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Functional Problems and Arthrofibrosis Following Total Knee Arthroplasty

By Thorsten M. Seyler, MD, David R. Marker, BS, Anil Bhave, PT, Johannes F. Plate, BS, German A. Marulanda, MD, Peter M. Bonutti, MD, Ronald E. Delanois, MD, and Michael A. Mont, MD

Introduction

Improved surgical techniques and multidisciplinary rehabilitation protocols that involve coordination among surgeons, physical therapists, anesthesiologists, and social services personnel have led to excellent knee function and range of motion in a large percentage of patients following total knee arthroplasty. Nevertheless, there remains a small number of patients with persistent dysfunction that is difficult to treat. Functional problems following total knee arthroplasty may be incapacitating as a result of persistent pain, instability, and a limited range of motion. It has been shown recently that there is a direct correlation between a decreased range of motion following surgery and a lower perceived quality of life as evaluated with use of the Short Form-36 health survey questionnaire. Continued dysfunction for any reason ultimately leads to decreased patient satisfaction.

There is controversy about treatment methods for patients for whom initial rehabilitation efforts are unsuccessful following total knee arthroplasty. The reported efficacy of both noninvasive and invasive treatment modalities has been variable, with the percentage of patients obtaining improvement ranging from 0% to 90%. Patients who have continued dysfunction despite initial rehabilitation efforts may require revision surgery. However, patients who have well-aligned, well-fixed prosthetic components will likely not benefit from a complete revision. Treatment of arthrofibrosis, scarring, soft-tissue contractures, and/or other soft-tissue dysfunction should involve less invasive treatment protocols before surgical options are considered. Nonoperative treatment modalities for restoring the range of motion include intensive rehabilitation protocols, static or dynamic splinting, injections, and application of serial casts. Manipulation with the patient under anesthesia and invasive procedures, including arthroscopic débridement, open débridement with or without polyethylene exchange, and complete component revision, have been utilized when initial nonoperative rehabilitation efforts have failed.

As a result of the variability in the functional limitations experienced by patients and the inconsistency in the success of present, commonly used rehabilitation modalities, additional treatment options need to be considered and evaluated. We are reporting our experience with diagnosing the underlying causes of dysfunction following total knee arthroplasty and the level of success that we have had with use of various rehabilitation and treatment modalities.

Materials and Methods

Diagnostic Methods

Patients for whom initial rehabilitation efforts following total knee arthroplasty were considered to have failed because of continued pain and/or functional limitations underwent a careful radiographic and clinical evaluation. Radiographic studies were used to identify component loosening, malalignment, or other problems (for example, retained bone cement) that indicated the need for revision surgery. When infection was suspected, aspiration and cultures were utilized to verify the diagnosis and to identify the organism, thus ensuring proper antibiotic therapy and timely surgical treatment.

Patients for whom standard rehabilitation efforts had been unsuccessful and who had no evidence of radiographic abnormalities were thoroughly assessed to identify any underlying soft-tissue problems associated with their dysfunction (Fig. 1). The range of motion was assessed at all clinical evaluations prior to and following the total knee arthroplasty. Standard flexion and extension measurements were performed with use of a goniometer. Limb length was measured with a tape measure when a limb-length discrepancy was suspected.

Muscle strength was measured with use of manual isokinetic strength testing and graded on a scale of 0 to 5. A grade of 0 corresponded to no contraction of the muscle and 100% loss of strength, whereas a grade of 5 indicated active movement against gravity with full resistance and no loss of strength.

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All measurements were made by two of us (A.B. and T.M.S.), who agreed with each other regarding the grade assessments >95% of the time.

