

A New Knee Orthosis: Clinical Evaluation of a Patellar Band

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INTRODUCTION

Patellofemoral disorder is a disease which has very recently begun to attract some attention. Patients suffering from this disease mainly complain of pain around the patella and of knee instability. As for activities of daily living, patients feel more pain when walking up and down hills and stairs and when squatting down and standing up, rather than when walking on a flat surface. They are also often incapable of kneeling on tatami floors, in the proper Japanese manner. This disease is thought to arise from the plica syndrome, malalignment of the patella, patellar subluxation or dislocation; chondromalacia patellae is also counted as one of its causes. The presence of one or a combination of these disorders manifests in patellofemoral disorder. Our aim is to treat this disease conservatively without resorting to surgery.

With this in mind, we devised a patellar band (Figure 1) and applied it to patients as a preservative (prophylactic) treatment. We also applied this patellar band to patients having undergone surgery. In the following report, the results we obtained are described, and the effects and indications of the patellar band are discussed.

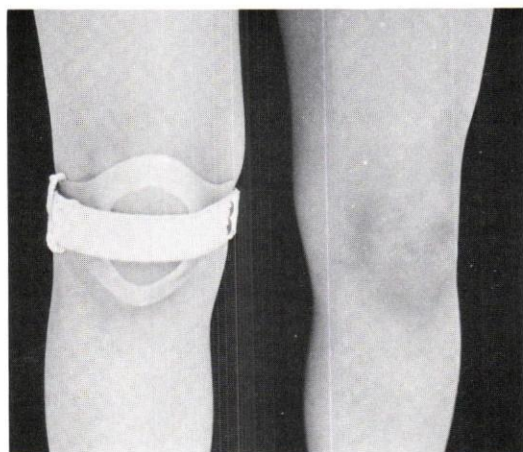


Figure 1-A. Wearing the patellar band. Frontal plane aspect (front).



Figure 1-B. Sagittal aspect (side).

MATERIALS AND METHODS

• Patellar Band

The band consists of a patellar part, which is made of silicone rubber, and popliteal parts, which function as orthosis bands (Figure 2). The silicone rubber part has a longitudinal elliptical hole and a small pad lateral to the patella; its medial portion is two and half millimeters in thickness and presses the patella mainly towards the medial condyle; its lateral portion is as thick as five millimeters and prevents lateral deviation of the patella. As the knee flexes, the tension of the band increases, becoming effective at more than 30° of flexion, resulting in strong compression toward the inside of the knee (Figure 3).

• The Contracture of Lateral Retinaculum Test or Determination of the Sponge Sign

It is important to clinically evaluate degrees of medial and lateral tensions in ligaments. In our clinic, the evaluator positions himself proximally to the head and at the foot of the patient when examining the right knee and the left knee, respectively. He then examines the knee being flexed at 30°, 45° and 60°, by placing his thumbs on the patella and grasping the knee internally with his other fingers. When the patella is medially moved, replacement of subluxation in other words, the bone touches the medial condyle. At that time, it can be determined whether or not high tension in the lateral retinaculum (malalignment) is present. In a positive case, the inspector feels as if he is pressing a sponge (sponge sign), while a negative case (normal alignment) gives no such sensations because joint surfaces make proper contact with each other.

• The Patellar Instability Test or Determination of Hypermobility and the Patient's Apprehension Sign

Medial and lateral margins of the patella are grasped under flexion of 30° or under extension, and the patella is manipulated both medially and laterally. When the pa-

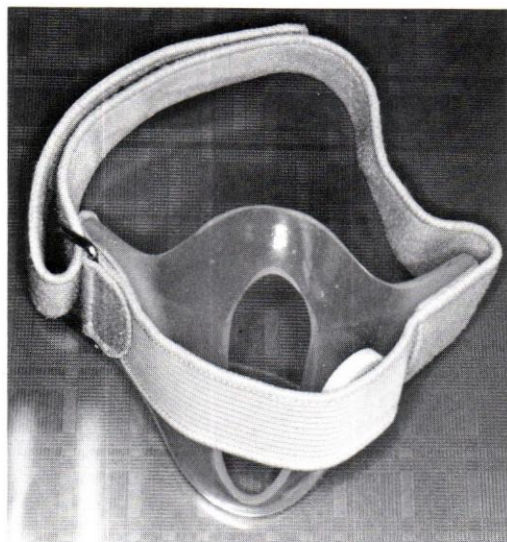


Figure 2-A. Patellar band.

