

## Judet Quadricepsplasty for Extension Contracture of the Knee

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### ABSTRACT

*Extension contracture of the knee is a well known complication of severe femoral fractures, especially in the supracondylar region. Traditional management by the Thompson quadricepsplasty may result in a variable return of knee flexion and the possibility of significant extension lag. The Judet technique of quadricepsplasty offers the advantages of a controlled, sequential release of the intrinsic and then the extrinsic components limiting knee flexion and a reduced potential for iatrogenic quadriceps rupture or extension lag. The modified Judet quadricepsplasty has definite advantages over the Judet technique since it usually involves less soft tissue dissection and consequently less blood loss.*

## La Cuadricepsplastia Operación Judet para la Contractura en Extensión de la Rodilla

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### RESUMEN

*La contractura en extensión de la rodilla es una complicación bien conocida de las fracturas femorales severas, sobre todo en la región supracondilar. El tratamiento tradicional mediante la cuadricepsplastia de Thompson, puede traer como resultado un retorno variable de la flexión de la rodilla y la posibilidad de un intervalo de extensión significativo. La técnica de cuadricepsplastia de Judet ofrece como ventajas un accionar secuencial y controlado de los componentes intrínsecos y extrínsecos que limitan la flexión de la rodilla, así como un potencial reducido para la ruptura de los cuadriceps iatrogénicos y el intervalo de extensión. La cuadricepsplastia de Judet modificada tiene ventajas definidas sobre la técnica de Judet, ya que usualmente involucra menos disección de tejido blando, y por consiguiente menos pérdida de sangre.*

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### INTRODUCTION

Femoral fractures are routinely treated with good results with improvement in techniques of internal fixation and early rehabilitation. However, extension contracture of the knee can occur following severe femoral fractures with gross soft tissue injuries, particularly in the supracondylar region (1, 2) and after femoral lengthening by the Ilizarov method (3).

Several methods of quadricepsplasty have been described such as the Thompson and Judet techniques and their modifications (1, 3–13). Distal quadricepsplasty such as the Thompson or V-Y Flaps, should not be performed in

adults because it leads to significant permanent knee extension lag, especially when lengthening of the quadriceps tendon is required (1, 3–6, 12, 13). This extension lag may occur in children as well, but because children are growing and constantly retensioning their quadriceps muscle, it may recover (13). The preferable way of obtaining knee flexion is the Judet quadricepsplasty (7–11, 13). This is a proximally based quadriceps muscle slide that addresses all elements of knee contracture. Paley (13) has modified the incision from the original Judet technique.

Two cases of Judet quadricepsplasty and two cases of modified Judet quadricepsplasty are reported along with a review of the literature.

### Case 1

An 11-year-old female presented to the Orthopaedic Service, The University Hospital of the West Indies (UHWD), with an 11 cm shortening in the left femur secondary to a growth

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plate disturbance of the distal left femur. Limb lengths were equalized by femoral lengthening using the Ilizarov External Fixator. Following removal of the fixator, the left knee was ankylosed in 0° of extension. An intensive programme of physical therapy was implemented for five months without any improvement in knee flexion. A Judet quadricepsplasty was then performed.

Under tourniquet control, an S-shaped incision was made along the lateral intermuscular septum line of the distal thigh and curved anteriorly to end parallel to the patellar tendon on the lateral side of the knee. The incision was made through the skin, fascia and muscle with no attempt being made to dissect between the fascia and the skin. This was done to avoid skin necrosis. A lateral parapatellar capsular incision was made and the joint entered. The intra-articular adhesions between the patella and the femoral condyles and between the tibia and the femoral condyles were released. Most of the intra-articular adhesions were released from the lateral side. A medial parapatellar incision was then made to achieve complete release of the medial adhesions. Passive knee flexion at this stage resulted in 45° of flexion. The lateral incision was then extended proximally to the greater trochanter. The tourniquet was removed to allow this part of the operation. The proximal thigh and groin were prepped and draped. The quadriceps muscle was elevated off the femur along the intermuscular septum in an extraperiosteal fashion. At the proximal end, the vastus lateralis fascia was cut transversely to reflect it from the femur. Transverse incisions at multiple levels were then made across the fascia lata and anterior thigh fascia. Care was taken to avoid injury to the subcutaneous tissue. Passive flexion of the knee achieved 70° of flexion.

