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Article *in* The Journal of arthroplasty · June 2009

DOI: 10.1016/j.arth.2009.04.015 · Source: PubMed

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Can an Anterior Quadriceps Release Improve Range of Motion in the Stiff Arthritic Knee?

Samih Tarabichi, MD, MS, FRCSC,* and Yasir Tarabichi, MD†

Abstract: We hypothesize that tethering adhesions of the quadriceps muscle are the major pathological structures responsible for a limited range of motion in the stiff arthritic knee. Forty-two modified quadriceps muscle releases were performed on 24 patients with advanced osteoarthritis scheduled for total knee arthroplasty. The ranges of motion were documented intraoperatively both before and immediately after the release. Passive flexion improved significantly in all patients (mean, 32.4° of improvement, $P < .001$) following a modified quadriceps release, despite any presence of osteophytes or severe deformities. These results strongly implicate adhesions of the quadriceps muscle to the underlying femur, which prevent the distal excursion of the quadriceps tendon, as the restrictive pathology preventing deep flexion in patients with osteoarthritis. **Keywords:** quadriceps excursion, quadriceps, excursion, quadricepsplasty, quadriceps release, release, knee flexion, range of motion, osteoarthritis, total knee replacement.

The numerous benefits of attaining a substantial postoperative range of motion (ROM) in patients with osteoarthritis undergoing total knee arthroplasty (TKA) has been extensively discussed and well documented [1-3]. What has yet to be fully elucidated, however, is the true nature of the underlying restrictive pathology in this setting.

Stiffness after periods of inactivity is known to be a major finding not only in patients diagnosed with advanced osteoarthritis but also those who undergo trauma or extensive surgery [4]. With regard to posttraumatic and postsurgical stiffness, the restriction in ROM has been demonstrated to be caused by adhesions that tether the distal quadriceps tendon and/or muscle to the bone surface, preventing the quadriceps muscle and tendon from its normal excursion during flexion [5].

We hypothesize that, as is the case in the posttraumatic stiff knee, tethering adhesions of the quadriceps muscle are the major pathological structures responsible for limited ROM in the stiff arthritic knee.

To assess the validity of our hypothesis, the primary author has developed a simple alternative approach to the conventional quadricepsplasty, where only the distal portion of the quadriceps muscle is bluntly released from any adhesions to the femur and surrounding tissue.

Our study focuses on the immediate intraoperative effect of a modified quadriceps release on ROM in 42 stiff arthritic knees scheduled for TKA before any other interventions are administered.

Patients and Methods

Approval for this study was obtained from the institutional review board of the (institution name withheld). During a 6-month period in 2001, all patients scheduled for TKA with a preoperative active ROM less than 90° were offered a modified quadriceps release during their operations. There were a total of 42 quadriceps releases carried out on 24 fully consenting patients (10 men and 14 women) by the same practicing surgeon. Of the 24 patients, 18 had a bilateral TKA, whereas 6 had only a unilateral TKA. The mean patient age was 68 years (range, 58-83 years), and the mean weight was 77.7 kg (range, 65-94 kg).

Range of motion was documented preoperatively when patients were under anesthesia and before any incisions were made. Both digital photographs and x-rays (portable lateral view) were taken for each patient with the knee in passive flexion (Fig. 1). ROM was determined from the x-ray to the nearest 5° using a standard goniometer.

Our technique utilizes a standard subvastus approach, initiated with an anterior midline skin incision. Once the extensor mechanism is mobilized, the underlying suprapatellar pouch can be identified and is subsequently excised along with any adhering bands or fibrotic tissue (Fig. 2A and B). Doing so provides direct access to the

*From the *Joint Replacement Center, American Hospital, Dubai, UAE; and †Weill Cornell Medical College, Doha, Qatar.*
Submitted April 20, 2008; accepted April 7, 2009.
No benefits or funds were received in support of the study.
Institutional review board approval obtained from American Hospital Dubai, Dubai, UAE.
Reprint requests: Yasir Tarabichi, MD, Weill Cornell Medical College, PO Box 24144, Doha, Qatar.