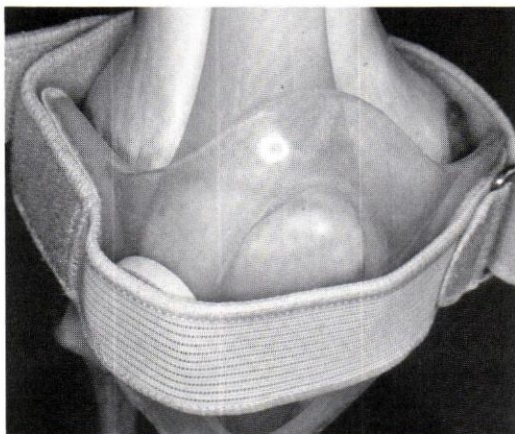


Figure 2-B. Anatomical scheme showing placement of the band.

tella laterally deviates more than a width of a finger, or when a patient becomes fearful of the movement, the case is determined to be positive. During this test, the quadriceps femoris muscle should be completely relaxed.

Classification of Patients for Whom the Patellar Band Is Indicated

Group A: Patients having plica syndrome. They lack the sponge sign of the patella, but have local tenderness in the medial patellofemoral joint and

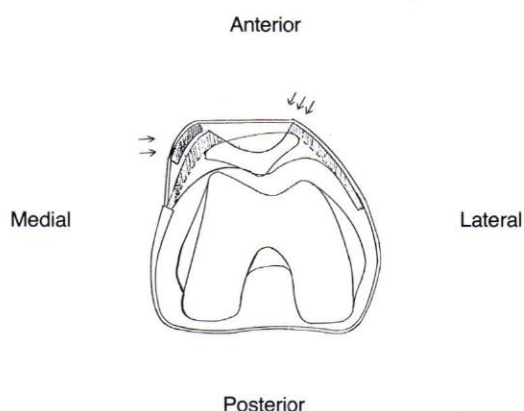


Figure 3. Functional mechanisms of the patellar band. The lateral force of the band prevents subluxation; its medial force corrects joint malalignment.

snapping of the plica, the presence of which is confirmed by arthrography.

Group B: Patients having the sponge sign of the patella. They have radiographic evidence of joint malalignment at a flexion of either 30°, 45° or 60°.

Group C: Patients having a history of patellar dislocation or showing clear evidence of the apprehension sign.

Group D: Patients having clear degeneration of the patellar cartilage. They have local tenderness in the knee on the medial and lateral sides, and are positive for the hypermobility test or show the sponge sign. Patients showing radiographic evidence of a narrowed patellofemoral joint were excluded from the study.

RESULTS

The first survey was given to 75 patients, and answers were obtained from 51 of them. These patients' main complaints were found to be: spontaneous pain, pain while moving, giving way, popliteal pain,

snapping, swelling, pain when kneeling, walking up and down stairs, kneeling for a long time, and pain when sitting in the correct manner on tatami. Among these items, improvement was observed in the first three and snapping due to the stability of the patellar movement obtained by application of the band. Many of the patients showed improvement in swelling, pain, and stability of the knee. As for activities of daily living, reduction of pain was most markedly noted.

In comparison with other orthopedic appliances, our patellar band was found to have the following advantages. It is handy (being small in size) and can be carried in a handbag. Its effects appear quickly, because its application gives a feeling of stability to patients and gradually decreases pain.

The second survey was sent to 61 patients whose ages ranged from 11 to 80 years. Follow-up periods ranged from one to eight months, with the mean being six months. The following items were included (34 patients responded).

