Acta Orthop. Belg., 2016, **82**, 365-371

ORIGINAL STUDY

Outcomes of combined tibial tuberosity transfer and medial patellofemoral ligament reconstruction for recurrent patellar instability

Gopalakrishna Pemmaraju, James Bassett, Raad Abbas, Gurpreet Nagra, Sanjiv Chugh, Ejaz Mughal

From the Royal Wolverhampton NHS trust, New Cross Hospital,U.K.

Patellofemoral instability is multifactorial and is associated with pathomechanics secondary to anatomical variance. Surgical management of this problem must be tailored to each patient and a thorough clinical and radiological assessment of the anatomical alignment should be carried out pre-operatively.

The aim of this study is to assess the role of medial patellofemoral ligament reconstruction combined with tibial tuberosity transfer in patients with increased tibial tuberosity to trochlear groove (TT-TG) distance. Twenty-four patients (27 knees) over 2-years were operated on by a single surgeon, with standardised post-operative rehabilitation and follow up. Mean follow up was 31-months. Two patients had problems with recurrent instability, 1 had a traumatic re-dislocation at 2 years and a total of 4 required further operation for complications. Mean post-operative Kujala scores were 87.4 (SD 9.8).

Combined medial patellofemoral ligament reconstruction and tibial tuberosity transfer is an appropriate treatment for patients with increased TT-TG distance.

Keywords : patella dislocation ; patella instability ; medial patellofemoral ligament reconstruction ; tibial tuberosity transfer.

INTRODUCTION

Patients who develop patellofemoral instability are generally found in younger age groups (*7*). From full extension to approximately 30 degrees the medial patellofemoral ligament (MPFL) plays an important role providing 50-60% of patellofemoral stability (*12*). During knee flexion the patella becomes centred in the trochlea and increasingly the lateral trochlear wall contributes to patellar stability (*5*). Dejour *et al* (*4*) found a very high incidence of trochlear dysplasia in patients with recurrent patellar instability. Another important factor is the presence of increasing tibial tuberosity to trochlear groove (TT-TG) distance found in up to (56%) of patients with patellofemoral instability (*4*). This increased distance acts as a lateral vector and therefore increasing the tension of the medial ligamentous structures.

Since the role of the MPFL in resisting lateral displacement of the patella is well established (*12*), reconstruction has become an important strategy in

■ Mr Gopalakrishna Pemmaraju, Consultant Trauma & Orthopaedics.
■ Mr James Bassett, Core Surgical Trainee Trauma and Orthopaedics.
■ Mr Raad Abbas, Clinical fellow Trauma & Orthopaedics.
■ Dr Gurpreet Nagra, Foundation Year Two, Trauma & Orthopaedics.
■ Mr Sanjiv Chugh, Consultant Trauma & Orthopaedics.
■ Mr Ejaz Mughal, Consultant Trauma & Orthopaedics.
Royal Wolverhampton NHS trust, New Cross Hospital, U.K.
Correspondence : Mr Gopalakrishna Pemmaraju, Consultant Trauma & Orthopaedics, New Cross Hospital, Wolverhampton, U.K. E-mail : gkmortho@gmail.com

No benefits or funds were received in support of this study.
The authors report no conflict of interests.

the treatment of patellar instability (*2,5,6,8*). There is however a growing consensus that when there are significant bony abnormalities, MPFL reconstruction alone may not be sufficient (*13*) and a more individual approach addressing both the ligamentous and bony abnormalities of each patient is warranted. Isolated osteotomy to medialise the tibial tuberosity does not address deficiencies in the medial restraints and can be associated with recurrent dislocations (*1*).

The aim of this study was to assess whether a combined tibial tuberosity transfer with MPFL reconstruction leads to increased morbidity in comparison to the current literature.

