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Patellar Taping: A Radiographic Examination of the Medial Glide Technique

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ABSTRACT

The purpose of this study was to radiographically determine the effectiveness of the McConnell medial glide patellar taping technique. Twenty apparently healthy men, between ages 18 and 35, participated in this study. Subjects underwent a series of three radiographs in a modified Merchant view. First, a bilateral tangential view of the patellofemoral joints was taken to establish a baseline. Next, the same view was obtained with the experimental knees taped using the McConnell medial glide technique. Subjects then underwent a standardized exercise protocol to stress the tape and the accompanying knee structures. This was followed by a third view of the patellofemoral joints. Radiographs were measured using the Merchant congruence angle and analyzed statistically with dependent, mean difference tests. Results from this study indicate that the McConnell medial glide technique was effective in significantly moving the patella medially ($P = 0.003$), but that the tape was ineffective in maintaining this significance after exercise ($P < 0.001$). In 3 subjects (15%) of this sample, the tape was ineffective in moving the patella medially in any degree. One interesting finding was that exercise caused a statistically significant ($P = 0.016$) lateral shift from baseline in the control knees. This may suggest some clinical significance for patellar taping in preventing excessive lateral shift.

Patellofemoral pain is a common complaint among patients in the orthopaedic setting (Refs. 1–9, 14–17, 20, 22, 24, 25, 28–37; MG Kowall et al., unpublished data, 1993). Derscheid and Feiring[4] found that 30% of the patients seen in their clinic had patellofemoral pain. The causes of patellofemoral pain are numerous, but one of the most common causes is lateral tracking syndrome.[1,5,13,24,25,31,32] Some causative factors of lateral tracking of the patella include bony abnormalities, lateral retinacula tightness, iliotibial band tightness, hamstring muscles tightness, gastrocnemius muscle tightness, elongated patellar tendon or patella alta, lower extremity malalignment, such as genu valgum, increased Q angle, femoral anteversion, genu recurvatum, external tibial torsion, excessive foot pronation, and trauma.[5,6,11,23] Many authors have suggested that a muscular imbalance between the vastus medialis and vastus lateralis muscles also contributes to a lateral tracking.[8,16,17,24,25] Many treatment regimens have been developed to rehabilitate patellofemoral disorders such as tracking disorders. Most of these programs involve a customized quadriceps muscles strengthening program combined with one or more of the following: flexibility training, proprioceptive training, endurance training, bracing or external support, foot orthoses, medications, patient education, modalities, and, in severe cases, surgical intervention.[1,3,7,14,15,24,25,31–35]

Bracing and external support as a means of conservative management have been described.[7,28,35,37] Palumbo[28] reported success using a dynamic patellar brace that exerts a medial force on the lateral surface of the patella. Levine and Splain[22] also reported success in decreasing pain using an infrapatellar strap.

McConnell taping, another recent means of treatment with external support, is frequently mentioned in the literature.[1,5,9,24,25,31,32,35–37] McConnell[24,25] introduced this technique and her program in the mid 1980s as a means of controlling patellar maltracking, decreasing pain, and enhancing quadriceps muscles rehabilitation. The taping is intended to serve as a customized brace that helps control lateral patellar maltracking, rotation, and tilt. This program also involves specific strengthening and stretching activities. Initially, McConnell[25] reported a 92% success rate when using this program. On a later occasion, she reported a 96% success rate within the athletic population and a 75% success rate within a workers' compensation population.[24] Gerrard,[9] in a clinical trial of the McConnell program, reported that 86% of his subjects resumed pain-free normal activity and retained these results at a 12-month follow-up examination. Both McConnell's and Ger-

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rard's studies, however, were performed without a control group and lack objective evidence to support the use of taping.

A controlled study (MG Kowall et al., unpublished data, 1993) compared rehabilitation success between taped and untaped groups in an otherwise identical rehabilitation program. Their study rated success in several areas including radiographic imaging, isokinetic muscle testing, visual analog pain scale, EMG activity of the vastus medialis and lateralis muscles, and patient reports of other subjective data such as ease in performing various activities of daily living and athletic activity. Each of these parameters were tested before and after a rehabilitation program. The results of their study indicated that "there is no beneficial effect of adding a patellar taping program to a standard physical therapy program" in the treatment of patellofemoral pain. Brockrath et al.,[2] in another recent study, found that patellar taping did not change the congruence angle in patients with patellofemoral pain, although it did affect perceived pain, decreasing it by nearly 50%.

