

The Outcome of Acute Quadriceps Tendon Rupture Managed with Primary Repair and Mersilene Tape Augmentation

Primer Tamir ve Mersilen Teyp ile Tedavi Edilen Akut Kuadriseps Tendon Ruptürlerinde Sonuç Analizi

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ABSTRACT Objective: To report of the results of acute quadriceps tendon ruptures that were treated by primary repair with Mersilene tape and to evaluate the strength by isokinetic testing. **Material and Methods:** Nine patients (all male with an average age of 53.7, average follow-up of 35.2 months), with acute quadriceps tendon ruptures surgically treated who were followed-up for a minimum of two years were analyzed. Clinical examination included measurement of knee range of motion and diameter of quadriceps muscle. A questionnaire was used for functional outcome. Isokinetic testing was performed at 120°/sec and 180°/sec angular velocities and bilateral work of the knee flexors and extensors was evaluated; a difference of 20% or more between the extension strengths of the affected and the unaffected limbs was considered significant. In radiologic examination, Caton index, patellar spurs, patello-femoral arthrosis and patellar malalignment were evaluated. **Results:** Average active range of motion of the affected limb was 2.7° for extension and 1350 for flexion. Mean quadriceps girth was 48.3 cm, compared with 48.6 cm in the unaffected limbs. Average time for patients returning to their pre-morbid daily activity was 3.2 months. Mean functional score was 22.7. Only one patient had a significant extension deficit with 24.3% loss at 180°/sec velocity. All the other patients were the same or better (no extension deficit greater than 20%) compared with the uninjured side. There were no degenerative changes of the patello-femoral joint, patellar malalignment or patellar spurs. The pre- and post-operative Caton index was 1.07 and 1.02, respectively. **Conclusion:** Satisfactory results with good clinical, radiologic and functional outcomes can be achieved by transosseous primary repair. Isokinetic testing indicates that our attempts to provide adequate rehabilitation for these patients postoperatively were successful. Mersilene tape augmentation may allow more aggressive rehabilitation with good quadriceps strength.

Key Words: Tendon injuries; treatment outcome; quadriceps muscle; kidney failure, chronic;

ÖZET Amaç: Primer tamir ve Mersilen teyp ile tedavi edilen akut kuadriseps tendon rüptürlerinde sonuç analizi yapmak ve izokinetik test sonuçlarını değerlendirmektir. **Gereç ve Yöntemler:** En az 2 yıl takibi olan ve akut kuadriseps tendon rüptürü nedeniyle hastanemizde cerrahi tedavi görmüş 9 hasta (9 erkek, ortalama yaş 53.7, ortalama takip süresi 35.2 ay) incelendi. Klinik değerlendirmede diz ekleme hareket açıklığı ve kuadriseps kas çapı ölçümleri yapıldı. İşlevsel değerlendirme için işlevsel sonuç anketi yapıldı. İzokinetik test, 120°/sn ve 180°/sn hızlarında uygulandı ve her hızda diz fleksör ve ekstansörlerinin yetmezliği değerlendirildi. Ekstansiyon yetmezliği için ameliyat olan taraf ile olmayan taraf arasındaki %20'lik fark veya daha fazlası anlamlı olarak kabul edildi. Radyolojik değerlendirmede Caton indeksi, patellar spür, patello-femoral artroz ve patellar dizilim değerlendirildi. **Bulgular:** Ortalama aktif ekleme hareket açıklığı, 2.7° ekstansiyon ve 135° fleksiyon olarak tespit edildi. Kuadriseps çevresi ameliyat olan tarafta ortalama 48.3 cm, olmayan tarafta 48.6 cm olarak bulundu. Hastalar ortalama 3.2 ay sonra ameliyat öncesi aktivite seviyelerine döndüler. İşlevsel skor ortalama 22.7 olarak belirlendi. Sadece bir hastada 180°/sn hızda, %24.3 kayıp ile belirgin ekstansiyon yetmezliği oluştuğu görüldü. Diğer hastaların hepsinde ameliyat olmayan taraf ile karşılaştırıldığında aynı veya daha iyi izokinetik sonuç (%20'den daha az bir ekstansiyon yetmezliği) elde edildi. Patello-femoral ekleme artrozuna, patellar dizilim bozukluğuna ve patellar spür oluşumuna rastlanmadı. Ameliyattan önce Caton indeksi 1.07, ameliyattan sonra ise 1.02 olarak tespit edildi. **Sonuç:** Kuadriseps rüptürlerinin transosseöz tamiri ile klinik, radyolojik ve fonksiyonel olarak tatminkar sonuçlar elde edilebilir. İzokinetik test sonuçları hastaların ameliyat sonrası dönemde başarılı bir şekilde rehabilite edildiğini göstermektedir. Mersilen teyp ile güçlendirme, daha dayanıklı tamir ile daha yoğun rehabilitasyona olanak sağlar.