An inguinal incision of approximately 4 cm was made along the anterior inferior iliac spine. The fascia was cut and the lateral femoral cutaneous nerve was identified and retracted. The interval between the sartorius and the tensor fascia lata muscles was dissected until the anterior inferior iliac spine was reached. The rectus femoris muscle was identified and released before it divided into the direct and indirect heads, allowing the entire muscle to slide distally. Passive knee flexion at this stage achieved 100° of flexion. The lateral incision was closed over a haemovac drain and only the skin and subcutaneous tissue were closed. No attempt was made to close the capsule of the knee.

Post-operative analgesia was achieved *via* an epidural catheter for 48 hours, after which parenteral and oral analgesics were administered. Continuous Passive Motion (CPM) was started in the recovery room and maintained for three weeks. Aggressive physical therapy was started during the first post-operative week and continued for nine months. At six months follow-up, the patient had achieved 90° of flexion but had a 10° extension lag. At nine months follow-up, there was 90° of active flexion and no extension lag.

### Case 2

A 65-year-old female presented with a comminuted Grade III B open fracture of the distal 1/3 of the right femur. There was significant soft tissue injury to the muscles of the anterior distal thigh. The fracture was immobilized with a ring fixator which was extended across the knee for greater stabilization. Allogenic bone graft was used to fill the defect in the distal femoral metaphysis. Following bone union, there was no active or passive knee flexion. Aggressive physiotherapy did not improve knee flexion. A Judet quadricepsplasty, as described in Case 1, was performed. At surgery, 100° of flexion was obtained. Post-operatively, CPM was commenced in the recovery room and maintained for six weeks. Epidural analgesia was administered for one week and this was followed by parenteral and oral analgesics. Following surgery, there was 85° of active flexion with an extension lag of 45°. Intensive physical therapy was maintained for one year. At two-year follow-up, there was 95° of active flexion with no extension lag.

### Case 3

A 72-year-old male presented with severe osteoarthritis of the left knee and inability to flex the knee actively. Examination revealed no active or passive knee flexion. A total knee arthroplasty was performed and attempts at passive flexion during closure of the knee, revealed no flexion. The rectus femoris muscle was found to be fibrotic. A modified Judet quadricepsplasty was then performed. Steps 1 and 2 which involved lateral and medial, respectively, parapatellar incisions to allow release of the intra-articular adhesions and elevation of the medial collateral ligament off the tibia, were easily achieved through the incision used for the total knee arthroplasty. After Step 2, passive manipulation achieved 30° of flexion. The third phase involved an inguinal incision approximately 4 cm centred over the anterior inferior iliac spine. The interval between the sartorius and tensor fascia lata muscles was dissected until the anterior inferior iliac spine was visualized. The rectus femoris tendon was identified and transected before it divided into the direct and indirect heads thereby allowing distal slide. Passive manipulation achieved 95° of flexion. Vastus lateralis release was therefore not performed. An intensive rehabilitation programme was maintained for six months. At one year follow-up, there was 90° of flexion with no extension lag.

### Case 4

A 31-year-old female sustained a Grade III Schatzer Type V injury to the left knee, in February 2002, following a road traffic accident.

She presented to the UHWI in August 2002 with severe extension contracture of the knee. An intensive programme of physical therapy was instituted for four months following which flexion was 30°. A modified Judet quadricepsplasty

was performed in January 2003. Following Step 2, passive manipulation achieved 90° of flexion. Step 3 which involved rectus femoris release was therefore unnecessary. The incisions were closed over a continuous suction drain.