MATERIALS AND METHODS

From 1st January 2010 to 31st December 2012 25 patients (27 knees) underwent simultaneous tibial tuberosity transfer and MPFL reconstruction for recurrent patellar instability performed by a single surgeon. In each case the tibial tuberosity transfer was performed as the first part of the procedure followed by MPFL reconstruction using a suture anchor technique. There were 4 male and 21 female patients with a median age of 28 years (range : 16-42 years) and all were skeletally mature at the time of surgery. All patients were symptomatic from chronic patellar instability. The preoperative assessment of these patients included clinical and radiological examination for factors of instability and in some instances a Kujala score was completed (*10*). The senior author performed the clinical examination in each case and radiological assessment involved anterior-posterior, lateral and skyline views of the affected knee. Computed tomography (CT) or magnetic resonance imaging (MRI) was completed to further evaluate the knee and calculate the TT-TG distance. The decision to perform tibial tuberosity transfer and MPFL reconstruction was based on the clinical findings of an increased Q angle associated with TT-TG distance greater than 20 mm or 15-20 mm associated with trochlear dysplasia. All the patients completed a standardised post-operative rehabilitation programme, and had consultant clinic follow up at 4 weeks, 3 months and 6 months. Post-operative knee radiographs were completed to assess union of the tibial tubercle osteotomy. During clinical follow up wound complications, range of movement, patella apprehension and redislocation were recorded. Patients were finally contacted by telephone to complete a Kujala score to assess their patellofemoral pain at a mean post-operative follow up of 31 months (range 20-47).

Surgical technique

Each patient underwent general anaesthetic and was positioned supine on a standard operating table. A thigh tourniquet was applied and the leg was held using a side support at the thigh and a roll support at the foot in order to hold the knee at 45 degrees of flexion. The tibial tuberosity transfer was completed first, followed by the MPFL reconstruction as described below.

Tibial Tuberosity Transfer

A longitudinal incision approximately 6-7 cm in length was made over the tibial tuberosity staying slightly lateral to the prominence down to the tibia (Fig. 1). Minimal dissection medially or distally was completed to preserve the soft tissues. The leg was internally rotated at the foot to help guide the plane of the osteotomy completed using an oscillating saw from lateral to medial in an oblique coronal plane in the direction as shown in (Fig. 2). Internal rotation of the tibia helps to guide the osteotomy in the correct orientation producing a thin shelf of bone comprising of the tuberosity alone. An osteotome helps to break some of the bony bridges if the osteotomy is not complete (Fig. 3). Proximally the osteotomy must not disprupt the anterior tibial slope and the transition should remain smooth. Once complete, the knee is extended and the tuberosity is elevated and translated medially up to 12 mm. Due to the plane of the osteotomy, this invariably results in a degree of anteriorisation. To facilitate medialization and to achieve biomechanical off loading of the lateral PFJ the distal under surface of the patella tendon needs to be released from Hoffa's Pad. This is best done with the knee in extension and has a more marked affect in this position. An extra synovial inferolateral release is also performed, however the distal most soft tissue sleeve where the patella tendon fibres meet the periosteum of the tibial crest should be preserved as these offer some stability to the osteotomy. Finally, the osteotomy is secured under image intensifier control with two 4.0mm cannulated screws with washers placed parallel to the posterior tibial slope of the proximal tibial and to each other (Fig. 4).

Medial Patellofemoral Ligament (MPFL) Reconstruction

A 1.5 cm medial incision is made over the medial border of the patella down to bone. Two DePuy-Synthes 5.5 mm Healix anchors are placed into the medial patella facet approximately 12 mm apart in the upper two-thirds

