Total Knee Arthroplasty in Patient with Paraplegia after Spinal Cord Injury. What Factors Should be Considered before a Procedure? A Case Report and Review of Literature

Totální náhrada kolenního kloubu u pacientů s paraplegií po poranění míchy. Které faktory by měly být zohledněny před operačním výkonem? Kazuistika a přehled literatury

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SUMMARY

The clinical management of paraplegic patients is more complex than in able-bodied subjects. Spinal cord injury (SCI) affects younger, active people more often than the elderly during high-energy fall or traffic accidents. In order to return to work after suffering an SCI, patients need to regain their functional independence, especially their ability to drive. The literature lacks strong evidence addressing the surgical solutions in severe knee arthrosis in paralyzed patients after SCI. We present a favourable outcome of total knee arthroplasty (TKA) of a stiff knee in extension in a man with T12 grade C paraplegia after SCI. We describe an effective rehabilitation protocol after knee arthroplasty in patient with damage to the spinal cord. Several factors should be taken into account before performing surgery:

1. ability of regaining some of spinal cord locomotor function through intensive gait rehabilitation in SCI patients,
2. presence of muscle imbalance and knee contractures combined with a risk of bone fracture resulting from intensive postoperative rehabilitation,
3. the impaired microvasculature of the skin and subcutaneous tissues and increased risk of occlusion occurrence of the capillaries and small vessels of the leg,
4. higher prevalence of secondary infections via urinary entry sites in patients after SCI,
5. patient's strong determination and willingness to undergo the arthroplasty procedure. TKA might be considered in selected paralyzed patients after SCI, especially in those with severe arthrosis as well as significant knee contractures. Our study reveals the advantage of performing TKA in improving functional state in patients with cord injury.

Key words: total knee arthroplasty, spinal cord injury, paraplegia, rehabilitation, improvement of life.

INTRODUCTION

Implantation of a knee prosthesis into an ankylotic joint in patients with muscle failure in lower extremities is a rare procedure. Very recent studies does not report such procedures in paraparesis and paraplegia, although the annual incidence of spinal cord injuries (SCI) is high, especially in developing countries (22, 31). It is more common to perform a hip joint arthroplasty in patients with femoral neck fractures and associated hemiparesis following a stroke or hip arthroplasty in patients with cerebral palsy. In patients after SCI current management focuses on surgical stabilization of the spine, intensive neurological rehabilitation, and the prevention and treatment of acute and chronic complications, as severe muscle atrophy or bone loss (27). A primary goal of many persons after SCI is the ability to independently ambulate. Even slight functional recovery can have high impact on the daily functioning of severely handicapped patients. On the other hand early active resistive standing may provide the most effective means to prevent bone loss after SCI (19). In cases of coexistence of severe knee arthrosis, the standing with isometric contractions is often impossible to perform. In such patients, a total knee arthroplasty (TKA) might be a solution.

Thus, the first purpose of this study was to present a rare procedure with a favourable outcome: TKA of a stiff knee in extension in a man with T12 grade C paraplegia according to the American Spinal Injury Association Impairment Scale (AIS) after spinal cord injury (SCI). We also describe a simple, effective rehabilitation protocol after knee arthroplasty in patient with damage to the spinal cord.

The second purpose was to review the published articles about TKA after SCI and to point some important issues, which should be taken into consideration before

performing TKA in paraplegic or spinal cord-injured patients in accordance with available literature.

A systematic review of scientific literature has been performed. We have examined the issue of TKA following SCI. We utilized the PubMed, Scopus and Science Direct online databases for English-language articles using the search terms throughout the title/abstract. Initially, a query was run on PubMed using the terms „knee arthroplasty/replacement", and „paraplegia", „spinal cord injury", „spinal injury", „spinal fracture", „cord injury", „SCI", then these terms were taken in various combinations using the Boolean operators „AND" and „OR".

The titles and abstracts were viewed electronically to determine if the article included patients who underwent TKA after SCI. If the topic of the article and/or the inclusion/exclusion criteria were unclear from the abstract, the full text version of the article was retrieved and reviewed. The dates of the searches were from January 1, 2000, to September 09, 2014.

The search identified 190 publications, the full texts of 5 papers were examined, from which only one was identified as meeting inclusion criteria (other not relevant to the topic). This process was then repeated using Science Direct and Scopus but did not identify another publications. Then a search on specific operative problems in patients after SCI was performed.