Post-operatively, the knee was immobilized at 90° in a cast for forty-eight hours at which time the drain was removed. Continuous passive motion was then commenced and active assisted exercises were started when the patient was comfortable. Adequate parenteral and oral analgesics were administered post-operatively. The patient was discharged from hospital after three weeks of CPM. Physical therapy was continued for four months. At two months follow-up, there was 90° of flexion without any extension lag. At final follow-up, seven months following surgery, the range of motion remained unchanged.

## DISCUSSION

The first description of the pathologic anatomy of knee extension contracture was provided by Bennett (14). The patella was described as the intrinsic component and the quadriceps tendon as the extrinsic component of knee flexion. These two components move in series and anything that anchors one will affect the excursion of the other.

Nicoll (5) identified four ways in which normal distal excursion of the patella may be blocked in flexion: (1) extrinsic fibrosis of the vastus intermedius tying down the deep surface of the rectus femoris tendon to the front of the femur and suprapatellar pouch; (2) intrinsic adhesions from the deep surface of the patella to the femoral condyles and adhesions of the tibia to femoral joint surfaces; (3) extrinsic fibrosis and shortening of the lateral expansions of the vasti and their adherence to the lateral aspect of the femoral condyles with obliteration of the smooth, gliding mechanism of the paracondylar gutters; and (4) extrinsic actual shortening of the rectus femoris.

The treatment of knee extension contracture varies from an intensive programme of physical therapy, manipulation under anaesthesia, simple arthroscopy to lyse adhesions, to more extensive quadricepsplasty (13).

The most frequently performed technique of quadricepsplasty was first described by Thompson (4). The Thompson quadricepsplasty uses an anterior midline incision. The vastus lateralis and medialis are isolated from the rectus femoris and divided close to their patellar insertions. The interval between the vastus intermedius and the rectus femoris is identified and the former is removed in part, or completely, if fibrotic. The rectus femoris is left intact without any attempt to lengthen it. Passive knee flexion is then obtained by manipulation. Thompson reported satisfactory results in ten of the twelve cases operated on for stiff knees.

Since then, many authors have reported their results with this procedure (5, 6, 12-15). Each of these authors noted residual extension lag in many of their patients as well as a variable

return of active flexion. Significant permanent extension lag resulted from lengthening of the rectus femoris muscle.

Moore *et al* (12) reviewed nine patients and found that six developed a mean lag of 10° and eight had an average flexion of 78°, 16.4 months post-operatively. Nicoll (5) reported thirty patients with an average flexion of 68°. In 21 patients, there was full active flexion, while three had an extension lag of 5°. Six patients required lengthening of the rectus femoris muscle and these had permanent significant extension lag ranging from 20° to 40°. Pick (15) noted that two of his three patients had a significant extension lag and an average final flexion of 90°. Hesketh (6) performed Thompson's quadricepsplasty on ten patients, and in all patients 100° of flexion was achieved. Two patients had an extension lag of 5°. Hahn *et al* (3) performed a modified Thompson quadricepsplasty on 20 stiff knees and, at final follow-up, the mean extension lag was 5° (0° to 20°) and the mean active flexion was 120° (85° to 150°). In four patients in whom a satisfactory range of flexion had not been achieved, Z-plasty of the rectus femoris was performed to lengthen the tendon. The modified Thompson quadricepsplasty involves medial and lateral parapatellar incisions for arthrolysis. The knee is then flexed and if inadequate flexion is obtained, an anterolateral or lateral incision is made in the distal 2/3 of the thigh to allow release of the adhesions around the quadriceps muscle. The tensor fascia lata is divided transversely in the distal thigh. The vastus lateralis is then isolated from the rectus femoris and released close to its patella insertion. Vastus medialis is also released from rectus femoris which is then freed from vastus intermedius and from the anterior surface of the femur. Z-plasty of the rectus femoris is then performed if necessary.