Anahtar Kelimeler: Tendon yaralanması; tedavi sonuçları; kuadriseps; kronik böbrek yetmezliği;

Rupture of extensor mechanisms of the upper and lower extremity is common in the literature.^{1,2} In contrast, rupture of the quadriceps tendon is a relatively infrequent but serious injury that affects the extensor mechanism of the knee joint.³⁻⁵ It is most commonly seen in patients older than 40 years of age.⁶ There is a strong association between tendon ruptures and numerous systemic diseases or prior degenerative changes. Ruptures most often occur unilaterally. Bilateral ruptures are usually associated with systemic disease but have also been reported in healthy patients without predisposing factors. Classic risk factors for spontaneous rupture of the quadriceps tendon include steroid therapy, hypercholesterolemia, gout, rheumatoid arthritis, advanced age, long-term dialysis, renal transplantation and usage of fluoroquinolone use.^{6,7}

Although partial quadriceps tendon ruptures are usually treated nonsurgically, complete tendon ruptures require surgical repair. Although numerous surgical techniques have been described in the literature with or without augmentation of the quadriceps tendon the gold standard in treatment is still a matter of discussion.^{6,8-11} Several methods of augmentation of the repair site have also been described, including synthetic materials, allografts and xenografts.^{9,12,13} Suture anchors have been used with success in recent years.¹⁴ However, three types of repair continue to be the most popular: direct repair of the tendon to the patella, the Scuderi technique for acute tears and the Codivilla tendon-lengthening and repair technique for chronic ruptures.^{15,16} In the Scuderi technique, a triangular flap with 2-3 mm thickness, which is prepared from the anterior surface of the proximal tendon end, is attached approximately 5 cm above the ruptured tendon. Codivilla technique is mostly indicated for chronic ruptures where the tendon edges cannot be opposed. Recently, one of the most widely used repair techniques is the transosseous repair. In this technique, one of the most important things is that, drill holes must be far enough from the anterior surface of the patella in order to avoid any patellar tilt. Although the augmentation of the quadriceps tendon with mersilene tape has been previously described in the literature, one of the most important



FIGURE 1: Preoperative MRI view of complete quadriceps tendon rupture at the osteo-tendinous junction.



FIGURE 2: Intraoperative view of repaired quadriceps tendon.

differences of this study was the evaluation of the outcome of the quadriceps tendon repair augmented with mersilene tape by using isokinetic testing as an objective measure.¹³

Hence, the purpose of this study was to report the results of patients with acute quadriceps tendon ruptures that were treated by transosseous primary repair with Krackow sutures and Mersilene tape augmentation.