The purpose of the Brockrath et al. study was to quantitatively evaluate, through radiographic examination, the effectiveness of the medial glide patellar taping technique, before and after exercise, in apparently healthy men without a history of patellofemoral problems. Our goal was to validate the effectiveness of the medial glide technique in moving the patella and holding it in alignment after a specific exercise bout. The results of this study were analyzed and compared with the results of each subject's control leg, and differences were reported. The Kowall et al. study (unpublished data, 1993) was only the second study, to our knowledge, to compare taped knees with untaped knees. We hypothesized that there would be a significant difference between radiographs of the patella before and after taping and between those taken after taping and after exercise. We further hypothesized that there would be no significant difference between before and after exercise measures on the control knee.

METHODS AND MATERIALS

Subjects

This study was approved by the Human Subjects Committee at Idaho State University before its commencement. Twenty apparently healthy male volunteers between ages 18 and 35 were studied. These subjects had a mean age of 24.8 years with a standard deviation of 4.4 years. The subjects were recruited through verbal contact with students at Idaho State University. Each volunteer was asked to read and sign an informed consent form and to complete a medical history form that asked questions regarding lower extremity abnormalities. Eligibility requirements for inclusion into this study consisted of the following: 1) no history of prior knee trauma or surgery, 2) no history or evidence of patellofemoral pathology, 3) lower quarter evaluation must be negative for any neuromuscular dysfunction, 4) age between 18 and 35, and 5) ability to complete an exercise program lasting approximately 15 to 20 minutes. The methods and risks of this study were explained fully to each subject before testing.

During the course of the study, each subject's radiographs were coded with an identifying letter and marked with a 1 at baseline, 2 after taping, and 3 after exercise to avoid errors during data analysis and to ensure the subject's confidentiality.

Protocol

Subjects meeting the stated eligibility requirements were assessed for leg dominance by a functional test of kicking a ball. This resulted in 18 right-leg dominant and 2 left-leg dominant subjects. Dominant and nondominant lower extremities were then randomly assigned, by the flip of a coin, to either an experimental lower extremity group (received patellar taping) or a control lower extremity group (no patellar taping). Nine subjects had their right legs taped, and 11 had their left legs taped. An initial baseline patellofemoral radiograph was taken with the subjects in a modified Merchant view in a partial weightbearing position with their knees flexed to 40° as assessed by goniometric measurement (Fig. 1). This technique was developed by the

Figure 1. The radiographic technique used in this study is a modified Merchant view in a partial weightbearing position with the knees flexed 40°.

authors to provide a more functional view of the patellofemoral joints, since most functional activities are weightbearing. This view also allowed for closed chain active contraction of the quadriceps muscles during the radiograph.

The experimental knee was then shaved, cleaned with alcohol, prepared with Tuf-Skin spray-on tape adhesive (Cramer Products Inc., Gardner, Kansas), and taped by one investigator. The investigator was formally trained in the McConnell technique and used the medial glide procedure, applying Hypafix (Smith and Nephew DonJoy, Carlsbad, California) and rigid strapping tape (Smith and Nephew DonJoy) (Fig. 2).[24]

The investigator attempted to medially glide the patella two quadrants of each subject's patellar width when taping the patella. Each knee was taped in full extension with the quadriceps muscles relaxed. A second bilateral tangential radiograph was taken in the same position as previously described. Each subject then performed a standardized exercise protocol consisting of five sets of three repetitions, each with a 1-minute rest between each set (Fig. 3). This program was a modified version of the exercise protocols used by Keetch,[18] Gross et al.,[12] and Laughman et al.[20] in their studies on exercise and ankle taping. It was designed and selected because it allowed the subject to stress the tape in a variety of common movement planes and because it simulated many movements found in athletic activity. This protocol was also selected since the approximate time of completion would approach the 10- to 15-minute time limit in which tape is commonly found to break down in other taping procedures.[12,18,20] The mean exercise time for subjects in this study was 16 minutes, 15 seconds (range from 13 minutes, 53 seconds to 21 minutes, 15 seconds with a standard deviation of 1 minute, 59 seconds). After exercise, radiographs of the subjects' patellofemoral joints were taken using the same method previously described.