• Preapplication evaluation:

Points	Pain	Description
20	None	Only feelings of heaviness.
15	Slight	Pain at the time of starting to move or after walking for a long time. Slight pain present when flexing knees.
10	Moderate	Pain is present while active but disappears at rest. Complete flexion could be attained, but very painful.
5	Strong	There is strong pain during active periods and sometimes while resting. Flexion is restricted to a certain degree.
0	Very strong	Very strong pain, even while resting. Flexion is almost impossible to attain.

- *Activities of daily living:*

As for walking on a flat surface, walking up and down stairs, squatting (necessary when using a Japanese toilet), standing up from bed (from the floor) and so on, degrees of pain were scored as four = none, three = slight, two = moderate, zero = incapable of the activity. The highest score possible was 40 points; the patients' points ranged from 14 to 34, with a mean of 23 points.

- *Postapplication evaluation:*

The following items were scored:

Pain: none = five, much decreased = four, decreased = two, and unchanged = zero.

Swelling: disappeared = five, slightly present = four, slightly decreased = two, and unchanged = zero.

Walking: becoming normal = five, much better = four, better = two, and unchanged = zero.

Other activities: becoming normal = five, much better = four, better = two, and unchanged = zero.

An improvement rate was then calculated by adding the preapplication score to the postapplication score and dividing the sum by the preapplication score, as described below:

Improvement rate (%) =

$$\frac{\text{Preapplication score} + \text{Postapplication score}}{\text{Preapplication score}} \times 100$$

Totals of preapplication and postapplication scores ranged from 16 to 59 points, with a mean of 42 points. Improvement rates of each group are as follows:

Group A (7 cases)	158.3%
Group B (9 cases)	159.0%
Group C (31 cases)	142.0%
Group D (4 cases)	134.0%

There were no significant differences between the groups.

In consideration of the results of tests previously mentioned, one of the four patients in Group A underwent excision of the plica, as shown in the Table, and the remaining three showed decreases in pain after application of the band.

Almost all of the 13 patients in Group B underwent lateral release and began to walk while wearing the band one week after surgery. At the time of surgery, plica was also removed in those cases having it. Only one of the six patients in Group C underwent surgery.

In Group D, which consisted of nine patients, patients who had no radiographic evidence of degeneration in joint cartilages wore the band and intra-articularly received mucopolysaccharides.

Effects of the band were expressed as excellent (++), good (+), or effective (-). Surgical treatment was performed on ineffective cases, and such cases then wore the band after surgery. Cases showing excellent responses to the application of the band were those who did not show the sponge sign, were positive for hypermobility, and had no local tenderness on the surface of the patellofemoral joint. Among the four groups, excellent responses were most frequently seen in Group C (Figures 4 and 5).

DISCUSSION

Joint malalignment due to plica formation and due to abnormal axial rotation of the patella, patellar subluxation and dislocation are involved in patellofemoral disorder. In the presence of these disorders, the patellar cartilage is always subjected to shock and gradually degenerates into chondromalacia patellae. Needless to say, direct trauma to the patellar cartilage can also cause this disease. The abnormal axial rotation in such cases is mainly induced by hypertension in lateral ligaments, or it may occur by hypermobility of the patella as the patella laterally deviates to a large extent. Thus, it is generally agreed that there are two types of abnormal axial rotation of the patella. Our patellar band was more effective in the latter type.



Figure 4-A. Case report: N.S., an 11-year-old girl in Group C. This patient had buckling of the knee joint and lateral deviation of the patella one year previously (examined in February, 1986). Right knee at 30° flexion.

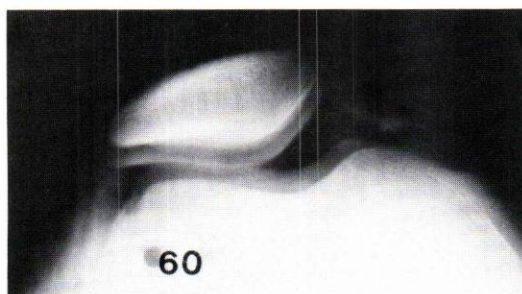


Figure 4-B. Right knee at 60° flexion.