Video gait analysis was conducted with use of an eight-camera motion analysis system (Motion Analysis, Santa Rosa, California) combined with two central force-plates (Advanced Mechanical Technology, Watertown, Massachusetts). This system was utilized to measure body kinematics, muscle activation, and ground reaction force along a 10-m, level-surface walkway. Twenty-six reflective markers (Helen Hayes marker set) were placed on both sides of the patient at the hip, knee, ankle, and foot. After the setup of markers for movement recording, electrodes were placed for surface electromyography. The force-plates and electromyography system were synchronized with the motion analysis system to measure ground reaction forces and activities of the lower-extremity muscles. The subjects were instructed to walk several passes at a self-selected speed until ten consistent force-plate recordings were collected for each side. Throughout the observation period, the sampling rate for the data points was 60 Hz. The data were processed with use of standard OrthoTrak software (Motion Analysis). The analyzed parameters were walking velocities, ground reaction vectors, joint moments, power, knee flexion, and ranges of ankle dorsiflexion during the stance phase as well as during the loading response.

**Patient Cohort**
On the basis of a thorough clinical evaluation performed with use of the previously mentioned diagnostic methods, functional problems and stiffness of the knee after total knee arthroplasty were diagnosed in 106 patients (108 knees). Initial rehabilitation efforts, which included manipulation under anesthesia in some cases, had failed for all of these patients. The patients had shown minimal improvement in terms of both function and pain relief at a minimum of two months postoperatively. Common symptoms included quadriceps fatigue pain, anterior knee pain, abnormal gait, back pain, limp, difficulty with walking long distances, and an inability to participate in non-strenuous sports or recreational activity. Patients also reported difficulty with sitting in and rising from a chair, descending and ascending stairs, and sexual relations. There were sixty-four women and forty-two men, and the mean age was fifty-three years (range, nineteen to seventy-seven years). Seventeen of the patients had the functional problems following revision total knee arthroplasty, and all others had them after primary total knee arthroplasty.

Fig. 1
A standardized algorithm was used to diagnose and treat functional problems following total knee arthroplasty. CKD = customized knee device, JAS = Joint Active Systems, and NMES = neuromuscular electrical stimulation.
All individuals demonstrated gait abnormalities that were associated with one or more biomechanical dysfunctions. The six most prevalent categories of dysfunction were flexion contracture, knee flexion deficit, quadriceps weakness, limb-length discrepancy, peroneal nerve entrapment, and functional malalignment of the distal joints. Sixty-six patients (sixty-eight knees) were diagnosed as having a knee flexion contracture; forty-three patients (forty-four knees), muscle tightness; twenty-eight patients (twenty-eight knees), quadriceps muscle weakness; seven patients (seven knees), a limb-length discrepancy of 1 to 2.5 cm; four patients (four knees), functional malalignment; and fourteen patients (fourteen knees), peroneal nerve dysfunction. Some of the patients had more than one functional problem.

The specific rehabilitation and physical therapy modalities were customized for each patient, and treatments with these modalities were not mutually exclusive. Some of these treatments included the use of a customized knee device (seventy-nine knees), a JAS device (Joint Active Systems, Effingham, Illinois) (thirty knees), botulinum toxin injections (nine knees), electrical stimulation (forty-one knees), and peroneal nerve release (fourteen knees). In general, the physical therapy regimens lasted for three to six months (mean, 4.6 months) (Fig. 2). All rehabilitation efforts failed for seven patients, who subsequently received surgical treatment, including arthroscopic débridement, open débridement with or without polyethylene exchange, and complete component revision.

**Results**

**Nonoperative Treatment**

Connective tissue is viscoelastic in nature, and under tension it responds by reaching either the elastic or plastic deformation state. In elastic deformation, tissue can revert to its original length after the force is removed. In the plastic deformation state, tissue will maintain the newly elongated length after elimination of the force. The goal of therapeutic stretching is to achieve permanent length changes without requiring new tissue growth by plastically deforming tissues that have stiffened or shortened.