Figure 2. McConnell medial glide taping technique on the left leg.

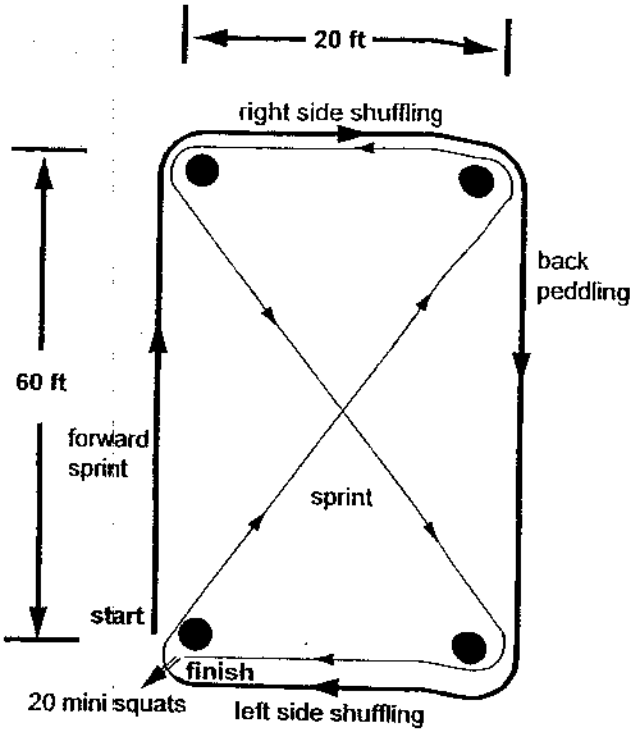

Figure 3. This exercise program consists of the following: each subject began at the start position and forward sprinted, side shuffled to the right, back pedaled, and side shuffled to the left. The subject then immediately began a figure-of-8 pattern and finished with 20 minisquats. This constituted one repetition. Each subject performed five sets of three repetitions each with a 1-minute rest period between each set.

Radiographic Examination

Traditionally, the patellofemoral joint has been examined radiographically using the sunrise view.[19] However, this view is no longer considered the view of choice among orthopaedic surgeons because more popular methods have been developed.[19] The most popular methods of viewing the patellofemoral joint include the Merchant and Laurin views.[10,19,21,26,29,30] Walsh and Helzer-Julin[36] suggest that to be able to see lateral subluxation in these views the angle of the knee should be from 30° to 45° of flexion since, at more than 45° flexion, the patella is too deeply seated in the trochlea.

In this study, we used a modified Merchant view of the patellofemoral joint in a partial weightbearing position as previously described. The radiographs were measured using the Merchant congruence angle (Fig. 4).[10,26,27,29,30] This method was chosen because it is an index of patellar

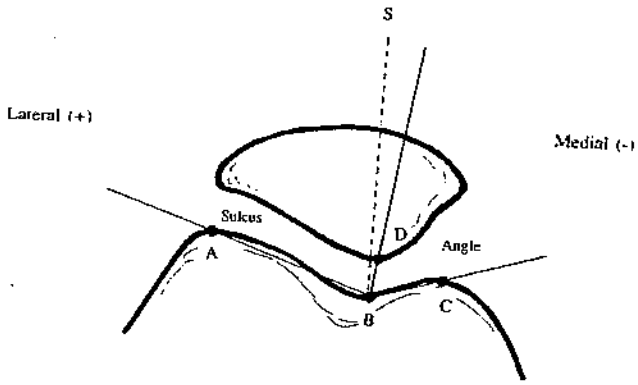

Figure 4. The Merchant congruence angle is measured by bisecting the sulcus angle (ABC) with the reference line (BS). A second line is projected (BD) from the sulcus (B) to the lowest aspect of the patella (D). The congruence angle (DBS) is negative if D is medial to the reference line (BS). The congruence angle (DBS) is positive if D is lateral to the reference line (BS). The angle DBS is expressed in positive or negative degrees.[25,27]

subluxation and does not assess patellar tilt.[30] Each radiograph was measured by two separate investigators independently, and mean values were recorded when differences in measurements existed. This was done to control for measurement and recording errors.

