Oral Corticosteroid Use for Loss of Flexion After Primary Anterior Cruciate Ligament Reconstruction

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**Purpose:** Postoperative loss of motion after anterior cruciate ligament (ACL) reconstruction can lead to suboptimal outcomes. Short-term low-dose oral corticosteroids are an option for nonsurgical management of this condition. The purpose of this study is to retrospectively review a series of patients treated with a single Medrol Dosepak (MDP) (Pfizer, New York, NY) in the early postoperative period for the treatment of loss of flexion, focusing on range of motion, objective instrumented stability measurements, and complications. **Methods:** From September 1, 2003, through January 1, 2007, 28 (11%) of 252 patients who underwent primary ACL reconstruction were treated with an MDP at a mean of 6.1 weeks postoperatively (range, 4 to 12 weeks; SD, 1.4 weeks) for early postoperative loss of motion. Of these 28 patients, 4 were not included because of unavailable clinical records. One patient who underwent combined ACL and posterior cruciate ligament reconstruction with medial collateral ligament repair was excluded from the analysis. Range-of-motion and KT-1000 (MEDmetric, San Diego, CA) measurements were independently recorded by a single examiner preoperatively, at 6 weeks postoperatively, and again at final follow-up evaluation at a mean of 10.4 months (range, 4 to 24 months; SD, 4.3 months). **Results:** The mean flexion deficit compared with the normal, contralateral knee at the time of treatment with an MDP was 31.3° (range, -2° to 55°; SD, 14.8°). Patients treated with an MDP showed a significant improvement in flexion deficit (mean, 29.2°; range, 0° to 60°; SD, 17.1°) after MDP treatment (P < .001). KT-1000 side-to-side differences at final examination were 2 mm or less in 22 of 23 patients (mean, 1 mm; range, 0 to 4 mm; SD, 1 mm). Of the 23 patients treated with an MDP, 5 (22%) were considered failures because they required surgical intervention for persistent loss of motion, resulting in a reoperation rate for loss of motion after primary ACL reconstruction of 2.0% (5/252). There were no documented complications of MDP treatment. Specifically, no patients treated with an MDP had a postoperative infection develop. **Conclusions:** The use of oral corticosteroids, in the form of an MDP, was associated with a successful return of normal range of motion in 78% of patients with early postsurgical loss of flexion and near-normal extension after primary ACL reconstruction without any associated complications or decrease in objective instrumented stability measurements. **Level of Evidence:** Level IV, therapeutic case series. **Key Words:** Anterior cruciate ligament—Reconstruction—Loss of motion—Oral corticosteroid—Range of motion—KT-1000.

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The authors report no conflict of interest.

The views expressed in this article are those of the author and do not necessarily reflect the official policy or position of the Department of the Navy, Department of Defense, or the U.S. Government.

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0749-8063/08/2405-7315$34.00/0
doi:10.1016/j.arthro.2007.10.013

Note: To access supplementary Table 2 accompanying this report, visit the May issue of *Arthroscopy* at www.arthroscopyjournal.org.

After anterior cruciate ligament (ACL) reconstruction, regaining adequate knee range of motion (ROM) is critical to subjective and objective patient outcomes. Loss of motion after ACL reconstruction is a well-recognized complication, with a reported incidence ranging from 2% to as high as 59%. A commonly encountered situation is a loss of full extension resulting from mechanical impingement of structures anterior to the graft. It has been suggested that when the postoperative knee has not been fully extended for a period of time, fibroproliferative nodules of granulation tissue may form and block terminal extension. Loss of flexion is associated with a diffuse scarring of the patellar tendon to the fat pad, formation of adhesions in the gutters, and capsular contractures likely due to postoperative capsulitis.
Inability to regain full extension is typically more symptomatic because of the added stress on the extensor mechanism while standing.\textsuperscript{4} Patellofemoral pain, quadriceps muscle weakness, accelerated articular degeneration, and overall poor knee function have been correlated with the inability to regain full extension.\textsuperscript{2} Factors that may place a patient at higher risk for postoperative loss of motion include lack of full ROM preoperatively, surgery within 3 weeks of injury, prolonged immobilization, infection, inadequate notchplasty, graft malpositioning, cyclops lesion, infrapatellar fat pad contracture syndrome, reflex sympathetic dystrophy, or multiligament injury.\textsuperscript{2,4,5,7-10}

Management of loss of motion depends largely on the degree of limitation in ROM and time from surgery.\textsuperscript{11} In the early postoperative period, nonoperative modalities such as aggressive physical therapy with extension-board and prone-hang exercises, as well as extension casts, may be beneficial. In addition, ice and anti-inflammatory medications or oral methylprednisolone\textsuperscript{12} in the form of a Medrol Dosepak (MDP) (Pfizer, New York, NY), containing 84 mg of methylprednisolone, are often used in conjunction with aggressive physical therapy because the knee may still be in the inflammatory phase of healing.\textsuperscript{5} Traumatic manipulation and surgical lysis of adhesions are not recommended during this phase because the added tissue insult may lead to increased scar formation. Intra-articular steroid injections for treatment of pain and decreased motion have been described in the setting of chronic shoulder pain and arthrofibrosis of the shoulder resulting from adhesive capsulitis.\textsuperscript{13} However, because of the concern regarding postoperative infection, intra-articular injections are generally avoided in our postoperative patients.