**Custom Knee Devices**

Seventy-eight patients (seventy-nine knees) followed a daily outpatient rehabilitation algorithm using a fitted custom knee device (Fig. 3). The device is hinged at the knee and has elastic bands (Thera-Band; The Hygenic Corporation, Akron, Ohio), which produce a flexion moment. The patients were instructed how to position the brace for maximum tolerated force and were expected to utilize the custom knee device for...
All patients who were treated with the custom knee device had a knee flexion deficit, which was defined as a flexion angle of <90° and which resulted in functional deficits in the ability to rise from and sit in a chair, sit for prolonged periods of time, ascend and descend stairs, and engage in sexual activities. These problems were mainly related to tightness of the rectus femoris muscle, patellar tracking problems, and tightness or inflammation of the patellar tendon. In addition to the patients’ use of the custom knee device, physical therapists supervised inferior patellar, patellar tendon, quadriceps tendon, rectus femoris, and knee joint mobilization efforts to further increase knee flexion (Fig. 4).

Patients with a knee flexion contracture used a customized device to increase knee extension, which was similar to the custom knee device used to increase flexion and which was also applied for thirty to forty minutes three times a day (Fig. 5). Knee flexion contracture leads to problems with walking, anterior knee pain, extensive patellar wear, and patellar tendinitis. An overall excellent result was obtained in seventy-one knees (90%) treated with the custom knee device. The mean Knee Society score at the time of final follow-up was 91 points (range, 55 to 100 points), and the total arc of motion improved by a mean (and standard deviation) of 24.7° ± 18.3°. After obtaining minimal improvement with use of the custom knee device, three patients required arthroscopic lysis of adhesions, one patient had an open débridement with polyethylene exchange, and one patient had complete component revision. Some patients chose not to undergo additional surgery and ended their rehabilitation efforts despite continued range-of-motion deficits.

**JAS (Joint Active Systems) Device**

Twenty-nine patients (thirty knees) with a soft-tissue contracture after total knee arthroplasty or trauma to the joint used the JAS (Joint Active Systems) knee device to treat both flexion and extension limitations (Fig. 6). The JAS device is a patient-directed, bidirectional orthosis that can be used conveniently in a home setting. It incorporates stress relaxation and static progressive stretch, while simulating some of the manual techniques used by physical therapists in the clinical setting. Patients with heterotopic ossification, peroneal nerve palsy, or true osseous blocks were not treated with this device. Fifteen men and fourteen women with a mean age of fifty-two years began using the JAS device at a mean of 14.1 ± 9.7 weeks after the index surgery or injury.

Patients were instructed regarding the application of the device and the protocol for its use as described by Bonutti et al.18. After they placed the orthosis on the affected limb at the current limit of motion, the patients were directed to increase the stretch to the extent that they could tolerate by turning the ratchet on the device and holding that position for a period of five minutes. They then increased the stretch to the extent that they could tolerate and held the new position for another five minutes. Patients were instructed to stretch to the extent that they could tolerate, without causing excruciating pain, and they continued this incremental stretching for the entire thirty-minute treatment session.

All but two patients who underwent rehabilitation with use of the JAS device had a favorable outcome, with an increase in the range of motion, and two patients made no progress in at least one direction. The patients gained a mean of 7.4° ± 8.1° of additional extension and 15.1° ± 12.3° of additional flexion. The total mean increase in the flexion-extension arc was 22.5° ± 16.3°, from a mean of 85.4° ± 22.2° before utilization of the JAS orthosis to a mean of 107.9° ± 16.8° after a mean of 9.4 ± 7.8 weeks (range, three to thirty-three weeks) of treatment. Of the two patients who did not have an improvement in the range of motion, one required arthroscopic lysis of adhesions and one had an open débridement without polyethylene exchange.