In 1959, Judet proposed an alternative technique of quadricepsplasty (7). The technique is performed in phases with increments of flexion achieved by passive manipulation after each phase of the release. Phase 1 involves release of the intra-articular adhesions and mobilization of the suprapatellar pouch (intrinsic components) through an antero-medial, parapatellar arthrotomy incision. Usually some flexion is obtained after this phase. Phase 2 requires a long lateral incision extending from just lateral to the superior pole of the patella to the level of the greater trochanter. The vastus lateralis is divided from the linea aspera with meticulous attention to haemostasis of the large perforating vessels. The vastus intermedius is then identified and lifted extraperiosteally off the lateral and anterior surfaces of the femur. Portions of the vastus intermedius may be densely invested with scar tissue and may require excision. Additional passive flexion is then obtained by manipulation. In cases in which flexion is still limited, Phase 3 involves extension of the lateral incision proximally and anterolaterally over the hip in the fashion described by Watson-Jones (16). The origin of the rectus femoris is then detached from the anterior inferior iliac spine, thus allowing the

quadriceps muscle to slide distally. The vastus medialis is undisturbed since it is usually not involved with the intrinsic contractures.

Paley (13) modified the Judet quadricepsplasty by first performing lateral and medial parapatellar incisions which allow release of the intra-articular adhesions between the patella and the femoral condyles and between the tibia and femoral condyles. Through these incisions, the suprapatellar adhesions, the medial capsule and the medial collateral ligament are released. Paley emphasized that the medial parapatellar incision should extend across the medial joint line to the proximal tibia to allow for elevation of the medial collateral ligament. The third step involves the release of the rectus femoris muscle instead of the vastus lateralis release as performed by Judet. The quadriceps slide afforded by this release usually results in adequate flexion following passive knee manipulation. The fourth step which involves the release of the vastus lateralis through a long lateral incision is performed, if necessary. This phase is usually associated with moderate blood loss.

In Cases 1 and 2, Judet quadricepsplasty was performed while in Case 3 a modified procedure which involved release of the intra-articular adhesions and the medial collateral ligament followed by rectus femoris release was sufficient in obtaining adequate knee flexion. In case 4, adequate flexion was achieved following intra-articular, capsular and medial collateral ligament release.

The results of 53 quadricepsplasties performed by Judet (5) showed that 11% had extension lags, and the majority achieved active flexion beyond 100°. Daoud *et al* (11) reported the results of six patients whose average final range of motion was 0° to 115°. A report of a bilateral case of Judet quadricepsplasty by Warner (8) noted active range of motion from 0° to 120° bilaterally, 25 months post-surgery. Merchan and Myong (9) reported the results of twenty-one quadricepsplasties. Extension lag was less than 10° in six cases and greater than 10° in five patients. There was normal extension in the remaining patients. In twelve cases, greater than 90° of flexion was achieved while in nine patients less than 90° was obtained. Bellemans *et al* (10) performed sixteen quadricepsplasties and at final follow-up, eleven patients (68.7%) had flexion of 90° or greater. In four cases, there was a 15° loss of terminal active extension. In all the four cases presented in this report, there was 90° of flexion and no extension lag.

The post-operative management after quadricepsplasty is extremely important if flexion is to be maintained without loss of active extension. Some authors recommend hip and knee flexion to 90° for 24–48 hours following surgery (8–10). Continuous passive motion is then begun, and active assisted exercises are commenced when the patient is com-

fortable. Electric muscle stimulation of the quadriceps muscle is helpful. Quadriceps muscle strengthening should be maintained for at least six months.

In three of the four cases presented, CPM was started in the recovery room and maintained for three weeks in two patients and six weeks in one patient. In one patient, the knee was maintained at 90° of flexion in a cast for 48 hours, following which CPM was started and maintained for three weeks. Adequate analgesia especially for the first post-operative week is essential. Epidural anaesthesia was used in two cases.

The advantage of the Judet technique is that it permits a controlled, sequential release of the intrinsic and then the extrinsic components limiting knee flexion. At any phase of the procedure if adequate flexion is obtained, the dissection is ended. This greatly reduces the potential for iatrogenic quadriceps rupture or extension lag and limits the potential dissection. The modified Judet quadricepsplasty has definite advantages over the Judet quadricepsplasty since it usually involves less soft tissue dissection and consequently less blood loss.

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