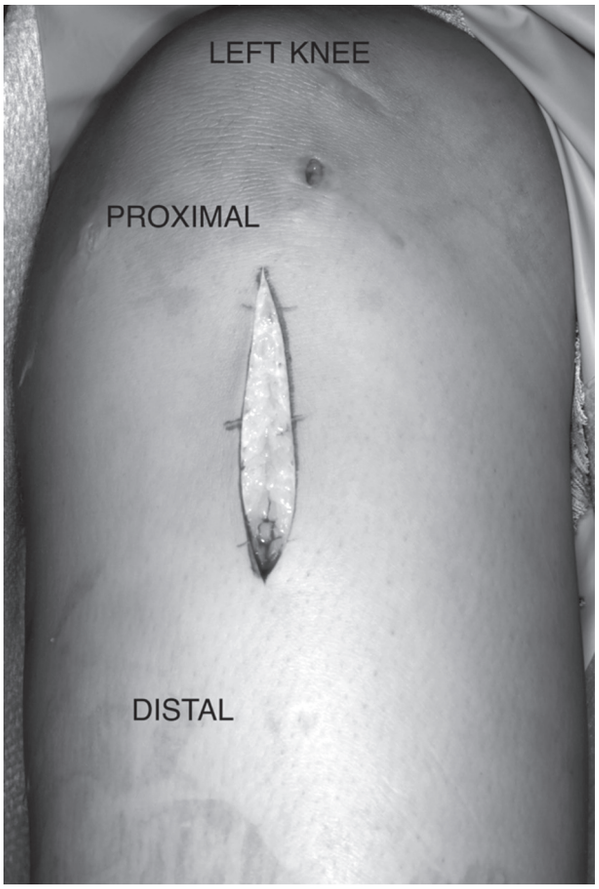

Fig. 1. — Vertical skin incision just lateral to the tibial tuberosity.

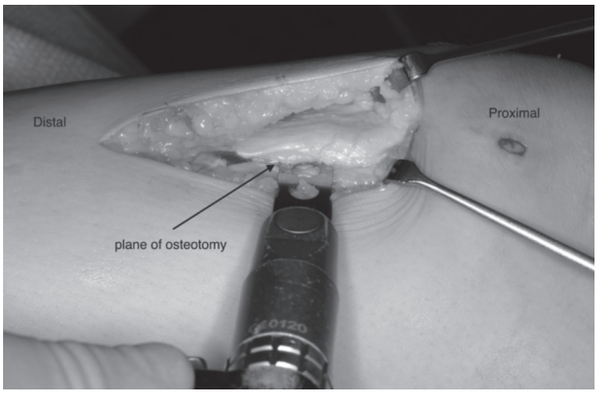

Fig. 2. — Plane of tibial tuberosity osteotomy

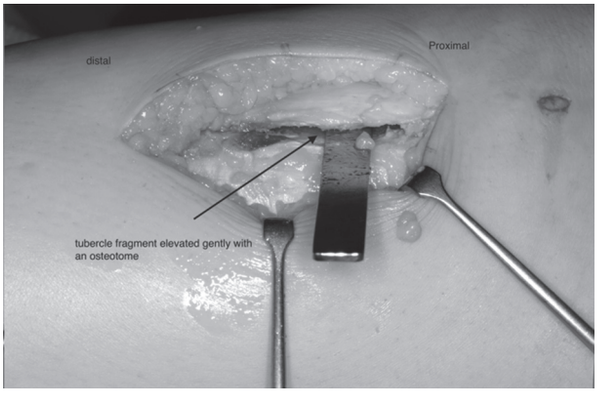

Fig. 3. — Tuberosity fragment gently elevated by an osteotome

of the medial border of the patella (Fig. 5). With the anchor delivery systems still in place, a burr is used to create a bony trough between the two anchors, after which the delivery systems may be removed. A gracilis graft (if available) is taken, prepared and then positioned perpendicular to and with its midpoint overlying the medial trough (Fig. 6). The graft is then secured using the anchor sutures to the medial border of the patella.

Under image intensifier control the MPFL attachment on the medial femoral condyle is identified and a 2 cm longitudinal incision is made over this point down to bone. An ACL guide pin with suture eye is passed under image intensifier guidance through the femoral origin of the MPFL and passed laterally, superiorly and slightly anteriorly (Fig. 7). The passing pin is over drilled with a 6mm acorn reamer stopping before reaching the far cortex. Through the same incision the fascia overlying vastus medialis is identified and incised and a small curved artery clip is used to create a plane between the overlying fascia and vastus medialis fibres towards the medial border of the patella. (Fig. 8) The graft ends are pulled through this soft tissue plane before being passed into the bone tunnel created in the femur. The knee is placed in 30 degrees flexion and with moderate tension on the graft it is secured using a 25 × 7 mm Bilok screw.