**Botulinum Toxin Injections**

Eight patients (nine knees) who had rigidity of the hamstring and/or gastrocnemius muscle as the primary cause of a con-
continued flexion contracture despite initial physical therapy were treated with botulinum toxin type-A injections. These injections produce a neuromuscular blockade for approximately three months. The underlying mechanism of action of botulinum toxin is at the cellular level. By acting selectively on peripheral cholinergic nerve endings, it leads to chemodenervation and local paralysis. The temporary paralysis and reduction in functional muscle spasticity or muscle tone provided by botulinum toxin promote better motor balance across joints; improve walking ability; and, when combined with intensive physical rehabilitation, allow the therapists to progress the range of motion beyond previous limitations.

The decision regarding which muscles to inject was based on the patient’s reported feeling of tightness and spasm as well as on the findings of the clinical examination. Patients who lost knee extension as the hip joint was being flexed to 45° were considered candidates for botulinum injections into the hamstring muscles. The hamstring muscles were palpated as the knee was extended to determine whether the medial or lateral hamstrings required treatment. The decision to inject the gastrocnemius muscle was based on a loss of the range of knee extension as the ankle was dorsiflexed compared with the range in the plantigrade position.

The mean time from the index surgery to treatment with botulinum toxin injections was eighteen months (range, three to eighty-one months). Following the primary total knee arthroplasties, we injected the medial hamstrings in eight cases (seven patients) and both the medial and the lateral hamstrings in one patient. Two patients also received injections into both heads of the gastrocnemius muscle. All injections were administered by one of us (M.A.M.). The patient was placed in a prone position, and a 25-gauge needle was used to inject the muscle belly with a dilution of 50 units/mL.
The injections into the medial hamstring muscles consisted of 100 units of botulinum toxin type A distributed evenly among four sites, those into the lateral hamstrings consisted of 100 units of toxin distributed evenly among three sites, and those into the gastrocnemius muscle consisted of a total dose of 50 units of toxin injected into two sites in both the medial and the lateral heads of the muscle belly (Fig. 7).

After receiving the injections, the patients started a rehabilitation regimen that consisted of inpatient and outpatient treatment for eight continuous weeks. Intensive physical therapy combined with careful knee, quadriceps muscle, and inferior patellar mobilization and stretching of the rectus femoris muscle and the patellar tendon was provided three, four, or five times per week. The patients who received gastrocnemius injections were encouraged to sleep with the foot in a splint to maintain maximum dorsiflexion stretch on the muscle.

There were no serious complications directly associated with the botulinum treatment. A transient flu-like condition developed in one patient and lasted for two days. However, the patient recovered without additional difficulties and showed no later effects. Another patient had redness and swelling at the site of the injection for several days after treatment; this cleared up by one week.

Eight of the nine knees treated with the botulinum injections achieved extension within 5° of the neutral position. The range of motion increased by a mean of 42° (range, 10° to 75°; p < 0.001) at a mean of thirty-eight months (range, twenty-four to fifty-eight months) following the injections.

Fig. 7
Botulinum toxin type A was injected into four sites of a contracted medial hamstring muscle, three sites of a contracted lateral hamstring muscle, and two sites in each head of a contracted gastrocnemius muscle.

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Fig. 8
Neuromuscular electrical stimulation (7 to 10-sec on-time, 15 to 20-sec off-time, frequency of 70 to 90 pulses/sec, 400-µsec-pulse duration, 90 Hz, and intensity set at the maximum tolerated to produce a superimposed muscle voluntary contraction) augmented isometric strengthening at 30° of flexion to treat an extensor lag.
The Knee Society scores improved by a mean of 35 points (range, 15 to 53 points; \( p < 0.001 \)) from the time prior to the botulinum treatment to the final follow-up examination. All patients had a good or excellent clinical outcome as indicated by a Knee Society score of \( \geq 80 \) points, except for one patient with a score of 76 points. That patient had a residual knee flexion contracture of 10° but was satisfied with the result and declined further treatment.