Data Analysis

All data were analyzed using Statistical Processing for the Social Sciences software (SPSS Inc., Chicago, Illinois). Hypothesis testing was conducted using a series of dependent, mean difference tests with a significance level set at $P < 0.05$.

RESULTS

The results of our study revealed no statistically significant difference ($P = 0.612$) in the baseline radiographic values between the subjects' two knees. This allowed the untaped knee to serve as a control for each subject throughout the study. Comparisons were then made between the control knees' baseline radiographs and the control knees' second radiographs in which the opposite knees were taped and the control knees remained untaped. No significant difference between radiographs was obtained ($P = 0.618$ and an average angle difference of only 0.9°), implying that the radiographic procedure was reliable.

To examine the effects of taping on the experimental knees, a comparison was made between the baseline measures from each subject's baseline radiograph and his after-tape measures from his second radiograph. This comparison, which revealed a statistically significant difference ($P = 0.003$), demonstrated the effectiveness of the taping procedure in moving the patella medially an average of approximately 9°. It should be noted, however, that in 3 of the 20 subjects (15%) the tape was completely ineffective in moving the patella medially in any degree. In these three cases, the radiographs taken after taping revealed no medial movement of the patella when compared with baseline radiographs. It is unclear why the tape did not move the patella medially in these three subjects since no obvious bony abnormalities were noted radiographically. Further research into this area is needed.

Additionally, comparisons were made between the values of the experimental knees' baseline radiographs and the values obtained from the after-exercise radiographs of the experimental knees. These comparisons were made to determine the tape's effectiveness in holding the patella medially after exercise. No significant difference was revealed ($P = 0.835$, and an average angle difference of only 0.58°), implying that the tape was ineffective in maintaining the patella medially after exercise. For further evaluation, comparisons were made between radiographs of the experimental knees after taping and radiographs of the experimental knees after exercise. This comparison also revealed that the tape failed to maintain the patella medially to a significance level of $P < 0.001$. Radiographic examination of one subject (Fig. 5) clearly demonstrates alterations in patellar movement (glide) at before- and after-tape and exercise positions.

Furthermore, comparisons were made between the radiographs of control knees' baseline and the control knee

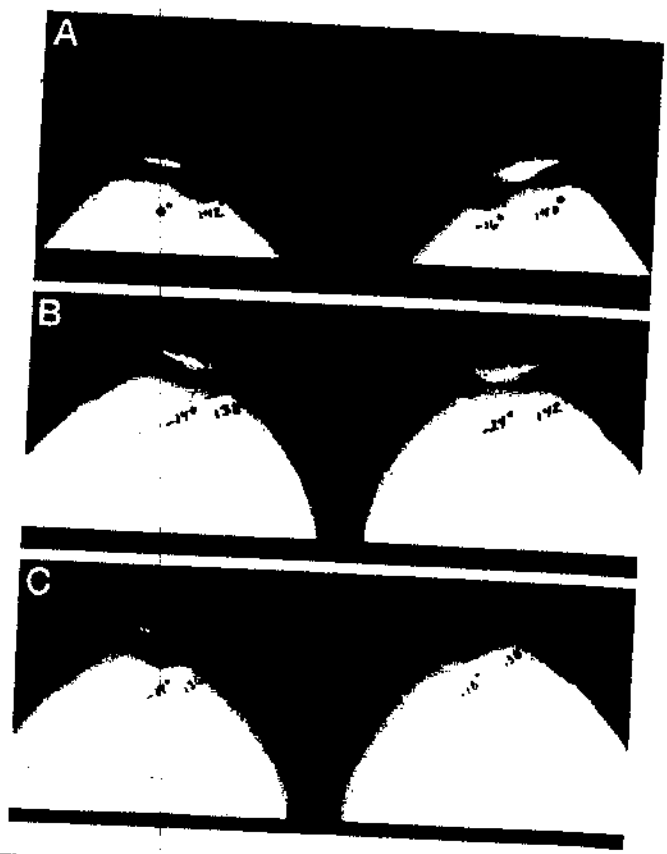

Figure 5. The three sequence radiographic views of a patient showing alterations in the Merchant congruence angle of the left and right knees. The left knee is the experimental knee taped with medial glide technique. A, baseline and before tape; B, after tape; C, after exercise.