CASE REPORT

A 47-year-old man sustained a compression fracture of vertebra L1 with dislocation of the Th12/L1 vertebrae and comminuted intra-articular fracture of the right proximal tibia in a traffic accident. The patient presented partial T12 grade C paraplegia according to the AIS. He was taken to surgery and underwent a Th12–L1 laminectomy with osteosynthesis with a bone graft, and open reduction, instrumented fusion and plate-osteosynthesis of the tibial fracture. In the treatment process, no neurological improvement was achieved. Patient did not present any sensory loss, and was able to walk for many minutes with a high-weight rolling walker and ankle-foot orthosis on both legs. Over the next several years, during which the patient lived at home, he developed arthritis in the right knee with stiffness on extension (Fig. 1A, B). Patient was not able to drive due to stiffness and the knee contracture and for this reason his walk became extremely difficult. A knee, hip, and ankle range of motion (ROM) was of 0–15º flexion, 0–110º flexion, and 0–20º (the both dorsi- and plantar flexion, respectively). The quadriceps femoris and hamstrings muscles status were 4 in both limbs according to the Medical Research Council grading system. The patient had no muscular atrophy, but he had pain (7 in visual analogue scale – VAS), swelling, and crepitation during gait with the advanced reciprocating gait orthosis. Knee pain and joint function were assessed with the Knee Society score (KSS). The score is based on the dimensions of pain, stability, and range of motion

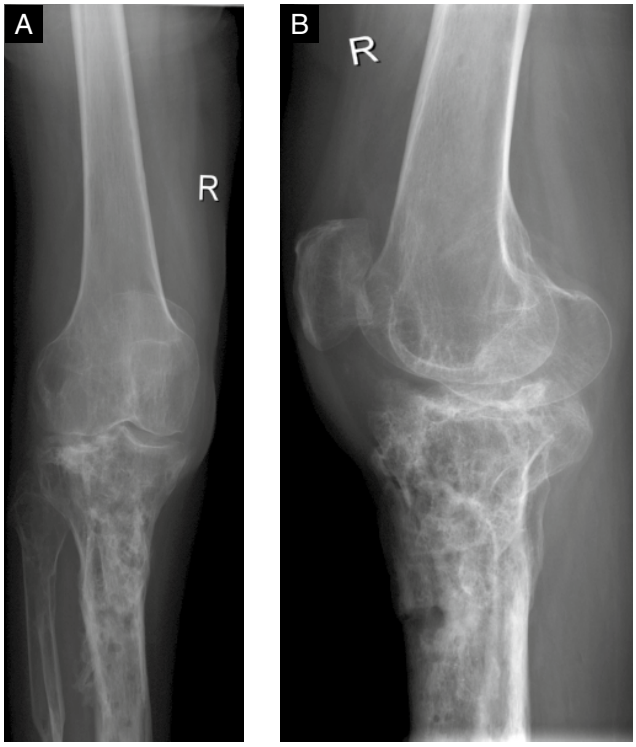

Fig. 1. Preoperative antero-posterior (A) and lateral (B) radiographs of the patient's right knee.

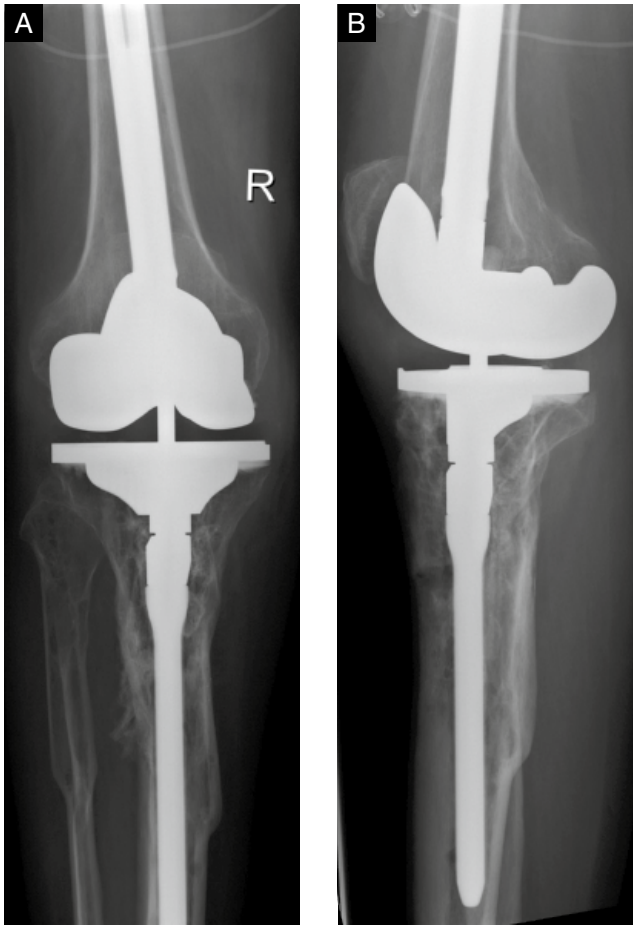

Fig. 2. Postoperative antero-posterior (A) and lateral (B) radiographs of a total stabilized posterior cruciate-substituting prosthesis.