**Electrical Stimulation**

Forty patients (forty-one knees) who had an extension lag and were included in the previously discussed cohorts (those treated with botulinum toxin injections and/or a custom knee device) also received electrical stimulation during their physical therapy sessions to augment strength training. The stimulation was administered while the patient underwent soft-tissue mobilization and exercises with use of a leg-press to activate the quadriceps and inhibit the flexors (Fig. 8). Throughout the session, the electrical stimulation was set at a 7 to 10-sec on-time, a 15 to 20-sec off-time, a frequency of 70 to 90 pulses/sec, a 400-µsec pulse duration, and 90 Hz.

**Manipulation Under Anesthesia**

Patients who had a range of motion of \( \leq 90^\circ \) at six weeks following the total knee arthroplasty were candidates for manipulation under anesthesia (Fig. 9). These patients showed no improvement or a reduction in both flexion and extension despite initial rehabilitation efforts. Like the other nonoperative treatments, manipulations were not utilized for patients who had component malposition or failure, incorrect component sizing, joint line displacement, or inadequate bone resection. Manipulations were not performed more than three months following total knee arthroplasty because of decreased effectiveness and the risk of fracture after that time. Patients who continued to show a limited range of motion after three months underwent extensive radiographic and clinical evaluation and were treated with a customized rehabilitation regimen with use of one or more of the previously mentioned nonoperative treatment modalities.

The criteria used to select candidates for manipulation under anesthesia in this study differed from those reported in other studies. Keating et al. selected patients for manipulation as early as two months following total knee arthroplasty, and the procedure was utilized as late as forty-four weeks postoperatively. Fox and Poss treated patients as early as two weeks after surgery, and Shoji et al. reported that their patients received manipulations at ten days following surgery. The range-of-motion criteria used in other studies also varied. For example, Brassard et al. selected patients with a range of motion limited to \(< 75^\circ\), and Esler et al. treated patients in whom flexion had failed to increase to \(> 80^\circ\) following the initial physiotherapy.
The reported outcomes of manipulations under anesthesia have also been variable. In the study by Keating et al., patients had a mean increase in flexion of 35° after a mean of five years of follow-up\(^1\). Keating et al. also reported no significant difference in the improvement in flexion between patients who had been treated within twelve weeks following surgery and those who had had the manipulation at more than twelve weeks. In contrast, a study by Yercan et al. suggested that the timing of the procedure does affect the final outcome\(^2\). They found the results in patients who had received the manipulations less than three weeks postoperatively to be better than those in patients who had been treated between three weeks and three months postoperatively. They reported an improvement of 47° in the range of motion at the time of final follow-up. In contrast to both of these studies, Fox and Poss\(^2\) reported that manipulations ultimately did not

![Diagram](image)

**Fig. 10**

A five-step surgical technique was utilized for peroneal nerve release to decrease peroneal nerve symptoms. (Reprinted, with permission of Springer Science and Business Media, from: Paley D. Principles of deformity correction. New York: Springer; 2002. p 284-5. Also printed with permission of the Rubin Institute for Advanced Orthopaedics. The assistance of Dr. Dror Paley with the creation of this figure is appreciated.)
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Surgical Treatment

Functional problems, persistent pain, and arthrofibrosis after total knee arthroplasty are debilitating complications. The underlying etiology is often multifactorial, and little information regarding these problems is known. Although the etiology of these complications is poorly understood, several surgical procedures have been proposed as viable treatment modalities. Open operative procedures such as a complete revision of the prosthesis or a simple component exchange have been described. More recently, and with the use of arthroscopic surgery, there have been numerous attempts to address these types of complications with minimally invasive techniques.

Peroneal Nerve Release

Peroneal nerve release with both proximal and distal decompression at the fibular head was performed after the total knee arthroplasty in fourteen patients (fourteen knees). All patients had had constant burning or shooting pain in the dorsum of the foot, which was made worse by physical therapy. In addition, electromyographic and nerve conduction velocity studies demonstrated electrophysiological abnormalities of the peroneal nerve in all fourteen patients. The possible causes of the peroneal nerve palsy appeared to be direct traction on the nerve or tension on the surrounding soft tissues created during the surgery. Other, indirect mechanisms of injury might have included compression from tight dressings or possibly a combination of these factors.