MATERIAL AND METHODS

STUDY GROUP

Patients with acute quadriceps tendon ruptures surgically treated in our hospital between January 2003 and September 2004 were enrolled in the study. The diagnosis of quadriceps tendon rupture was made with clinical examination and X-ray findings of avulsion from the proximal pole of the patella. Magnetic resonance imaging was used to confirm the diagnosis if there was any suspicion (Figure 1). Patient charts were reviewed and bilateral ruptures (simultaneous or staged), patients with systemic inflammatory disease, a history of knee surgery, concomitant patellar tendon rupture or other ligamentous injuries and previous fracture history of the knee were excluded from the study. Chronic quadriceps ruptures (ruptures 3 days after injury) and patients who had less than 2 years of follow-up were also excluded. For all patients, data regarding age, sex, mechanism of tendon rupture, presence of a recognized medical risk factor (ie. chronic renal failure, history of steroid administration, fluoroquinolone use, diabetes mellitus and hyperparathyroidism) were recorded from the patient database.

A total of 9 patients (4 right, 5 left) who met the inclusion criteria with a minimum 2-year of follow-up and who had regular outpatient controls (3 weeks, 1 month, 3 months, 6 months and annually thereafter) were found eligible for the study and their charts were retrospectively analyzed for the final evaluation. All patients were males with an average age of 53.7 (range: 39-68). Of the 9 patients, 5 had chronic renal failure as predisposing factor. These patients recalled a simple jump or fall as the cause of rupture. Additional risk factors were diabetes mellitus in one and obesity (BMI > 30) in 2 patients. The average follow-up was 35.2 months (range: 24-48 months).

OPERATIVE TREATMENT

All the patients were operated within 72 hours by 2 orthopedic surgeons. An anterior longitudinal approach was adopted. Following irrigation and exploration of the knee joint, the ruptured tendon ends

were debrided to healthy tendon tissue. Three pairs of number 5 Ethibond® (Ethicon Inc., US) sutures were placed in the distal 7 cm of the quadriceps tendon using the technique described by Krackow.¹⁷ These sutures were passed through 3 longitudinal trans-osseous patellar tunnels and were tied at the distal end. A 7 mm Mersilene Tape® (Ethicon Inc., US) was used to augment the repair. The tape was weaved through the distal 9 cm of the quadriceps tendon, coursing distally on each side of the patella and was tied around the distal pole (Figure 2). After establishing the continuity of the quadriceps tendon, the maximum flexion angle without tension or gapping at the repair site was recorded and it served as a guide to limit knee flexion during the postoperative rehabilitation program.

POSTOPERATIVE TREATMENT AND FOLLOW-UP

Full-weight bearing in a brace locked in extension was allowed in the early post-operative period. Passive knee flexion exercises were initiated in the 3rd post-operative week up to the safe angle determined intra-operatively and continued until post-operative week 6. Knee flexion was increased 10 degrees/week after week 6 and most patients had achieved full flexion at 3 months. Squatting and jumping was restricted for 6 months, after which light sports activity was allowed.

CLINICAL AND RADIOGRAPHIC EVALUATION

All clinical assessments were performed by one investigator blinded to the surgical procedure. Clinical examination included measurement of knee range of motion with a standard goniometer (Blundell Harling Ltd, London, England) and circumferential diameter of the quadriceps muscle 10 cm above the patella. Active extension power of the quadriceps was evaluated with manual testing which was a universal measure with a total of 5 scales with scale 0/5 was considered no sign of muscle contraction and 5/5 was considered as active contraction against resistance.

A functional questionnaire, previously used by Rougraff et al, was used to figure out the functional outcome in the final follow-up visit.¹⁰ The patients were questioned for 5 distinct issues including ove-

rall satisfaction, knee movement, knee strength, ability to climb stairs and pain. Each answer was given a score from one to 5; the higher the score better was the symptomatic result. Functional limitations were noted.

After a minimum of 1 year post-surgery, Isokinetic muscle testing was performed with the Cybex dynamometer (Medway-MA, USA). All tests were performed by a trained physiotherapist who was blinded to the clinical outcome. After a suitable warm-up period, the patients were asked to perform 5 repetitions of concentric/eccentric knee flexion/extension exercises with maximal effort at two different angular velocities, 120°/sec and 180°/sec. First the unaffected and then the injured knee were tested. The following parameters were recorded; peak torque, bilateral work of the knee flexors and extensors at each peak torque velocity and their totals.