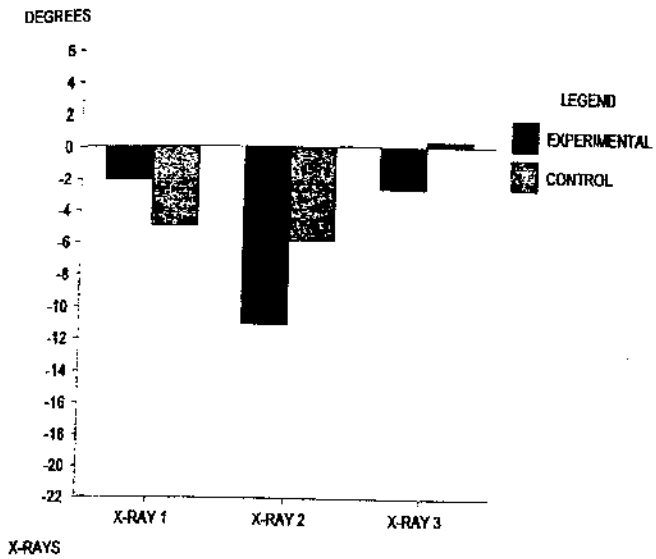

Figure 6. The mean differences between experimental and control knees on three successive radiographs: baseline, after tape, and after exercise.

radiographs taken after exercise. This comparison revealed a significant difference ($P = 0.016$), demonstrating that exercise alone caused the patella of the control knees to move laterally by an average of approximately 4.6°. To verify this, further comparisons were made between the second control radiographs and the third after-exercise control radiographs, and again significant values were achieved ($P = 0.015$) (Tables 1 through 3, Fig. 6).

DISCUSSION

In this study, the experimental knees showed a significant response to the taping procedure with the patella moving medially from baseline in 85% (17 of 20) of our subjects. This response suggests that in a small percentage of the sample (15%) patellar taping was an ineffective means of correcting patellar malalignment. Patellar taping appears, however, to be effective in the majority of the patient population studied. On designing this study, we expected that the medial glide technique would be effective in initially moving the patella medially, but that the tape would not withstand the rigors of exercise and a lateral shift of the patella would occur. These speculations were supported in our data as evidenced by comparisons between baseline and after-exercise radiographs on the experimental knees, and comparisons between radiographs of the experimental knee taken after exercise (Fig. 5). The mean differences

TABLE 1
Baseline comparison of experimental knees with control knees[a]

Baseline radiographs	Mean difference	SD	Group range
Control to experimental	2.925	25.337	−27.5 to 23.0 −56.0 to 60.0

[a] All values are in degrees.

TABLE 2
Comparison of group experimental knee values[a]

Experimental knee	Mean difference	SD	Group range
Radiograph #1 to Radiograph #2	9.050	11.653	−56.0 to 60.0 −57.5 to 28.0
Radiograph #2 to Radiograph #3	8.475	5.111	−57.5 to 28.0 −55.0 to 39.0
Radiograph #1 to Radiograph #3	0.575	12.176	−56.0 to 60.0 −55.0 to 39.0

[a] All values are in degrees.

TABLE 3
Comparison of group control knee values[a]

Control knee	Mean difference	SD	Group range
Radiograph #1 to Radiograph #2	0.900	7.928	−27.5 to 23.0 −32.0 to 31.0
Radiograph #2 to Radiograph #3	6.275	10.486	−32.0 to 31.0 −23.0 to 30.0
Radiograph #1 to Radiograph #3	5.375	9.049	−27.5 to 23.0 −23.0 to 30.0

[a] All values are in degrees.

between baseline and after-exercise radiographs showed no statistical difference and were nearly identical on the experimental knees. The mean differences between radiographs after taping and after-exercise radiographs on the experimental knees showed a strong statistical difference that suggested a breakdown in the tape (Table 2, Fig. 6).