The mean age of the patients was sixty-three years. None had an underlying neurological disorder. In each case, the peroneal nerve was released at two possible entrapment points with use of a standard five-step surgical technique (Fig. 10). First, a short oblique incision was made at the level of the neck of the fibula in line with the course of the nerve. Next, the superficial fascia of the leg was incised and divided over the peroneal nerve. The third step was to divide the fascia over the muscles medially. At this stage, the underlying fascial band that passes over the nerve was exposed and then sectioned to release the first potential entrapment point. The final step involved isolating and then cutting the intermuscular septum between the anterior and lateral compartments. This last step releases the second common point of entrapment. In some patients, the anterior compartment fascia was also released longitudinally in a subcutaneous fashion.

Following peroneal nerve release, all patients received intensive physical therapy three, four, or five times a week for eight weeks, with use of either the custom knee device or the JAS device. At the end of these eight weeks, thirteen of the fourteen patients had achieved full extension within 5°. They were completely symptom-free within six weeks after the surgery. One patient had a persistent knee flexion contracture of 15°. Thirteen patients reported a return to normal gait and recovery of ankle dorsiflexor function. Also, sensation in the cutaneous distribution of the superficial and deep peroneal nerves returned in all cases.

Arthroscopy

Arthroscopy at the site of a prosthetic knee is a technically challenging procedure, but various reports have shown promising success rates. Williams et al. reported on arthroscopic release of the posterior cruciate ligament in ten stiff painful knees that had undergone posterior cruciate ligament-sparing total knee arthroplasty. At a mean of twenty months after the arthroscopic procedure, the mean increase in knee flexion was 30.5° (range, 10° to 50°). Eight patients reported satisfaction and decreases in pain and stiffness, whereas two patients went on to have a revision total knee arthroplasty. Diduch et al. studied the efficacy and safety of arthroscopy for diagnosing and treating symptoms in forty knees that had undergone total knee arthroplasty. Arthroscopy was used successfully to diagnose the cause of the symptoms in 97.5% of the patients, and arthroscopic treatment included removal of impinging tissue or loose bodies. At an average of 19.9 months, the rates of clinical success were 82% for procedures done to treat “clunks,” 60% for those used to remove impinging synovial or soft tissue, and 63% for those used to treat arthrofibrosis. Similarly, Jerosch and Aldawoudy evaluated the efficacy of arthroscopic management of knee stiffness after total knee arthroplasty. In their series of thirty-two knees, twenty-five demonstrated improvements in both the range of motion and the Knee Society scores. In the present study, four patients underwent arthroscopic removal of scar tissue. These patients had an improvement in the range of motion ranging between 10° and 20°. At a mean of sixteen months following the arthroscopy, no patient had required an additional surgical procedure and the mean Knee Society score was 89 points.

Arthrotomy and Débridement

When a patient presents with severe stiffness of the knee, an arthrotomy with synovectomy, removal of scar tissue, lateral retinacular release, posterior capsular release, posterior cruciate ligament release, and/or exchange of a single component can be a reasonable approach. Babis et al. reported the results in seven knees in which stiffness after total knee arthroplasty had been treated with an arthrotomy, débridement of scar tissue, and isolated exchange of the tibial polyethylene insert. At the time of final follow-up, two knees had been revised, four knees were severely painful, and one knee was moderately painful. The authors concluded that open débridement and exchange of the polyethylene insert alone was not an effective treatment approach in their hands. Conversely, Maloney, in a comment on the evaluation and management of arthrofibrosis, pointed out the risk of damage to the articulation during arthroscopy to remove scar tissue and found open
débridement and resection of the posterior cruciate ligament to be a good treatment option. However, he did not report the actual number of patients in his series. Yercan et al. reported the results in seven patients who had been treated with an arthroplasty, which had been combined with component exchange in two cases. Although five of the seven knees showed improvements both in the range of motion and in terms of pain relief, the authors concluded that open arthrolysis and isolated revision of a component does not correct a limited arc of motion but leads to reliable pain relief. We performed an arthroplasty with débridement of scar tissue and exchange of the polyethylene insert to correct oversized components in two patients. Both patients demonstrated improvements in the Knee Society scores and the total arc of motion.