Radiographic evaluation included standing anteroposterior, lateral and tangential radiographs of both knees. The patellar height was measured on the 30-degree flexion lateral radiographs using the Caton index.¹⁸ This index is calculated by dividing the length of the articular surface of the patella by the distance between the inferior articular edge of the patella and most anterior articular edge of the tibia. The Caton index was selected because we believe that it is the most reproducible technique of measurement and is not affected by the shape and size of the patella. Patellar spurs were noted. Findings of patello-femoral arthrosis and patellar malalignment were evaluated in the tangential radiographs taken at 20 degrees knee flexion described by Laurin.¹⁹

RESULTS

In the final evaluation, the average active range of motion of the affected limbs was 2.7° for extension (range 0-10 degrees) and 135° (range 120-140 degrees) for flexion. All patients were able to lift their affected limbs against manual resistance. The mean quadriceps girth of the affected limb was 48.3 cm (range 43-55 cm) compared with 48.6 cm (43-55 cm) in the unaffected limbs. The average time for patients returning to their pre-morbid daily ac-

tivity was 3.2 months (range: 2-5 months). The mean Rougraff functional score was 22.7 (min: 21, max: 24) out of 25 indicating an excellent outcome (Table 1). None of the patients reported pain or problem in climbing stairs. Only 2 patients reported that their knee felt slightly weaker during strenuous activity.

In the isokinetic measurements of extension strength at peak torque velocity, a difference of 20% or more between affected and unaffected limbs was considered significant.⁵ There were a total of 5 extension deficits out of 9 patients detected at 120°/sec velocity but neither of them had a significant deficit of greater than 20%. At 180°/sec velocity, there were 8 extension deficits and only 1 patient had a significant extension deficit with 24.3% extension loss. The extension torques of the remaining patients was better, compared with the uninjured leg at each velocity (Table 2).

Final radiological evaluation revealed no degenerative changes of the patello-femoral joint, patellar malalignment or patellar spurs. Calcifications at the musculo-tendinous junction were detected in 4 patients, however these were asymptomatic. The preoperative Caton index was 1.07. This decreased to 1.02 after surgery. However, both values were within normal limits.

DISCUSSION

Quadriceps tendon rupture usually represents the final stage of a degenerative tendinopathy resulting from repetitive microtrauma to the tendon.⁶ This

TABLE 1: Outcome analysis of the study group.

Case	120°/second		180°/second	
	Flexion (%)	Extension (%)	Flexion (%)	Extension (%)
1	-14.5	-18.1	+27.2	-12.1
2	-3.6	-4.1	-7.2	-8.3
3	+5.6	+7.2	-13.4	-8.1
4	+47.8	+19.5	-11.1	-24.3
5	-8.7	-11.1	-4.3	-2.2
6	-9.3	-13.2	-16.7	-13.7
7	-6.7	-4.5	+3.5	+4.7
8	-8.9	+12.4	-10.3	-15.4
9	-7.1	+5.6	-7.8	-5.6

TABLE 2: The results of isokinetic testing. The percentages represent the difference of quadriceps and hamstring tendons between the affected and unaffected sides at two different velocities.

Case	Age	Follow-up (months)	ROM		Functional Score	Premorbid activity (months)	Quadriceps girth Affected/Unaffected
			Flx	Ext			
1	39	34	120°	0°	21	3	46/45 cm
2	46	24	135°	5°	21	3	43/43 cm
3	60	48	135°	0°	24	2	47/47 cm
4	55	41	140°	10°	23	2	45/46 cm
5	62	39	130°	5°	22	4	47/49 cm
6	49	30	140°	5°	24	5	52/52 cm
7	68	42	140°	0°	23	3	55/55 cm
8	58	28	135°	0°	23	3	49/50 cm
9	47	31	140°	0°	24	4	51/51 cm

ROM: Range of motion, Flx: Flexion, Ext: Extension.