All the incisions are then closed, a dressing applied followed by wool and crepe bandage. The knee is placed in a removable hinged knee brace set at 0 to 40 degrees and the patient is allowed to partially weight bear for four weeks. After four weeks the brace was discarded and unrestricted range of motion and full weight bearing was allowed.

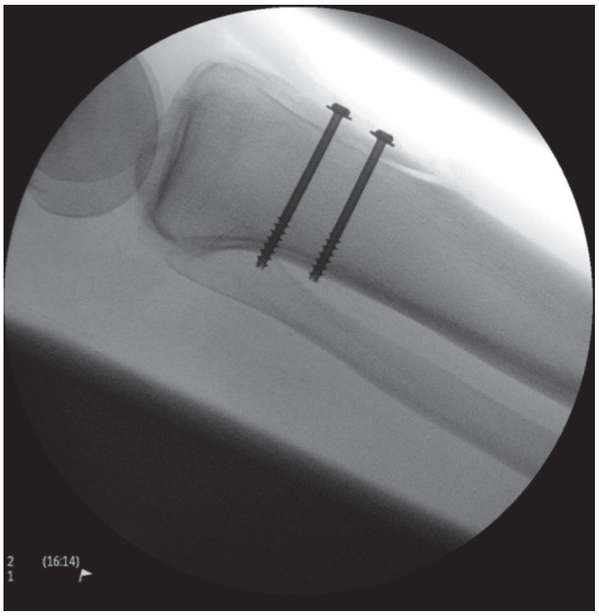

Fig. 4. — Image intensifier picture showing cannulated screws in place stabilising the tuberosity fragment.

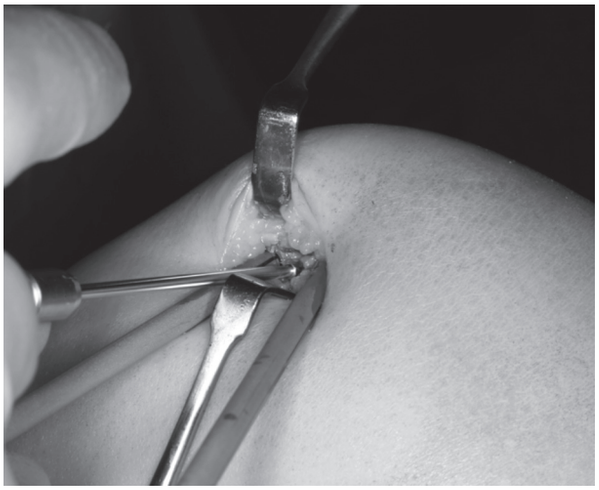

Fig. 5. — Suture anchors in place over the medial border of patella.

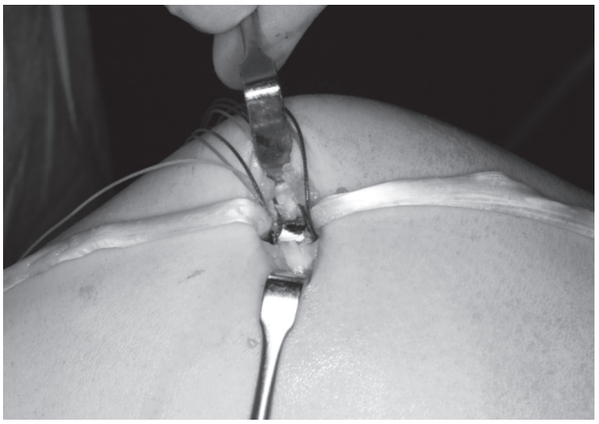

Fig. 6. — Graft positioned longitudinally centralising between the suture anchors and held in place.