These nonoperative modalities may be efficacious in reducing the production of fibrous scar tissue. If full ROM is not regained by 3 months after surgery, nonoperative therapy is unlikely to be successful and operative intervention is indicated.\textsuperscript{2,7} Surgical options include open or arthroscopic lysis of adhesions, resection of cyclops lesions, or possibly, ACL graft resection if malpositioned.\textsuperscript{2,5,14}

Despite their common usage, to our knowledge, there is no report in the literature documenting the efficacy of oral corticosteroids for the treatment of loss of motion in the knee after ACL reconstruction in the early postoperative period. Furthermore, there is conflicting evidence with regard to the risks associated with the use of a short course of low-dose corticosteroids such as the MDP.\textsuperscript{12,15-18}

The purpose of this study is to retrospectively review a series of patients treated with a single MDP in the early postoperative period for the treatment of loss of motion, focusing on ROM, objective instrumented stability measurements, and complications, to evaluate our hypothesis that oral corticosteroids are a safe and effective treatment for early postoperative loss of motion after ACL reconstruction.

**METHODS**

After appropriate institutional review board approval was obtained from our institution, a review of the senior author’s surgical case log from September 1, 2003, through January 1, 2007, revealed 252 patients who underwent primary ACL reconstruction, including 123 bone–patellar tendon–bone allografts (48.8%), 116 bone–patellar tendon–bone allografts (46.0%), 11 hamstring allografts (4.4%), 1 hamstring autograft (<1%), and 1 Achilles tendon allograft (<1%). Of these patients, 28 (11%) were treated with a single MDP for postoperative loss of motion after ACL reconstruction.

The criterion for prescribing an MDP, containing a total dose of 84 mg of methylprednisolone given as a tapered dose over a period of 6 days, was failure to achieve full ROM equal to the patient’s contralateral knee by the 6-week postoperative follow-up visit. In general, we defined an “at-risk” patient as one who had more than a 3° extension deficit and had less than 100° of flexion at this time interval. The mean time from ACL reconstruction to MDP administration was 6.1 weeks (range, 4 to 12 weeks; SD, 1.4 weeks).

Of the 28 patients, 4 were not included in the final analysis because of unavailable clinical records. One patient who underwent combined ACL and posterior cruciate ligament reconstruction with medial collateral ligament repair was excluded from the analysis. A retrospective chart review was performed. Goniometric ROM and KT-1000 (MEDmetric, San Diego, CA) measurements were independently recorded by a single examiner preoperatively, at the 6-week postoperative examination, and again at the most recent evaluation and were compared with the patient’s normal, contralateral knee. Any associated complications or infections and further interventions such as subsequent surgical procedures were also documented.

The demographics of the group are listed in Table 1. Reconstruction with bone–patellar tendon–bone autograft was done in 16 patients (70%), and reconstruction with bone–patellar tendon–bone allograft was done in 7 (30%). Of the 23 patients, 14 (61%) had
TABLE 1. Demographics

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>23</td>
</tr>
<tr>
<td>Mean age (yr)</td>
<td>25.2 (range, 14-46; SD, 10.1)</td>
</tr>
<tr>
<td>Male</td>
<td>7 (30%)</td>
</tr>
<tr>
<td>Female</td>
<td>16 (70%)</td>
</tr>
<tr>
<td>Other injuries</td>
<td>14 (61%)</td>
</tr>
<tr>
<td>Mean time from injury to surgery (wk)</td>
<td>5.6 (range, 2-9; SD, 2.3)*</td>
</tr>
<tr>
<td>Mean time from surgery to MDP treatment (wk)</td>
<td>6.1 (range, 4-12; SD, 1.4)</td>
</tr>
<tr>
<td>Mean follow-up (mo)</td>
<td>10.4 (range, 3.5-24; SD, 4.3)</td>
</tr>
<tr>
<td>Bone–patellar tendon–bone autograft</td>
<td>16 (70%)</td>
</tr>
<tr>
<td>Bone–patellar tendon–bone allograft</td>
<td>7 (30%)</td>
</tr>
</tbody>
</table>

*Excludes 2 patients in whom injury occurred more than 1 year before surgery.

concomitant procedures performed; all were for meniscal pathology. There were 5 meniscal repairs, including 3 inside-outside repairs and 2 all-inside repairs, and 9 partial meniscectomies. The mean age of the patients was 25.5 years (range, 14 to 46 years; SD, 10.2 years). The mean time from injury to surgery was 5.6 weeks (range, 2 to 9 weeks; SD, 2.3 weeks), excluding 2 patients whose injuries occurred more than 1 year before seeking surgical treatment. The standard, accelerated ACL reconstruction rehabilitation program used for all primary ACL reconstructions continued to be used in all patients, regardless of meniscal repair status, and all were prescribed a non-steroidal anti-inflammatory medication.