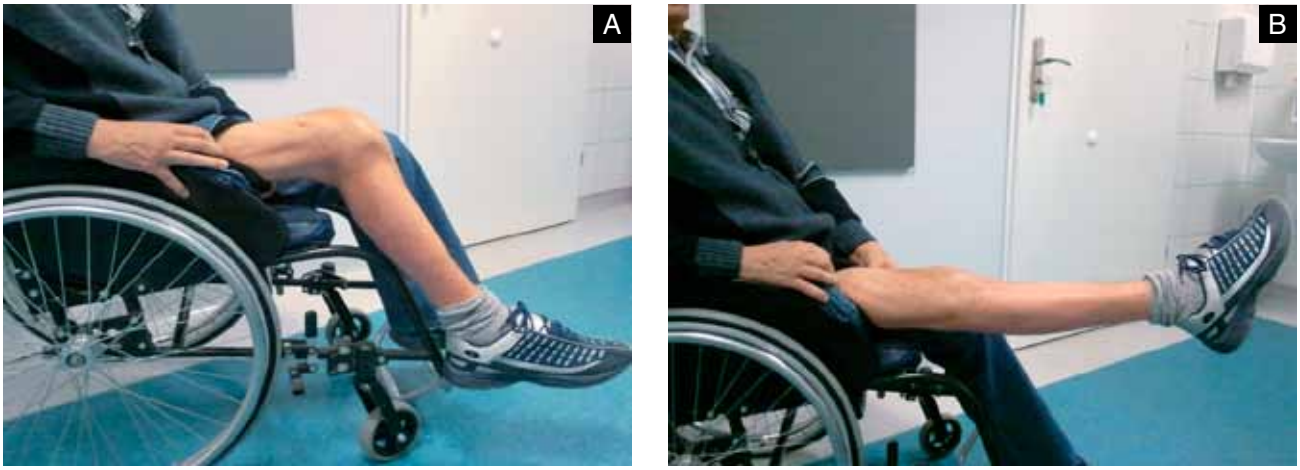

Fig. 3. Knee flexion (A) and extension (B) range of motion one year after arthroplasty.

and ranges from zero (worst) to 100 (best). A separate Knee Society score for function (KSS function) also ranges from zero (worst) to 100 (best). On both scores, points are added or subtracted for various components. In the patient the KSS and KSS function were 25 and 20, respectively.

Seven years after SCI and 3 months before the scheduled TKA, the patient was hospitalized to our orthopaedic department in order to remove a plate from tibia. After the operation there were no complications, including the wound healing. Laboratory tests did not reveal any inflammatory or infective syndromes. In response to the patient's strong desire for a final solution, a cemented, totally stabilized posterior cruciate-substituting Triathlon prosthesis (Stryker, Kalamazoo, MI, USA) with femoral and tibial stems was implanted (Fig. 2A, B). Beginning on the operative day, a cold compression device was used several times each day for 10-minute periods. To improve the conditions for healing, physical therapy, including nerve mobilization, and vascular mobilization was performed from the first postoperative day. Rehabilitation protocol included early intensive muscle strengthening, active isometric contractions of the quadriceps, physical therapy exercises with active and passive range-of-motion exercises, full weight-bearing on both legs, exercises to improve activities of daily living (e.g., the transition from sitting to standing). The patient was discharged from the hospital on postoperative day 10, at which time he presented an active ROM in the right knee of 0–90º flexion. We recommended that the patient continue the same rehabilitation protocol as in hospital.

One year after knee replacement, the patient had a ROM of 0–77º flexion in the right knee (Fig. 3A, B) and no pain (0 in VAS). The decrease in knee ROM took place during first six months of follow-up. KSS had increased at the 1-year follow-up and was 87, however there was no difference in outcome for patient in terms KSS function. The patient had become much more independent and was able to drive. At 2 years and 6 months of follow-up a clinical and functional state of the knee remains the same.

DISCUSSION

After performing this evidence-based review it is clear that the literature on joint replacements after SCI is extremely poor. An overview of studies on the subject revealed only one case of implantation of a knee prosthesis after SCI (15). Authors presented a patient who was hospitalized for septic arthritis of the knee thirteen years after L1 compression fracture complicated by T12 AIS grade A paraplegia. A treatment of infected knee lasted several years. Meanwhile the patient has lost the ability to walk following repeated, congestive flare-ups of gonarthrosis. The TKA was performed 6 years later. The functional and social outcomes were very good, that was in accordance to our presented case.