- Group A (plica syndrome): Because the application of the band reduces or extinguishes pain, the band is only applied when the patient is playing sports. In cases with strong pain or in those showing no responses to conservative treatment, we surgically remove the medial plica.

- Group B (malalignment): Since most patients suffer strong pain and have insufficient response to the application of the band when they exhibit the sponge sign, they usually request surgical treatment. Therefore, we have recently performed lateral release in all cases included in Group B along with the excision of the plica, if present. After the operation, many cases complain of instability of the patella and of giving way of the knee joint; for these reasons the band is automatically applied after the removal of sutures in these cases. This seems to contribute to stable walking and the recovery of knee functions. Although its mechanisms are

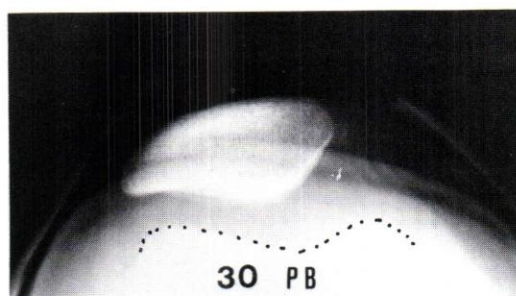


Figure 5-A. Case report: the same patient as shown in Figure 4 when wearing the band (June, 1986) with the right knee at 30° flexion.

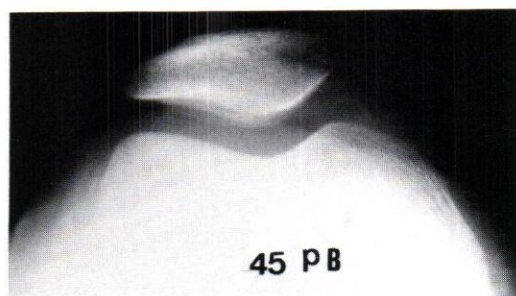


Figure 5-B. Right knee at 45° flexion.

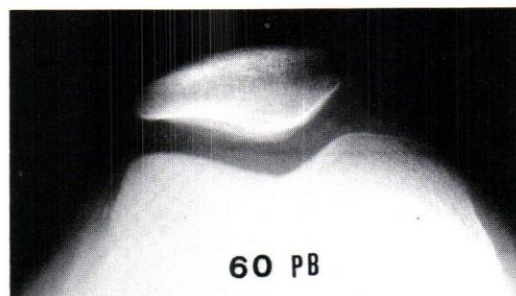


Figure 5-C. Right knee at 60° flexion.

not yet clarified, the band may play a certain type of "feedback-like" role.

- Group C (subluxation and dislocation): In this group, all patients had a history of dislocation. We performed surgical treatment in one case. This patient suffered his dislocation while playing sports and was brought to our hospital by ambulance. The patient had an intra-articular hematoma, and, therefore, lateral release of the retinaculum was made during arthroscopic examination. All other cases in

Name	Age	Mal- alignment	Hyper- mobility	Ope	P.B. Duration	Effect
A M.H	Rt 21	+	-	R.P., L.R.	3 M	+
A T.H	Bil 18	-	-		3 M	+
A K.H	Bil 15	-	-		3 M	+
A H.Y	Bil 18	-	-		6 M	+
B K.K	Bil 18	+	-	R.P., L.R.	3 M (P.O.)	-
B Y.Y	Bil 27	+	-	R.P., L.R.	2 M (P.O.)	++
B A.F	Rt 21	+	-	R.P., L.R.	3 M (P.O.)	-
B S.T.	Rt 18	-	-	R.P.+L.R.	3 M (P.O.)	+
B K.T.	Bil 28	+	-	R.P.+L.R.	3 M (P.O.)	
B N.H	Bil 21	+	-	V.T.	3 M (P.O.)	-
B H.M.	Bil 22	+	+	R.P.+L.R.	3 M (P.O.)	-
B E.N.	Bil 35	-	+		4 M	++
B S.M	Bil 38	+	-	P.P.+L.R.	4 M (P.O.)	
B T.S	Bil 11	+	-	R.P.→L.R.	2 M (P.O.)	+
B M.M	Bil 11	+	+	M.T.+L.R.	3 M (P.O.)	
B T.R.	Bil 16	+	-	R.P.+L.R.	2 M (P.O.)	
B I.M.	Bil 47	+	-		1 Y 2 M	+
C N.S.	Bil 11	++	++		R 1 Y 2 M • L 1 Y	++
C T.K	Bil 38	++	++	L.R.	3 M (P.O.)	++
C T.M.	Rt 57	+	-		3 M	++
C N.K.	Bil 18	+	+	L.R.+R.P.	5 M (P.O.)	+
C N.M	Bil 18	+	+		2 M	++
C H.R.	Rt 16	+	+		2 M	++
D S.M	Rt 56	-	-	V.T.+L.R.	3 M (P.O.)	++
D I.Y	Bil 53	+	-		10 M	++
D T.M.	Lt 65	+	-		5 M	+
D T.T	Bil 30	+	-	M.T.+L.R.	3 M (P.O.)	+
D T.M	Lt 53	+	+		4 M	++
D S.S	Rt 54	-	+		5 M	++
D M.S	Lt 67	-	+		3 M	+
D Y.M	Lt 54	+	-		4 M	+
D M.E	Rt 57	+	-		1 Y 2 M	+