All mean values are expressed with their respective ranges and SDs. Statistical analysis of continuous variables was done through a paired t test, with significance placed at the .05 level of probability.

RESULTS

A detailed summary of all 23 patients is shown in Table 2 (online only, available at www.arthroscopyjournal.org). At a mean final follow-up of 10.4 months (range, 4 to 24 months; SD, 4.3 months), there was no significant difference between the final flexion (P = .2) or extension (P = .5) of the MDP-treated knee compared with the normal, contralateral knee, and there were no documented complications of MDP treatment. Specifically, no patients treated with an MDP had a postoperative infection develop.

The mean flexion deficit compared with the normal, contralateral knee at the time of treatment with an MDP was 31.3° (range, −2° to 55°; SD, 14.8°). The mean extension deficit at the time of MDP treatment was 1° (range, −6° to 9°; SD, 3.8°). Patients treated with an MDP showed significant improvements in both flexion deficit (mean, 29.2°; range, 0° to 60°; SD, 17.1°) and extension deficit (mean, 1.6°; range, −3° to 8°; SD, 2.8°) at final follow-up examination after MDP treatment (P < .001 and P = .05, respectively).

KT-1000 maximum manual side-to-side differences at final examination were 2 mm or less in 22 of 23 patients, with a mean of 1 mm (range, 0 to 4 mm; SD, 1.0 mm).

Of the 23 patients treated with an MDP, 5 (21%) were considered failures because they required surgical intervention for persistent loss of motion at a mean of 8.5 months after their index procedure, resulting in a reoperation rate for loss of motion after primary ACL reconstruction of 2.0% (5/252). Excluding 2 of the 28 patients (1 with ACL/posterior cruciate ligament/medial collateral ligament injuries and 1 who underwent reconstruction with hamstring allograft), the relative risk for the development of a loss of flexion was 1.8 for bone–patellar tendon–bone autograft and 0.6 for bone–patellar tendon–bone allograft.

DISCUSSION

In our experience, a short course of low-dose oral corticosteroids in the form of an MDP is a useful means for improving flexion by reducing inflammation and intra-articular scar formation in patients who are having difficulty regaining full ROM at their 6-week follow-up without any associated complications such as loss of graft integrity or infection. Though statistically significant, the minimal extension deficit, as well as improvement in the extension deficit, was not considered to be clinically relevant.

Loss of motion in patients after ACL reconstruction has been defined as any symptomatic loss of ROM when compared with the normal, contralateral knee. To prevent postoperative loss of motion, it is generally accepted as the standard of care to delay reconstruction until the effusion has resolved and full ROM and strength compared with the normal, contralateral knee have been achieved.

It is well established that the best treatment for loss of motion is prevention. Cosgarea et al. recommended delaying surgery for 3 weeks or until the knee has less than a 10° extension deficit, splitting in full extension postoperatively, and instituting an accelerated rehabilitation program with early weight-bearing and ROM as significant factors in reducing the rate of
loss of motion. When using this protocol, their rate of loss of motion dropped from 23% to 2.7%.

Those patients who have mounted a significant inflammatory and cellular response to surgery typically present with a limitation in flexion from scar tissue that has formed. Paulos et al. described 3 stages of loss of motion based on time from surgery. Stage I is a “prodromal stage,” usually occurring within 2 to 8 weeks from surgery as a result of an inflamed synovium and fat pad causing tenderness of the patellar tendon and painful ROM. Stage II occurs between 6 and 20 weeks and is termed the “active stage.” In this stage continued swelling and limited patellar mobility restrict motion. Stage III is the “burned-out stage,” occurring greater than 8 months after surgery, and is significant for quadriceps atrophy and patellofemoral arthrosis. The goal of the MDP treatment in our series was to decrease the inflammation so that patients could achieve improvements in ROM with continued rehabilitation.

Corticosteroids work by diminishing the inflammatory response by inhibiting phospholipase A2 and thus the synthesis of potent inflammatory factors such as prostaglandins, leukotrienes, and thromboxanes. These cytokines and growth factors play a role in the attraction and extravasation of macrophages and leukocytes, as well as stimulation of fibroblasts, that ultimately result in fibrosis and joint contracture.