It is recognised that surgery on the limbs may exacerbate symptoms in patients suffering from neurological diseases (8, 24). TKA performed on patients with multiple sclerosis failed several times; usually patients developed recurrent dislocations due to hamstring spasticity (28). Recently, Bozic et al. (3) presented hemi- and paraplegia as a one of the most significant independent risk factors for revision TKA within 12 months; paraplegic patients remain in a group of major risk of secondary infections via urinary or cutaneous entry sites (15). In our patient, over the course of therapy and recovery, we did not observe, and the patient did not report, any local or general surgical complications.

In the present case, knee ankylosis in extension as a result of posttraumatic arthrosis, made the patient difficult for him to transfer from the bed to the wheelchair and back. It also affected his daily life; when moving forward in wheelchair, the patient were unable to reach objects in front of them or get into a car. The incidence of contracture in major joints 1 year after SCI ranges from 11% (knee) to 43% (shoulder), (6). In order to return to work after suffering an SCI, patients need to regain their functional independence, especially their ability to drive (23). TKA performed in our patient provided him with significant functional gain and ability to drive. Observations of our patient during early rehabilitation lend sup-

port to the validity of starting rehabilitation as soon as possible after surgery for more rapid resumption of self-therapy involving active motion and full weight-bearing by the operated limb.

It should be noted that a joint replacement in the spinal cord-injured patients is associated with higher risk of complications due to osteoporotic background (15, 18). During the procedure we implanted a prosthesis with femoral and tibial stems, which may reduce the risk of periprosthetic fractures and aseptic loosening of the prosthesis during intense postoperative rehabilitation, and may also overcome the considerable resistance of contracted soft tissues, as presented recently Ipach et al. (13).

The reported annual incidence of traumatic SCI varies from 2.3 per million in Canada to 83 per million in Alaska, and there are over 2.5 million people living with SCI worldwide (5, 12). Despite an increasing number of patients affected with SCI, a TKA in patients with severe paraparesis is a rare orthopaedic procedure. However, SCI affects younger, active people more often than the elderly (11). That may be a reason of less frequent coexistence of operated gonarthrosis up to date.

In the light of the recent literature and own experience, several factors should be taken into account before performing major joint arthroplasty in spinal cord-injured patients.

Firstly, even after a motor complete lesion with some preservation of sensory pathways, the spinal cord may regain some of its locomotor function through intensive gait rehabilitation (1, 21). The evidence from both animal and human studies indicates that with the appropriate training stimuli, neural and muscular plasticity can be induced even years after injury (17, 29). In persons with plegia, the residual strength of muscles affected by the injury is an important determinant of independence and function (10, 32). In certain number of injured patients the knee muscle strength is remarkably well preserved. In persons with SCI, strength assessment is typically based on the ability of muscles to resist gravity and external resistance (30). Specifically, the ankle plantar flexor and knee extensor muscle groups are of interest primarily because of their purported roles during bipedal locomotion (14). However, little is known about the extent to which skeletal muscle plasticity may impact functional outcomes after incomplete SCI (9).

Secondly, despite the preservation of muscle strength, muscle imbalance often happens (20). On the other hand, knee contractures, combined with a risk of bone fracture resulting from intensive postoperative rehabilitation, lead to choose implantation of a prosthesis with stems, as a means of preventing periprosthetic fractures and implant loosening (4).

Thirdly, the risk of occurrence of improper wound healing is higher, given the long-lasting impairment of exteroception, proprioception, and capillary microcirculation in the lower extremities. It has been reported that the microvasculature of the skin and subcutaneous tissues in the leg of the paraplegic patient is impaired and presents with enlarged endothelial cells and thickened and reduplicated basement membrane, mostly leading to the occlusion of the capillaries and small vessels (16). The associated tissue hypoxia and metabolic alterations are thought to be responsible for the occurrence of heterotopic ossifications of soft tissues described in paraplegics (7, 25, 26).

Finally, it is necessary to consider that the prevalence of secondary infections via urinary entry sites is higher in patients after SCI (15). Common recurrence of infections deserve close follow-up with repeat urine cultures at a minimum.

The strongest argument in favour of the surgery in this large patients cohort, however, is the patient's strong determination and willingness to undergo the arthroplasty procedure (2).

CONCLUSION

TKA provides substantial increases in knee ROM and improves functional state in patients with paraplegia, even when performed several years after SCI. TKA might be considered in selected paralyzed patients after SCI, especially in those with severe arthrosis as well as significant knee contractures. TKA after SCI is challenging orthopaedic procedure and several factors are required to be taken into consideration before surgery. Nevertheless the operation can be successful in achieving improvements in patients' daily life and overall satisfaction.

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