R.P. = Removal of plica

L.R. = Lateral release

P.O. = Post Operative

M.T. = Medial displacement of Tuberosity

V.T. = Ventralization of Tuberosity

++ = excellent

+ = good

- = unsatisfactory

Table 1. Individual responses to the application of the patellar band.

this group have so far shown no difficulties in performing daily activities and have not requested surgical treatment because of the absence of pain. We have followed up one case for one year and two months. He has worn the band as his exclusive therapy, and has not developed any problems. Radiographically, there are clear differences in alignment of the patella with and without the application of the band.

• Group D (chondromalacia patellae): Among the patients in this group, the most excellent responses were found in patients without the sponge sign, but with hypermobility. In addition to the application of the band, mucopolysaccharides and steroids were intra-articularly given to patients having a clear degenerative joint disease or to those exhibiting the sponge sign. We have followed up the longest case for one year and two months.

Functional mechanisms of the patellar band: Since symptoms of the medial plica appear more often in cases with malalignment than in cases with trauma, manifestation of the symptoms seems to result from abnormal axial rotation of the patella. Our band corrects the malalignment, and pain clearly disappears or is reduced during the application of the band. We usually apply the band for the first three months and then excise the plica under arthroscope in patients who still complain of pain. However, when arthrography reveals a large medial plica, we remove this plica without hesitation.

By means of functional radiography, it was found that sufficient prevention of subluxation was achieved at flexion angles of 45° and 60°. Even though complete prevention was not obtained at a flexion angle of 30°, neither patients nor their families requested surgical treatment because insecurity in daily activities and giving way of the joint disappeared.

There were also no difficulties in squatting or walking up and down stairs whenever patients wore the band. When patients were radiographically observed over a period of time, some of them showed gradual recovery from subluxation. These

findings encourage us to continue further follow-ups. However, we still perform lateral release of the retinaculum in patients with severe subluxation and then apply the band; medial displacement of the tuberosity is needed in patients showing no improvement in x-ray films.

As for complications, many female patients developed dermatitis. (The majority of our patients were female.) Therefore, at the beginning we instruct the patients to wear the band two hours in the morning and two hours in the afternoon. A characteristic of our patellar band is that its silicone rubber closely adheres to the skin, resulting in the prevention of deviation of rotational movement of the patella. We also instruct the patients to wear the band only at times when it is required, such as while walking or playing sports. This can be easily done due to the band's handiness.

SUMMARY

The patellar band was effective against pain and instability in the patellofemoral joint. Surgical treatment was performed in patients who showed no improvement in their symptoms after wearing the band for a certain period of time (about three months). In patients undergoing lateral release of the retinaculum, the band was especially effective against postoperative buckling of the knee. Patients who already had degeneration of the cartilage have worn the band while walking or when experiencing aggravation. For a long time, some of them simultaneously receive intra-articular medication.

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