The use of anti-inflammatory medication in the tender, swollen postoperative knee ultimately leads to a reduction in pain and granulation tissue formation, which in turn aids in postoperative rehabilitation and decreases scar formation. The anti-inflammatory effect may also help treat more diffuse capsulitis, which could lead to a hypercellular response that ultimately would result in a loss of flexion and extension.

The prescribing patterns of oral corticosteroids for the treatment of athletic injuries has been reviewed by Harmon and Hawley. They reported that oral steroids were most commonly given to treat postinjury swelling, stiffness, and pain. Oral corticosteroids have also been reported to lead to a decrease in pain and an increase in motion in patients with adhesive capsulitis of the shoulder.

Because corticosteroids affect many different tissues in the body and may have serious side effects, some surgeons have been cautious in their use of oral corticosteroids. Historically, complications such as hypertension, glucose intolerance, gastric ulcers, infection, inhibition of wound healing, and osteonecrosis were associated with chronic high-dose treatment (up to 1,400 mg of prednisone). Conflicting evidence exists in the literature regarding the use of lower-dose short-term corticosteroids such as treatment with an MDP (total of 84 mg of prednisone). Da Silva et al. however, reviewed chronic low-dose corticosteroid therapy (<10 mg prednisone daily) in patients with rheumatoid arthritis and found an increased risk of osteoporosis and cardiovascular disease but no cases of osteonecrosis, and they concluded that previously held fears regarding corticosteroid use were not supported by clear scientific evidence.

Nichols performed a critical review of the medical literature and identified 6 studies that reported on the complications of short-term oral corticosteroid use. Serious complications such as hyperglycemia and psychosis were noted, and in addition, 1 case of bilateral osteonecrosis of the hip and 3 cases of multifocal osteonecrosis were reported.

Langer et al. surveyed American Orthopaedic Society for Sports Medicine and Arthroscopy Association of North America members regarding their experience and MDP prescribing pattern. Of those responding, 47% admitted to prescribing MDP, and 32% admitted to prescribing MDP for their postoperative patients. Of the reported complications from the use of MDP, glucose intolerance was most common (37% of physicians surveyed); osteonecrosis was also reported by 8.5% of physicians (101 cases) who admitted to prescribing MDP and 25% of physicians (500 cases) who do not prescribe it.

A survey of National Football League team physicians showed that 83.9% admitted to prescribing MDP for their athletes. Serious complications such as osteonecrosis, tendon rupture, dyspepsia, psychosis, and cataacts were reported in 25.8% of patients when athletes and patients from practice partners were included. One conclusion that can be drawn is that there is widespread use of oral corticosteroids to treat a variety of pathologies and that serious complications from its use have been reported.

There is no clear consensus in the literature as to what constitutes a “safe dose” and prescribing pattern for oral corticosteroids in the postoperative patient. Although there were no complications during our follow-up period, longer follow-up is required because many of the possible complications of steroid use may occur later. It is critical to recognize the inherent risk of systemic corticosteroid therapy and counsel patients regarding the possible complications that may be associated with their use.

One limitation of our study is that it was a retrospective study without a control group. Ideally, we
could have randomized our “at-risk” patients into a conventional postoperative treatment arm and an MDP treatment arm. It was then the senior surgeon’s clinical observation that postoperative motion problems are frequently predictable within 2 weeks postoperatively. Historically, a 1% to 2% annual reoperation rate for symptomatic knee motion problems has been reported. We have used judicial timing of surgery after return of normal or near-normal motion and early ROM, extension splinting at night, prone knee hanging, early quadriceps activation, immediate patellar mobilization, postoperative walking with a hinged knee brace locked in extension, motorized cryotherapy, and early supervised physical therapy as the cornerstones of our perioperative ACL treatment.

Another limitation was the relatively short duration of follow-up of 10 months. Ideally, it would have been preferable to have more than 2 years of follow-up to ensure that the ROM gains shown at our final follow-up did not regress, although this has not typically been an issue with loss of motion in other studies. In previous studies all patients who lost ROM after ACL reconstruction did so within 3 months of surgery and no patients lost ROM more than 3 months postoperatively.

Another criticism would be the variability of using a goniometer to measure ROM to the degree. To minimize this variability, all measurements were performed by the same examiner, who has nearly 20 years of experience working with the senior surgeon. In addition, flexion deficits were reported compared with the contralateral knee, which was assumed to be normal.

CONCLUSIONS

The use of oral corticosteroids, in the form of an MDP, was associated with a successful return of normal ROM in 78% of patients with early post-surgical loss of flexion and near-normal extension after primary ACL reconstruction without any associated complications or decrease in objective instrumented stability measurements.

REFERENCES

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