Technical note

Percutaneous quadriceps tendon pie-crusting release of extension contracture of the knee

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1. Introduction

Arthrofibrosis and extension contracture of the knee are complications of total knee arthroplasty (TKA) [1] and are also associated with fractures [2–4]. Quadricepsplasty is a well-known procedure to improve knee flexion in case of severe contracture [3]. Traditional treatments such as Thompson quadricepsplasty [5], Judet quadricepsplasty [6] and their modifications [4,7] require extensive exposure and can result in recurrent adhesion, permanent extensor lag and infection. Although several modified approaches to quadricepsplasty [2,8] with limited exposure have been described, most cannot avoid transverse incisions in the quadriceps, with risk of extension lag. The pie-crusting technique for quadriceps lengthening, reported by Dennis [1], Mont et al. [9] and Mounasamy et al. [10], could provide a minimally invasive alternative to resection of the fibrotic vastus intermedius and transection of the rectus femoris. However, no detailed data on its effectiveness in improving extension contracture have been reported.

2. Technique

2.1. Surgical procedure

The procedure is performed under tourniquet. Arthrosis of articular adhesions is performed through a longitudinal parapatellar medial incision and the tendinous tissue of the quadriceps is separated from the anterior surface of the femur. The lateral retinacular tissues are freed, ensuring that the patella can be lifted off the femoral condyles. Extension contracture may be partially released after arthrolysis, and maximal flexion is recorded using a goniometer.

Then, pie-crusting release is performed using an 18-gauge needle (Fig. 1). The first puncture is usually located in the distal and lateral part of the vastus intermedius muscle about 5 cm away from the superior pole of the patella. A series of punctures is carried out from medial to lateral (10–20 punctures per level) and from distal to proximal (at 1 cm intervals). The stiff fibrous bands of the quadriceps tendon, felt as hard as stone when an assistant pushes the knee into maximum flexion, are punctured percutaneously. Needle penetrations are directed through the skin, rectus femoris tendon or vastus lateralis tendon and then the vastus intermedius tendon. One skin penetration allows four or five subsequent penetrations through the quadriceps. Passes through the stiff fibrous band of the tendon typically meet with resistance and produce palpable and audible crepitations. The contractual tendon is gradually

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released, with the tension tendon softening under multiple needle punctures; the knee is thus gradually bent to 100° or more.

3. Postoperative management

Epidural analgesia is administered for two days and followed by oral analgesics. A mobile hinged brace, adjusted to a range of 90° to 120° flexion, is fitted for one week. Flexion exercises are performed on the first postoperative day. Full extension and flexion exercises without the knee brace are encouraged one week after surgery and continued for three months.

4. Patients and Results

The selection criteria for quadriceps tendon pie-crusting release were:

- failure of physical therapy and passive motion to improve knee motion;
- no bony ankylosis or malunion in case of intra-articular fracture;
- no implant malpositioning in case of TKA.

Twelve patients were included: six male and six female, mean age 51 ± 11 years. Seven had fracture-related knee stiffness (commuted femoral supracondylar fracture in three patients, patellar fracture in two and comminuted tibial plateau fracture in two). Five had knee stiffness following TKA, two of which were due to superficial infection and delayed exercise and other three were due to lack of exercise. There was no flexion contracture. The mean interval between initial operation and pie-crusting release was 18 ± 4 months.

Differences in knee flexion angle were compared on paired t test between: preoperative versus after arthrolysis; after arthrolysis versus after pie-crusting release; and preoperative versus final follow-up. Linear correlation was used to evaluate the correlation between number of punctures and improvement in knee flexion.

Mean follow-up was 8 ± 2 months. Changes in knee flexion are shown in Table 1. Eight of the 12 results were excellent and four were good according to Judet’s criteria [6]. There was a positive correlation (r = 0.94) between number of punctures and improvement in knee flexion (Fig. 2). Three patients received more than 100 punctures: they showed 4/5 quadriceps force postoperatively, normalizing after a three-month exercise program. There were no other major complications, such as extensor lag, skin necrosis, deep infection, dislocation of the patella or recurrent stiffness.

5. Discussion

Minimally invasive arthrolysis combined with percutaneous quadriceps tendon pie-crusting release was effective. Pie-crusting played a more important role than arthrolysis in knee flexion improvement. Mean gain in range of motion was 70°, with satisfactory clinical results and no major complications. In contrast to other strategies with multiple complicated procedures, the pie-crusting technique is easy and conserves the longitudinal integrity of the rectus femoris, enabling early intensive postoperative exercises. Pie-crusting the quadriceps tendon significantly improves both post-traumatic and post-TKA knee stiffness, indicating a common etiology for extension mechanism contracture.

Table 1

<table>
<thead>
<tr>
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<th>Mean flexion angle</th>
<th>Absolute gain in flexion</th>
<th>Relative gain in flexion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preoperative</td>
<td>37 ± 11°</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>After arthrolysis</td>
<td>50 ± 10°</td>
<td>13 ± 3° (vs preop.)</td>
<td>35%</td>
</tr>
<tr>
<td>After pie-crusting</td>
<td>107 ± 9°</td>
<td>70 ± 1° (vs preop.)</td>
<td>189%</td>
</tr>
<tr>
<td>Final follow-up</td>
<td>103 ± 8°</td>
<td>66 ± 10° (vs preop.)</td>
<td>178%</td>
</tr>
</tbody>
</table>

*P < 0.001 (t test).
Extension contracture of the knee, resulting from scarring of the extensor mechanism with fibrosis of the vastus intermedius and shortening of the rectus femoris, can entail severe disability. Traditional quadricepsplasties involve excessive exposure and result in delayed postoperative rehabilitation. Judet’s quadricepsplasty [3], assessed in 10 stiff knees, provided a mean 72° gain in motion; three patients experienced complications: one hematoma, one infection and one minimal extension lag. Modified Thompson quadricepsplasty [4], assessed in 20 stiff knees, provided a mean 67.6° gain in motion; one patient had a deep infection.

Some new quadricepsplasty techniques [2,8,11] have been described, using various minimally invasive approaches, but complications still occurred although with low incidence. Wang [2] reported a mini-incision quadricepsplasty followed by arthroscopic lysis, providing 88° gain in flexion in 22 patients, of whom one had extension lag and another infection. Khakharia [11] reported a limited quadricepsplasty providing 88° gain in flexion in 16 patients, of whom one had quadriceps weakness. Martin [8] reported a quadricepsplasty by oblique cutting of quadriceps, providing 72° gain in flexion in 6 patients, of whom one had extension lag.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References