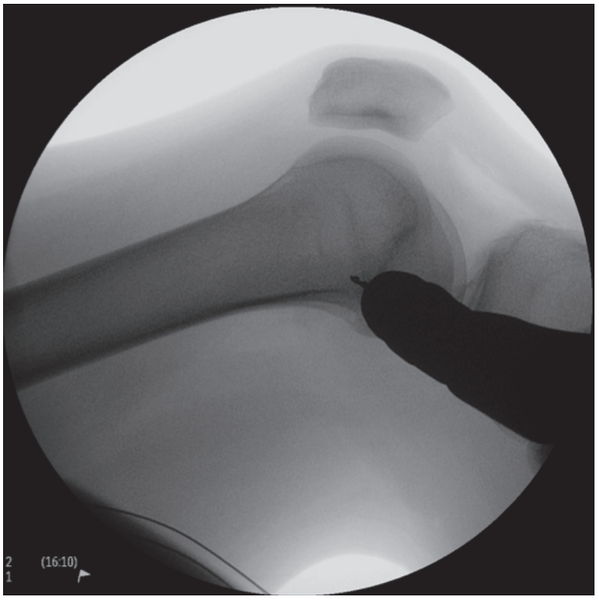

Fig. 7. — Image intensifier picture showing isometric femoral attachment point on the medial femoral condyle.

RESULTS

Patient demographics and results of follow up are displayed in table 1. There were no patients lost to follow up and all patients completed a Kujala score at follow up. Union of the tibial tuberosity transfer was satisfactory in all cases visible on plain X-ray. One patient (3.7%) had a traumatic re-dislocation at 24 months, which settled with conservative management. Two patients/3 knees (11.1%) had a persistent sensation of instability. Each of these patients underwent further operations for instability,

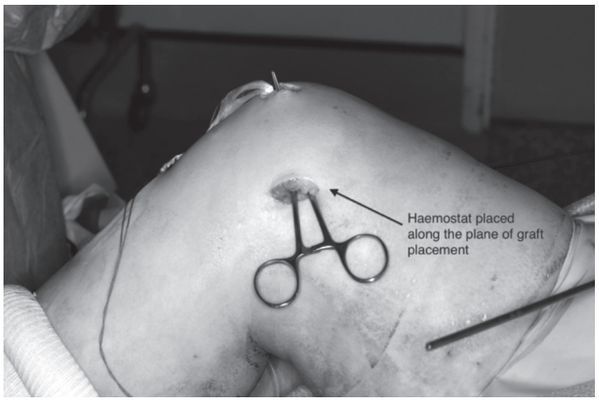

Fig. 8. — Plane for graft passage

1 patient had revision MPFL reconstruction and the other patient had trochleoplasty on one of the affected knees. Stiffness occurred in 3 patients (11.1%) and in one patient arthroscopy and removal of plica improved range of movement significantly. 2 patients (7.4%) had problems with screw irritation from the tibial tuberosity transfer, 1 necessitating removal. Scar hypersensitivity was present in 2 patients (7.4%) but had settled at final follow up. Five patients (18.5%) were found to have persistent anterior knee pain.

DISCUSSION

Several surgical modalities have been employed for the management of chronic patellar instability. The procedures advocated have been soft tissue procedures, bony procedures or a combination of the two. It is now accepted that reconstruction of the MPFL is a successful procedure for correcting chronic patellar instability particularly in patients with a history of dislocation (*11*). The majority of the patients suffering recurrent patellar dislocation have associated abnormalities of increased Q angle (reflected in increased TT-TG measured on axial cuts of CT or MRI scans) and trochlear dysplasia. All patients with patellar instability therefore require careful assessment of their longitudinal alignment to determine optimal operative management (*5*). Patients with markedly increased torsional profile may also benefit from a distal realignment procedure and not isolated MPFL reconstruction.