The radiographic procedure described here appeared to be reliable as evidenced by a comparison between baseline and the second untaped radiographs on the control knees. The mean difference between these radiographs was not significant with a difference of only 0.9°. We were surprised, however, when comparing baseline to after-exercise radiographs and when comparing the second untaped radiographs to the after-exercise radiographs on the control knee to find a statistical difference between values in both cases (Table 3, Fig. 6). This suggests that exercise alone may cause the patella to track more laterally than at rest.

There are several possible reasons for this phenomenon, although none could be substantiated without further study. We speculate that the vastus medialis oblique muscle may fatigue during exercise, allowing the patella to track laterally. Also, the lateral structures such as the iliotibial band may tighten because of enlargement of the tensor fascia lata and quadriceps muscles (secondary to fluid and blood shifts that occur during exercise) causing the patella to track more laterally.[5,6,11] Another possible mechanism to explain this lateral movement of the patella after exercise may be that the medial patellar constraints, such as the medial retinaculum, become more elastic during exercise, allowing the stronger lateral structures (e.g., iliotibial band, lateral retinaculum, and vastus lateralis muscle) to pull the patella in that direction.[5,6,11]

Because the experimental knee values after exercise were similar to baseline values and the control knees values after exercise were significantly more lateral to baseline values, we reevaluated our thinking about the tape's effectiveness. Our data showed an average lateral shift of

5.375° of the patella from baseline radiographs to after-exercise radiographs in the control knees (Table 3, Fig. 6). In the experimental knees, however, when comparing baseline radiographs with after-exercise radiographs, the tape maintained the patella medially from baseline by an average of 0.575° (Table 2, Fig. 6). This information may suggest that the tape was somewhat effective in preventing an excessive lateral shift of the patella beyond baseline after exercise. Further research into this finding is necessary to reach definite conclusions.

We recognize that this study has several limitations in relating these findings to a patient population with symptomatic patellofemoral disorders. These limitations were accepted, however, to generate some initial baseline data and to serve as a springboard for further research in this arena. We used an apparently healthy homogenous male population. The reason this subject population was chosen was to eliminate sex differences and to eliminate some of the variables associated with the multiple causes of patellofemoral pain. We realize that our subject population was much different from the general patient population with patellofemoral pain, which typically consists of muscular male and female athletes and overweight adolescent women.[1,16] We also realize that our exercise protocol was more aggressive than the typical rehabilitation program for someone with patellofemoral pain. This study was only concerned with the medial glide taping technique and did not include any rotatory or tilt components that would be used in a symptomatic patient. Also, patellar movement was only measured at one angle (40°) and not throughout the full functional range of the knee.

Another limitation of our study is the relatively small sample size of 20 that was used. This gave us a statistical power of 90, but undoubtedly a larger sample size would allow greater statistical power and generalization of the results to the general population. Another possible limitation of this study is the lack of objective information about the weightbearing of the hands, buttock, and feet during the radiographs. Our attempt was to remain consistent in mimicking weightbearing and stance to give a more reliable view of what is occurring during normal activity and gait. This could be controlled in future studies by simply addressing the exact foot and buttock pressure during radiography.

Follow-up studies should attempt to use typical patellofemoral rehabilitation exercises and a pathologic subject pool to generalize these results to the symptomatic population. It may be that McConnell taping would be even more effective in a population with compromised support structures, hypermobile patellae, weakness, pain, and other signs and symptoms consistent with patellofemoral disorders. Further research is needed in this area to better understand the efficacy of patellar taping in patients with patellofemoral disorders.

CONCLUSIONS

The results of this study indicated that the McConnell medial glide taping technique was effective in moving the patella medially to a significant level, but that the tape's ability to withstand the stresses of a specific exercise program was limited in apparently healthy men. In a small percentage of the sample studied (15%), the tape was ineffective in moving the patella medially. One interesting finding was that exercise caused a statistically significant lateral shift in the patella from baseline in the control knees. Although this shift occurred in the control knees, it was not evident in the experimental knees. This finding may suggest some clinical significance for patellar taping in preventing this excessive lateral shift. Further research into this area is needed.

Since this was a relatively small study using apparently healthy men, larger prospective studies involving a symptomatic population are needed to support these claims and prove the efficacy of patellar taping.

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