was demonstrated in this study that both elastic and rigid taping and braces had immediate effects on functionality. Braces are the most effective method for acute effect on functionality for individuals with mild knee OA necessary for daily life activities.

A knee adduction moment may reflect the mechanical load of the medial compartment during gait in individuals with knee OA. Most studies in literature highlight the important relationship between knee OA and increasing knee adductor moments (4, 26). Fukaya et al. (27) found that severe knee OA participants had higher knee adductor moments. The result of that higher knee adductor moments causes acceleration of knee osteoarthritis process. Rezaei et al. (11) showed statistical significance about pneumatic and conventional knee brace for higher knee adductor moments. Moreover, they also noticed that a three-point knee pressure is less effective on a knee adduction moment and range of motion on participants with knee OA. In this study, it was asserted that elastic taping decreased knee adductor moments and brace increased. The increase in adductor moments may have resulted from the non-adjustable form of the brace used and from overweight participants. This result can also be considered to have contributed to the progression of gait affected by various parameters.

Most studies investigating the secondary gait changes of patients with knee OA concentrated on flexion ranges at the knee (26-29). Duffell et al. (30) and Ismailidis et al. (5) indicated that their knee OA group had less walking flexion range compared to healthy ones. As we found in this study, the participants walked with the lowest maximum and minimum

knee flexion ranges in the first evaluation. After the applications, there were no statistically significant differences, but there were clinical differences like literature.

The spatiotemporal characteristics of gait in individuals with knee OA are also affected by pain, joint stiffness, decreasing the range of motion of the joints, and worsening muscle strength (3-5, 30). Several studies concluded that gait stabilization and balance loss must be evaluated and examined in individuals with knee OA (29-31). This study results there was no difference between baseline and after all 3 applications. This result may have been related to the short duration of the application and to the fact that all participants had a mild stage of knee OA.

To the knowledge of the study's authors, this study is one of the few studies to combine elastic taping, rigid taping, and braces together to evaluate their immediate effects using gait analysis and functionality in mild knee OA. It is important to prevent progression of mild knee OA to severe knee OA.

Limitations of the Study

Finally, the limitations of this randomized study were only including participants of a single gender, OA phase-based comparisons because of all participants were women. Individuals in the severe knee OA phase and a placebo group can be included to observe changes between these groups.

CONCLUSION

This study observed the immediate effects of elastic taping, rigid taping, and braces on pain, functionality, and gait adaptations altogether. In addition, it can be concluded from this randomized study that elastic taping, rigid taping, and braces decrease pain and max-min adductor moments and increase functional ability. Moreover, this study also provides information to clinicians that patients' OA knee pain can be relieved immediately after elastic taping, rigid taping, and brace applications.

Ethics Committee Approval: Non-Interventional Clinical Research Ethics Board of Hacettepe University (with the number of KA-120110).

Informed Consent: All procedures followed were in accordance with the ethical standards of the research committee of Hacettepe University of Health Sciences and with the Helsinki Declaration of 1975, as revised in 2008. Informed consent was obtained from all patients for being included in the study.

Peer-review: Externally peer-reviewed.

Author Contributions: Conceptualization, T.Y.Ş. G.B. ; Methodology, F.E ; Software, T.Y.Ş.,SG and F.E.; Formal Analysis, T.Y.Ş., G.B. and F.E.; Investigation, T.Y.Ş., and F.E.; Resources, F.E., and T.Y.Ş.; Data Curation, F.E., and T.Y.Ş.; Writing – Original Draft, T.Y.Ş.; Writing – Review & Editing, F.E., and T.Y.Ş.; Supervision, F.E and G. B., S. G.

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