Table I. — Study demographics and outcomes

Patient No.	Age	Sex	Indication	TT-TG	Lateral inclination	Mean depth	Trochlear grade	Follow up	Pain	Wound problems	ROM	Redislocation	Re-operation	Metalwork	Kujala Score
1	33	F	instability+pain	>20	23	10.25		47	none	none	0-105	none		none	92
2	19	F	instability	>20	5	2.75	A	44	none	none	full	Dislocation		none	72
3	19	F	instability	>20	25	6.4		44	none	Scar hypersensitivity	full	none		none	68
4	24	F	instability+pain	>20	24	8.1		42	Anterior	none	full	none		none	77
5	16	F	instability	>20	21	8.05		38	none	none	full	none		none	98
6	17	F	instability	>20	28	7.95		35	none	none	0-100	none	Removal of plica	none	71
7	18	M	instability	>20	21	5.8		34	none	none	full	none	Removal of screws	screw irritation	94
8	28	F	instability	>20	10	2.65	C	29	none	none	full	none		screw irritation	98
9	17	F	instability	20	7	2.6	A	45	none	none	full	Instability	Revision MPFL	none	82
10 (1)	21	F	instability	>20	6	2.75	A	32	Anterior	none	full	Instability		none	74
11	32	F	instability	>20	16	3.85	A	32	none	Scar hypersensitivity	full	none		none	94
12	42	F	instability+pain	18	6	2.95	A	32	none	none	full	none		none	88
13	36	F	instability+pain	>20	11	2.85	A	32	Anterior	none	full	none		none	82
14	31	M	instability	>20	14	5.2		32	none	none	full	none		none	94
15	22	F	instability	18	8	2.65	A	29	Anterior	none	full	none		none	96
16	25	F	instability	>20	19	3.1	C	29	none	none	full	none		none	78
17 (1)	17	F	instability	17	15	2.85	A	28	none	none	full	none		none	94
10 (2)	22	F	instability	>20	13	2.95	A	28	Anterior	none	full	Instability	Trocheoplasty	none	74
18 (1)	22	F	instability	>20	14	2.6	C	27	none	none	full	none		none	98
19	15	M	instability	15	7	2.15	A	26	none	none	full	none		none	98
20	22	F	instability	>20	20	1.05	D	26	none	none	full	none		none	88
21	25	F	instability	>20	35	4.35	D	24	none	none	full	none		none	82
17 (2)	17	F	instability	>20	16	3.35		23	none	none	full	none		none	94
22	30	F	instability	>20	15	3.95		22	none	none	full	none		none	96
23	18	M	instability	>20	20	5.15		21	none	none	0-90	none		none	86
18 (2)	22	F	instability	>20	5	0	B	21	none	none	full	none		none	94
24	32	F	instability+pain	>20	9	1.5	C	20	none	none	full	none		none	98

Previous studies have shown good results of isolated medial patellofemoral ligament reconstruction with low numbers of recurrent dislocations or instability averaging fewer than 3% and post-operative Kujala scores averaging 87.77 (*11*). In comparison early isolated tibial tuberosity transfer had recurrence rates as high as 35% (*1*). More current studies have revealed better results with comparable dislocation rates to isolated medial patellofemoral ligament reoncstruction (*9*).

In one study it was suggested that the management of recurrent patellar instability should take into consideration any bony malalignment and a treatment algorithm should be formulated (*4*). In patients with significant trochlear dysplasia and enlarged TT-TG an additional procedure such as trochleoplasty with tibial tuberosity transfer should be considered (*3*). Watanabe *et al* however found that the isolated MPFL reconstruction group fared slightly better when compared with combined MPFL and Tibial tubercle transfer when assessed using visual analogue scores (*14*). Comparison between groups is difficult without knowing the dimensions of the knees included in the studies.

In our practice we perform a tibial tuberosity transfer combined with MPFL reconstruction in patients with recurrent patellar instability and an increased TT-TG distance. MPFL alone may be beneficial in patients with 'normal' alignment, but those with abnormal anatomy require corrective surgery in order to improve the biomechanics of the patellofemoral joint as well as reconstructing damage to the MPFL. We believe that medialisation of the tibial tuberosity prior to MPFL reconstruction makes the subsequent reconstruction more anatomical.

In our series we had only one re-dislocation, which was traumatic and the functional Kujala scores achieved are comparable to other published studies using isolated MPFL reconstruction. 2 patients suffering a persistent sensation of instability both had trochear dysplasia and one had symptoms sufficient to undergo trochleoplasty during the follow up period.