0883-5403/2504-0013$36.00/0
doi:10.1016/j.arth.2009.04.015

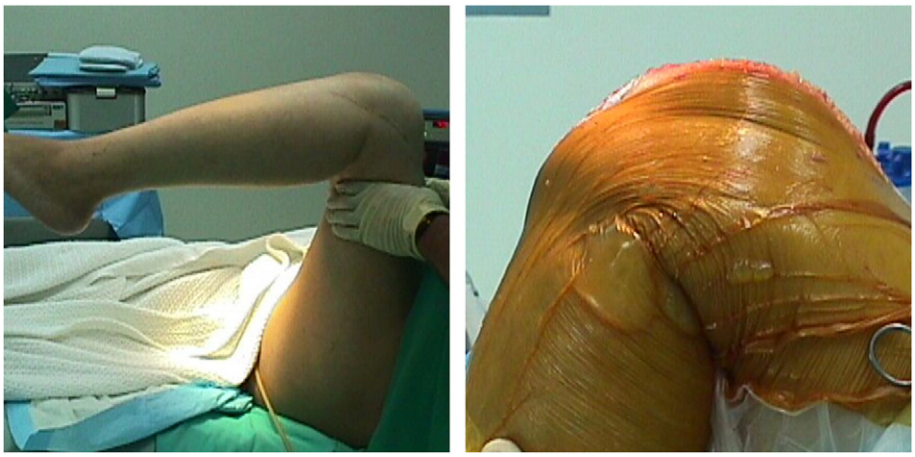

Fig. 1. Case number 7, a 58-year-old woman who had bilateral quadriceps release prior to commencing with TKA. Digital photographs of the lateral aspect of the left knee in passive flexion before (left) and after (right) release.

deep interface of the quadriceps muscle, allowing the release to be carried out (Figs. 2C and D; Fig. 3B). The modified quadriceps release was carried out by bluntly dissecting the quadriceps muscle away from the anterior surface of the distal femur, as well as both medial and lateral intramuscular septa. The release is carried out in a stepwise fashion where the knee is flexed after each release. If the ROM is estimated to be below 130°, the

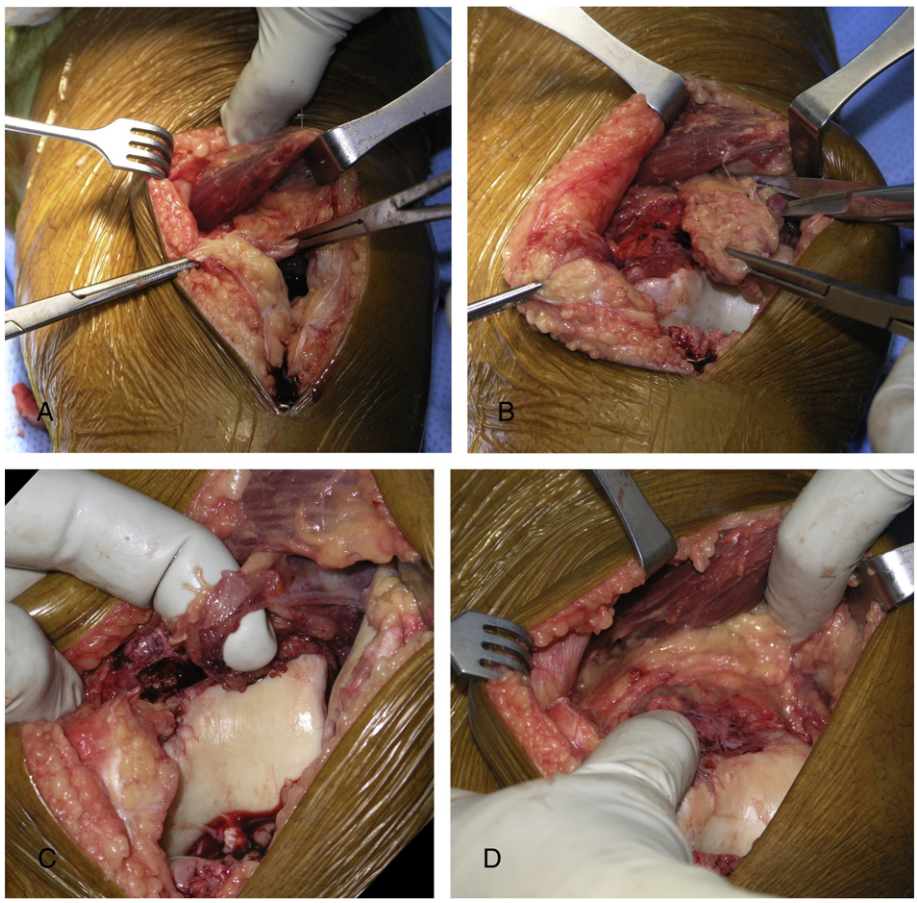

Fig. 2. Digital photographs of the anterior aspect of the left knee of a volunteer patient while undergoing quadriceps release prior to commencing with TKA. (A and B) The extensor mechanism being retracted laterally while the surgeon identifies and completely resects the suprapatellar pouch. (C) A fibrotic band found tethering the underbelly of the quadriceps muscle to the distal femur during the blunt release, which was subsequently excised. (D) The net outcome of the release, which is the clearing of the majority of adhesions between the quadriceps muscle and the distal aspect of the femur.