injury may also occur during less strenuous activity in patients whose tendons are weakened by systemic illness or the administration of local or systemic corticosteroid medications. Five of the nine patients in our series were undergoing dialysis for chronic renal failure and this was thought to be the major risk factor leading to rupture. Age, renal or endocrine disease, diabetes and multiple risk factors were also found to affect the outcome.^{11,20}

Non-surgical management of quadriceps tendon ruptures may be the accepted course of treatment for “incomplete” quadriceps tendon ruptures and jumper’s knee. For the jumper’s knee, surgical treatment is indicated only if a prolonged and well-supervised conservative treatment program fails in chronic cases (including local injection with steroid) or in acute total ruptures. In a study by Kelly et al., 13 patients (10 patellar, 3 quadriceps tendon ruptures) were evaluated. After an average of 4 years of follow-up, results indicated that patellar tendon ruptures, where the ruptures were complete, had a more favorable prognosis than those of the quadriceps tendon which were incomplete.²¹ Conservative treatment results of quadriceps ruptures are less satisfactory since these ruptures are usually incomplete and not all degenerative tissues may be involved in the healing response. On the other hand, non-surgical management of “complete” quadriceps tendon rupture yields poor results, including long-term disability and weakness.^{21,22}

After 72 hours, retraction of the tendon makes the apposition of the torn ends difficult, increasing the tension along the suture lines. For this reason, early surgical treatment of acute rupture of quadriceps tendon is recommended.^{3,5,10} Siwek et al, evaluated 36 ruptures of quadriceps tendon and concluded that patients treated after 2 weeks or more had unsatisfactory results.³ Rougraff et al, reviewed 53 ruptures and found similar results.¹⁰ In our study, all the patients were treated surgically within 72 hours after injury, and we believe that, this may be a factor for the good results achieved despite risk factors including chronic renal failure.

Multiple techniques for repair have been described in the literature.^{8,23-25} In the majority of the studies, moderate to good results have been reported, validating the effectiveness of surgical repair to achieve optimal functional results.^{5,23,25} Concerning augmentation of the repair site, there is no consensus in the literature.^{5,8,12,13} In a study by Wenzl et al, 36 traumatic ruptures of quadriceps tendon were evaluated.¹² Cerclage wire or Polyglactin bands had been used in 12 patients for augmentation. The comparison of the patients with or without augmentation revealed no significant difference and the authors concluded that routine augmentation was not necessary. In another study by Konrath et al, 45 out of 51 quadriceps tendon ruptures underwent primary suture of the tendon without augmentation.⁵ Although early active fle-

xion exercises were started immediately after surgery, only one patient had an extensor lag and one re-rupture occurred. The authors concluded that, the augmentation should be indicated only in unusually tenuous quadriceps tendon repairs. On the other hand, some investigators have recommended that augmentation of quadriceps tendon ruptures may be routinely needed, especially in patients with chronic renal failure and amyloid degeneration of the tendon.⁹ Although these patients with chronic renal failure generally do not have a high level of daily social activity and though postoperative rehabilitation can not be managed in an intense fashion due to long-lasting weekly hemodialysis sessions, we believe that, with intraoperative augmentation of the tendon, these patients can have both early but not intense rehabilitation and can have low rates of re-ruptures due to chronic degenerative effects of renal disease. As most of the patients in our study had chronic renal failure, they could not perform any high level sporting activities; however, their tendon repairs were found to be sufficient for activities of daily living. Only 2 cases had difficulty in performing higher levels of activity.

Mersilene tape augmentation was first described by Miskew et al in 1980.¹³ Though there was no control group without augmentation to compare, we believe that the non-absorbable Mersilene tape is strong enough to protect the repair during the early rehabilitation period while avoiding the skin irritation problems and the need for removal commonly seen in cerclage wire augmentation. One of the other limitations of our study was that, outcome of the chronic renal failure patients could not be compared with patients without any renal failure due to the low number of cases, nevertheless, since 5 of our 9 cases were patients with chronic renal failure, we felt augmentation would be appropriate to protect the repair site.