There are several limitations in this study, as it is retrospective with small numbers and no control group, however the numbers of patients appropriate for combined treatments are low. Longer follow up is required to assess whether the promising early results are maintained.

In conclusion, patients suffering recurrent patellar instability should be assessed thoroughly to establish the cause of recurrent instability and individualized surgical intervention should be tailored to address the various pathological factors. Using tibial tubercle transfer in combination with MPFL reconstruction is a safe procedure without significant complication rates. We attribute our results to the surgical technique used, enabling us to prescribe accelerated rehabilitation regimens.

REFERENCES

1. **Brown DE, Alexander AH, Litchman DM.** The Elmslie–Trillat procedure : evaluation in patellar dislocation and subluxation. *Am J Sports Med* 1984 ; 12 : 104 -109.
2. **Buckens CF, Saris DB.** Reconstruction of the medial patellofemoral ligament for treatment of patello femoral instability : a systematic review. *Am J Sports Med* 2010 ; 38 : 181-188.
3. **Daniel W, Florian P, Swen H, Jochen H, Freider M, Gerhard B.** The influence of risk factors on clinical outcomes following anatomical medial patellofemoral ligament (MPFL) reconstruction using gracilis tendon. *Knee Surg SportsTraumatol Arthrosc* 2013 ; 21 : 318-324.
4. **Dejour H, Walch G, Nove-Josserand L, Guier C.** Factors of patellar instability : an anatomic radiographic study. *Knee Surg Sports Traumatol Arthrosc* 1994 ; 2 : 19-26.
5. **Farahmand F, Senavongse W, Amis AA.** Quantitative study of the quadriceps muscles and trochlear groove geometry related to instability of the patellofemoral joint. *J Orhtop Res* 1998 ; 16 : 136-143.
6. **Fisher B, Nyland J, Brand E, Curtin B.** Medial patellofemoral ligament reconstruction for recurrent patellar dislocation : a systematic review including rehabilitation and return-to-sports efficacy. *Arthroscopy* 2010 ; 26 : 1384-1394.
7. **Fithian DC, Paxton EW, Stone ML *et al.*** Epidemiology and natural history of acute patellar dislocation. *Am J Sports Med*. 2004 ; 32 : 1114-1121.
8. **Howells NR, Barnett AJ, Ahearn N, Ansari A, Eldridge JD.** Medial patellofemoral ligament reconstruction : a prospective outcome assessment of a lare single centre series. *J Bone Joint Surg Br* 2012 ; 94 : 1202-1208.
9. **Koeter S, Diks MJF, Anderson PG, Wymenga AB.** A modified tibial tubercle osteotomy for patellar maltracking : Results at two years. *J Bone Joint Surg Br* 2007 ; 89 : 180-5.

10. **Kujala UM, Jakkola LH, Koskinen SK *et al.*** Scoring of patellofemoral disorders *Arthroscopy* 1993 ; 9 : 159-63.
11. **Mackay ND, Smith NA, Spalding T *et al.*** Medial patellofemoral ligament reconstruction for patellar dislocation : A systematic review. *Orthop J Sports Med* 2014 ; 2 : 2325967114544021.
12. **Senavongse W, Amis AA** The effects of articular, retinacular, or muscular defeciencies on patellofemoral joint stability. *J Bone Joint Surg Br* 2005 ; 87 : 577-582.
13. **Shah JN, Howard JS, Flanigan DC, Brophy RH, Carey JL, Lattermann C.** A systematic review of complications and failures associated with medial patellofemoral ligament reconstruction for recurrent patellar dislocation. *Am J Sports Med* 2012 ; 40 : 1916-1923.
14. **Watanabe T, Muneta T, Ikeda H, Tateishi T, Sekiya I.** Visual analog scale assessment after medial patellofemoral ligament reconstruction : with or without tibial tubercle transfer. *Joural of Orthop Science* 2008 ; 13 (1) : 32-38.