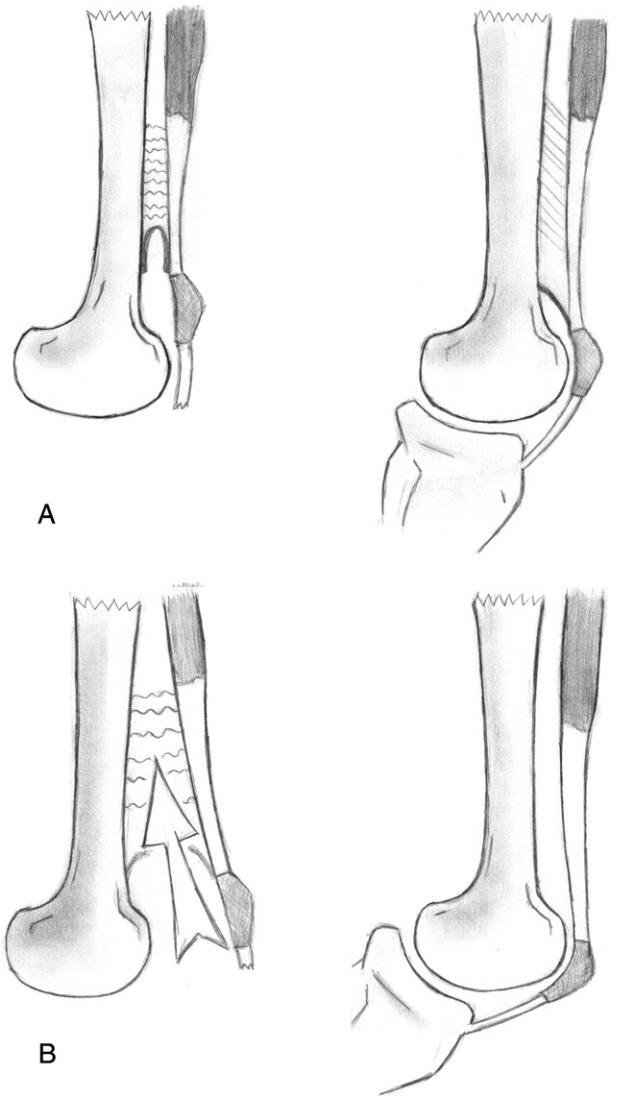

Fig. 3. Simplified illustrations demonstrating the basic principle of our approach. (A) How fibrotic adhesions between the quadriceps and the distal femur (left) can limit flexion substantially (right) by limiting quadriceps excursion. The suprapatellar pouch is represented by the inverted "U" distal to the aforementioned adhesions. (B) How a modified quadriceps release, demonstrated by the cartoon arrow above (left) would allow the extensor mechanism further excursion, leading to a greater ROM (right).

release is progressed further proximally until a ROM of over 130° is obtained.

No bony resection, ligament releases, or lateral and medial retinacular releases were performed, as was described by Nicoll [6] in his conventional quadricepsplasty. Any gross deformities such as the presence of osteophytes or irregular articular surfaces were left intact at that point in time.

Range of motion was documented immediately postrelease using the same approach preoperatively before any further incisions or releases were made (Fig. 1).

Table 1. Shown are the measured prerelease ROM (under anesthesia) and the average immediate postrelease improvement

Prerelease ROM (range) (°)	85 (*n*=2)	90 (*n*=2)	95 (*n*=9)	100 (*n*=4)	105 (*n*=14)	≥110 (n=11)
Post–release improvement (average, in degrees)	55	40	38	39	32.5	26

n indicates the number of patients who presented within the documented pre-release ROM ranges.

Doing so allowed us to measure the direct impact of the modified quadriceps release on ROM, controlling against any other potentially therapeutic interventions throughout the remainder of the surgery.

Results

Results for this study are shown in Table 1. The ROM increased in all patients, with a mean of 34° (SD 7.8; range, 15-55) improvement per patient ($P < .001$). The average post-release ROM was 137° (SD 5.2; range, 130-145). There were large osteophytes noted in 6 of 42 patients.

Discussion

Patients with advanced osteoarthritis retain a restricted ROM even when placed under general anesthesia, suggesting the causative factors to be permanent pathological changes in the knee. Sources of the restriction have been hypothesized to include osteophytes, irregularities in the bone surface, synovitis, adhesive capsulitis, restrictive soft tissues and adhesions of the quadriceps muscle, and/or tendon to surrounding structures [7,8].