Several different methods have been described for the postoperative management of surgical repairs. Most studies in the literature have used a standard immobilization and rehabilitation program for their patients, regardless of the stability of repair. Postoperative immobilization in a plaster cast between 2 to 6 weeks followed by knee range of mo-

tion exercises and partial weight bearing has been advocated.^{8,24} In our series, we routinely augmented the repair in all cases. Our aim was to start the rehabilitation program in the early postoperative period without plaster immobilization. The limits of rehabilitation were based on the intraoperative stability of the repair site. Therefore, the program was tailored for each patient regarding the safe range of postoperative knee motion.

Excellent clinical results were achieved in our patients, based on the functional scoring system described by Rougraff. Apart from the subjective functional scoring system, isokinetic testing can be used as an objective tool to validate functional disability after a quadriceps tendon rupture. In a study by Li et al, the reliability of the Cybex isokinetic dynamometer in measuring the knee muscle performance was studied in 30 subjects with no previous knee injuries. The results of the study suggested that, dynamometer had high reliability in measuring isokinetic concentric and eccentric variables.²⁶ In another study by Konrath et al, 51 quadriceps tendon ruptures which were primarily repaired were evaluated by isokinetic testing and functional questionnaire. Although 53% of unilateral rupture patients had persistent quadriceps strength deficits (>20%) in the injured extremity, it was concluded that isokinetic testing correlated significantly with functional scores.⁵ Isokinetic strength testing confirmed the restitution of the extensor mechanism with almost all patients achieving muscle strength within 20% of the uninvolved side. Relatively higher speeds of 120°/sec and 180°/sec were chosen for isokinetic strength testing to avoid overloading the repair site. These findings indicate that our attempts to provide adequate rehabilitation for these patients postoperatively were successful. As the reliability of isokinetic measurement as an objective tool was confirmed previously in the literature, we believe that satisfactory rehabilitation is essential to a good functional outcome.²⁶

No radiological degenerative changes were seen. Caton index was determined by the ratio between the distance from the inferior tip of the patella to the anterosuperior angle of the tibia, and the patellar articular surface length on the lateral radiograph of the knee. This index was primarily

used to determine the patellar instability.¹⁸ There are four primary factors predisposing to patellar instability, which are trochlear dysplasia, patellar tilt, tibial tubercle offset, and patellar height.²⁷ After quadriceps tendon ruptures, a major complication is the patellar instability owing to abnormal patellar height, mostly patella alta. In our study, to determine if there was any abnormal patellar height, we used Caton index and we found that patella height remained within normal limits in all our patients after surgery.

CONCLUSION

In conclusion, our study demonstrates that, a complete functional restitution after traumatic quadriceps tendon ruptures can be achieved in most cases with good clinical, radiological and functional outcomes. Almost all patients in our study regained a full range of motion of the injured knee with no significant extension deficits. Mersilene tape augmentation may allow a more aggressive rehabilitation program in these patients.