Revision Total Knee Arthroplasty

Patients with persistent stiffness and pain after total knee arthroplasty who do not benefit from intensive physical therapy may require a revision total knee arthroplasty. Revision arthroplasty is the preferred treatment for patients with malaligned or oversized components and/or late-onset stiffness. However, studies of revision arthroplasties performed to treat stiffness after total knee arthroplasty have yielded mixed results. Haidukewych et al. reported that, of fifteen patients (sixteen knees) with well-fixed and well-aligned components who had been treated with revision arthroplasty, ten were satisfied with the outcome and showed modest improvements in the Knee Society pain and functional scores as well as in the total arc of motion. In a study by Christensen et al., eleven patients who had been treated with revision arthroplasty because of stiffness after total knee arthroplasty had mean improvements in the Knee Society pain and functional scores of 39.6 and 53.7 points, respectively, and a mean improvement in the arc of motion of 43.5°. Three patients required manipulation under anesthesia because of recurrent stiffness, and one required revision surgery because of loosening of the femoral component. Nicholls and Dorr reported that, of thirteen revision arthroplasties (in twelve patients) performed to treat stiffness, five achieved an excellent or good result, four achieved a fair result, and four achieved a poor result. Four knees required manipulation because of recurrent stiffness postoperatively. Despite these suboptimal clinical outcomes, eleven of the twelve patients reported a high degree of satisfaction with the result of the procedure because of pain relief. Ries and Badalamente reported the results of six revision total knee arthroplasties in five patients who had had stiffness after the primary arthroplasty. The arc of motion increased from a mean of 36° before the revision surgery to a mean of 86° after it. In a study of fifty-six knees in fifty-two patients who had undergone revision surgery because of stiffness, Kim et al. reported that the mean Knee Society pain and functional scores improved from 15 to 47 points and from 39 to 87 points, respectively. Thirty-five knees (63%) had a decreased flexion contracture, and forty-five knees (80%) had increased flexion. Fifty-two knees (93%) demonstrated a gain in the total arc of motion. Only one patient underwent revision arthroplasty in our series. This patient had an improved but still limited range of motion and reported a high degree of satisfaction because of persistent pain relief.

Conclusions

Although total knee arthroplasties performed with modern surgical techniques and standard rehabilitation protocols have been shown to provide excellent functional outcomes for the majority of patients, as many as 15% to 20% of patients continue to have functional limitations. The sources of these functional deficits can be identified through a combination of careful radiographic and clinical examination, three-dimensional gait studies, and isokinetic strength testing. A review of the current literature shows that arthroscopic débridement, open arthroplasty, open arthrolysis as well as replacement of a polyethylene insert, or a complete revision can provide success in many cases, especially those involving malaligned or over-stuffed components. However, the goal should be to avoid these additional operations if possible. The results of the present study show that botulinum toxin injections, use of a custom knee device or a JAS device, and peroneal nerve release can improve the range of motion and enhance the clinical outcome in patients who have various soft-tissue dysfunctions and for whom standard rehabilitation protocols were unsuccessful. Furthermore, many of these techniques do not have to be delayed for two or three months after the total knee replacement but rather can be initiated at an earlier time.

Corresponding author:
Thorsten M. Seyler, MD
Rubin Institute for Advanced Orthopedics, Sinai Hospital of Baltimore, 2401 West Belvedere Avenue, Baltimore, MD 21215. E-mail address: arthrodiastasis@hotmail.com

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