Stiffness after periods of limited activity is characteristic of the arthritic knee as well as the posttraumatic knee, highlighting a potentially shared etiology for both. Structural pathologies that may limit flexion in the stiff posttraumatic knee have been previously discussed and include adhesions from the deep surface of the patella to the femoral condyles, fibrosis, and shortening of the lateral expansions of the vasti and their adherence to the femoral condyles, fibrosis of the vastus intermedius, and shortening of the rectus femoris [6]. All of these restrict flexion by blocking the normal distal excursion of the quadriceps, which Wendt et al [9] reported to be an average of 6.62 cm for flexion up to 90° and [6] reported to be up to 9 cm for "full flexion" to occur.

Our intraoperative procedure was designed to assess the direct effect of the release of adhesions tethering the quadriceps muscle to the femur and its surrounding structures. The rationale behind this is demonstrated in Fig. 3. As can be inferred from Fig. 3B, removal of the suprapatellar pouch is necessary to gain access to the inferior aspect of the quadriceps muscle. Once access is gained, the adhesions may be systematically resected

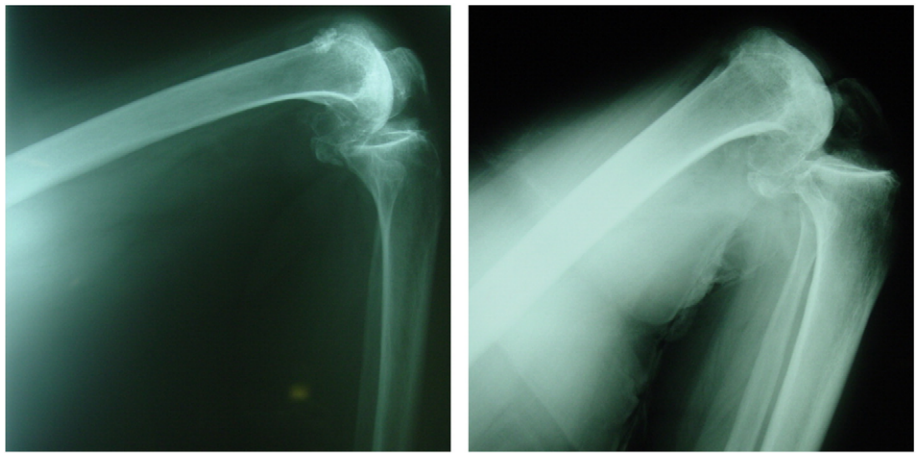

Fig. 4. Case number 10, a 74-year-old woman who underwent bilateral quadriceps release prior to commencing TKA. Despite the large posterior osteophytes that can be seen in the prerelease lateral x-ray (left), we were able to dramatically improve flexion from 105 to 140° as shown in the postrelease lateral x-ray (right).

until the quadriceps muscle is freed enough to allow a greater degree of flexion to occur.

The singular effect of the quadriceps release was demonstrable by the immediate and successive improvement in ROM as the release was continued proximally in all patients. Range of motion improved in all patients at an average 34.2° (SD 7.8, $P < .001$) post release before any soft tissue balancing, bone resection or resurfacing, or any other surgical interventions were applied. In fact, any knee deformities, including the presence of large osteophytes in 6 of the 42 cases, seemed to hinder the improvement in ROM post release (Fig. 4).

Although discussion of all of the potential underlying pathologies of the stiff arthritic knee is beyond the scope of our study, the most implicated culprit in the literature thus far, the posterior cruciate ligament (PCL), is worthy of some attention. The alleged association between the PCL and deep knee flexion has prompted its excision in certain cases in an attempt to increase postoperative ROM. The results of this procedure, however, have been equivocal since its conception. Jacobs et al [10] in their systematic review published in 2005, were unable to make any solid recommendations between retention and removal of the PCL given the disparate qualities of the studies they analyzed. Furthermore, in situ kinematic data of the knee in deep flexion published in 2004 by Li et al [11] shows minimal involvement of the PCL at flexion angles over 120°. The PCL was found to be maximally extended at only 90° of flexion, a value at least 5° below the intraoperative prerelease ROM of most of our patients (22/24). In fact, the in situ forces on the PCL at 120° and 150° of flexion are equivalent to almost half of the forces measured at 90°.

The finding that all of our patients were able to reach a minimum 130° of flexion post release, irrespective of their prerelease ROM, with a modified quadriceps release as the only intervention, strongly implicates inadequate excursion of the quadriceps muscle as the major underlying restrictive pathology in the stiff arthritic knee. Studies are already underway to determine whether a modified quadriceps release will have any long-term effects on these patients' postoperative ROM and function.

Conclusion

The success in obtaining an immediate and significant improvement in ROM by releasing only the quadriceps muscle from its tethering adhesions and keeping other pathological changes such as large osteophytes, severe knee deformities, and irregular articular surfaces intact clearly demonstrates that the inadequate excursion of the quadriceps muscle and tendon is the main limiting factor to better knee flexion.

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