REFERENCES

- Baydar M. [Disorders of extensor mechanism]. *Türkiye Klinikleri J Surg Med Sci* 2006;2(39): 113-6.
- Karapınar H, Altay T, Sener M. [Extensor tendon injuries]. *Türkiye Klinikleri J Surg Med Sci* 2006;2(17):21-6.
- Siwek CW, Rao JP. Ruptures of the extensor mechanism of the knee joint. *J Bone Joint Surg Am* 1981;63(6):932-7.
- Larsen E, Lund PM. Ruptures of the extensor mechanism of the knee joint. Clinical results and patellofemoral articulation. *Clin Orthop Relat Res* 1986;(213):150-3.
- Konrath GA, Chen D, Lock T, Goitz HT, Watson JT, Moed BR. Outcomes following repair of quadriceps tendon ruptures. *J Orthop Trauma* 1998;12(4):273-9.
- İlan DI, Tejwani N, Keschnr M, Leibman M. Quadriceps tendon rupture. *J Am Acad Orthop Surg* 2003;11(3):192-200.
- Casparian JM, Luchi M, Moffat RE, Hinthorn D. Quinolones and tendon ruptures. *South Med J* 2000;93(5):488-91.
- Esenyel CZ, Oztürk K, Cetiner K, Yeşiltepe R, Kara AN. [Quadriceps tendon ruptures: evaluation and treatment]. *Acta Orthop Traumatol Turc* 2005;39(2):150-5.
- Fujikawa K, Ohtani T, Matsumoto H, Seedhom BB. Reconstruction of the extensor apparatus of the knee with the Leeds-Keio ligament. *J Bone Joint Surg Br* 1994;76(2):200-3.
- Rougraff BT, Reeck CC, Essenmacher J. Complete quadriceps tendon ruptures. *Orthopedics* 1996;19(6):509-14.
- Shah MK. Outcomes in bilateral and simultaneous quadriceps tendon rupture. *Orthopedics* 2003;26(8):797-8.
- Wenzl ME, Kirchner R, Seide K, Strametz S, Jürgens C. Quadriceps tendon ruptures-is there a complete functional restitution? *Injury* 2004;35(9):922-6.
- Miskew DB, Pearson RL, Pankovich AM. Mersilene strip suture in repair of disruptions of the quadriceps and patellar tendons. *J Trauma* 1980;20(10):867-72.
- Maniscalco P, Bertone C, Rivera F, Bocchi L. A new method of repair for quadriceps tendon ruptures. A case report. *Panminerva Med* 2000;42(3):223-5.
- Scuderi C. Ruptures of the quadriceps tendon; study of twenty tendon ruptures. *Am J Surg* 1958;95(4):626-34.
- Farrell C, Scuderi G, Easley M. Patella and extensor mechanism disorders In: Insall JN, Scott WN, eds. *Surgery of the Knee*. 4th ed. London: Elsevier Churchill Livingstone; 2005. p.1127.
- Krackow KA, Thomas SC, Jones LC. A new stitch for ligament-tendon fixation. Brief note. *J Bone Joint Surg Am* 1986;68(5):764-6.
- Caton J, Deschamps G, Champat P, Lerat JL, Dejour H. Les rotules basses: A propos de 128 observations. *Rev Chir Orthop Reparatrice Appar Mot* 1982;68(5):317-25.
- Laurin CA, Lévesque HP, Dussault R, Labelle H, Peides JP. The abnormal lateral patellofemoral angle: a diagnostic roentgenographic sign of recurrent patellar subluxation. *J Bone Joint Surg Am* 1978;60(1):55-60.
- Shah MK. Simultaneous bilateral rupture of quadriceps tendons: analysis of risk factors and associations. *South Med J* 2002;95(8): 860-6.
- Kelly DW, Carter VS, Jobe FW, Kerlan RK. Patellar and quadriceps tendon ruptures--jumper's knee. *Am J Sports Med* 1984;12(5): 375-80.
- Raatikainen T, Karpakka J, Orava S. Repair of partial quadriceps tendon rupture. Observations in 28 cases. *Acta Orthop Scand* 1994;65(2):154-6.
- Rasul AT Jr, Fischer DA. Primary repair of quadriceps tendon ruptures. Results of treatment. *Clin Orthop Relat Res* 1993;(289): 205-7.
- O'Shea K, Kenny P, Donovan J, Condon F, McElwain JP. Outcomes following quadriceps tendon ruptures. *Injury* 2002;33(3):257-60.
- De Baere T, Geulette B, Manche E, Barras L. Functional results after surgical repair of quadriceps tendon rupture. *Acta Orthop Belg* 2002;68(2):146-9.
- Li RC, Wu Y, Maffulli N, Chan KM, Chan JL. Eccentric and concentric isokinetic knee flexion and extension: a reliability study using the Cybex 6000 dynamometer. *Br J Sports Med* 1996;30(2):156-60.
- Dejour H, Walch G, Nove-Josserand L, Guier C. Factors of patellar instability: an anatomic radiographic study. *Knee Surg Sports Traumatol Arthrosc* 1994;2(1):19-26.