Arthrodesis of the knee using cannulated screws

We retrospectively evaluated eight patients who underwent arthrodesis of the knee using cannulated screws. There were six women and two men, with a mean age of 53 years. The indications for arthrodesis were failed total knee arthroplasty, septic arthritis, tuberculosis, and recurrent persistent infection. Solid union was achieved in all patients at a mean of 6.1 months. One patient required autogenous bone graft for delayed union. One suffered skin necrosis which was treated with skin grafting. The mean limb-length discrepancy was 3.1 cm. On a visual analogue scale, the mean pain score improved from 7.9 to 3.3. According to the Knee Injury and Osteoarthritis Outcome score quality of life items, the mean score improved from 38.3 pre-operatively to 76.6 at follow-up. Cannulated screws provide a high rate of union in arthrodesis of the knee with minimal complications, patient convenience, and a simple surgical technique.

Arthrodesis may be used to obtain a stable, painless knee in a patient with a failed arthroplasty, septic arthritis, peri-articular tumour, or recurrent infection. Successful fusion may be obtained in 80% to 98% of patients. Various techniques have been described. External fixation may use uniplanar, modified biplanar frames with transfixation pins and half pins, or circular frames. Methods of internal fixation include an anterior plate, double plating, an antegrade locking nail, combined intramedullary nailing and plate fixation, and modular intramedullary nails. No single technique has proved to be superior in all situations.

The purpose of this study was to evaluate the outcome after arthrodesis of the knee using cannulated screws.

Patients and Methods

Eight patients who underwent arthrodesis of the knee using cannulated screws (Synthes, Paoli, Pennsylvania) between 1998 and 2005 were evaluated retrospectively (Table I). There were six women and two men, with a mean age of 58.3 years (36 to 76). The indications for arthrodesis were failed total knee replacement (TKR) in two, soft tissue and bone loss in one, tuberculosis in three, and recurrent infection in two.

In the six patients with infection arthrodesis was not undertaken until it had been eradicated. On the basis of culture and sensitivity testing, appropriate intravenous antibiotics were administered for four to six weeks, or anti-tuberculous medication for 9 to 12 months or until the serum levels of inflammatory markers had become normal.

The loss of bone at operation was classified as mild, moderate or severe. It was considered to be mild if full bony contact was possible, moderate if there was incomplete bony contact and severe if there was minimal bony contact. Bone loss was mild in two patients, moderate in three and severe in three.

Pain was assessed using a visual analogue scale from zero to 10, with 10 being the most painful. The Short Form-36 Health Survey (SF-36) was used as a measure of general health status, and each of the eight subscales had a score of zero to 100, with 100 being the best score. Quality of life was assessed using four questions from the Knee Injury and Osteoarthritis Outcome Score (KOOS) questionnaire, which has been validated for the evaluation of patients undergoing knee injury, with 100 being the best outcome.

Serial radiographs were used to determine the time of fusion. Clinical and radiographic union were defined as the ability to walk without pain, no tenderness at the site of the arthrodesis and the appearance of trabecular bone bridging at the site of arthrodesis on both anteroposterior and lateral radiographs. The alignment of the limb and leg-length discrepancy were measured on full-length radiographs taken after union had been achieved.
Surgical technique. The patient is supine and the leg draped from the buttock to the toes. Either a midline incision is used, or previous incisions as dictated by the condition of the skin. Skin flaps should not be undermined more than necessary, and should be handled with care to minimise damage to the cutaneous circulation. The patella is excised to relieve tension on the incision and to add to the site of the arthrodesis later. The menisci, cruciate ligaments and any debris are excised. Samples of fibrous tissue and bone are taken for microbiological studies. If present, the prosthetic components and all cement are removed with wide debridement and lavage. The bone ends are prepared with removal of all articular cartilage and the preparation of appropriate surfaces for apposition. In order to maintain limb length, minimal bone resection is performed when arthrodesis is undertaken after TKR. Autogenous iliac bone graft is used if there is moderate or severe bone loss. The femur and tibia are placed in 5° to 7° valgus and 0° to 5° flexion, and are fixed with two or three crossed cannulated screws (Figs 1 and 2). Two parallel screws are inserted to obtain compression, and a further screw is added to obtain resistance to shear stress.

A cylinder cast is retained for six to eight weeks with partial weight-bearing as tolerated. Full weight-bearing is allowed when there is radiological evidence of union.

Results
Primary union was achieved in seven patients (87.5%). At a mean follow-up of 5.8 years (2.3 to 10) all patients were able to walk without pain and none had evidence of instability or recurrent infection. The mean time to union was 6.1 months (4 to 8). Delayed union occurred in one patient (No 3, Table I) with severe bone loss, who
underwent a further bone grafting procedure six months after the initial operation. Union was achieved two months later. One patient (No 2, Table I) had necrosis of the wound margins and required skin grafting. Two patients required autogenous iliac bone graft during arthrodesis. Excised patella was used in patients with moderate or severe bone loss (Fig. 3).

The mean post-operative alignment was 4° valgus (0° to 7°) and the mean leg-length discrepancy was 3.1 cm (1.1 to 6.5). Two patients had shortening of > 5.0 cm. No patient had significant rotational deformity.

The mean Short-Form (SF-36) scores at follow-up are shown in Table II. The mean pain score improved from 7.9 (7 to 9) to 3.3 (2 to 4). The mean KOOS score improved from 38.3 (31.3 to 43.8) to 76.6 (62.5 to 87.5).

**Discussion**

The techniques that are available to obtain arthrodesis of the knee may be categorised by the type of fixation used. We are not aware of descriptions of arthrodesis using fixation with cannulated screws. The rate of primary union in our patients was 87.5%, with one patient requiring a secondary procedure. The mean time to union, 6.1 months, was similar to that in studies using other forms of fixation (Table III).
Each technique has advantages and disadvantages. Intramedullary nailing has a high rate of union and excellent stability, but has the risk of the intramedullary dissemination of any infection.\textsuperscript{3,5,26} Arthrodesis using an external fixator has been popular, but pin track infection and adjustments requiring hospital admission are common.\textsuperscript{12} Good rates of union have been achieved using compression plates,\textsuperscript{14,27} but there are concerns about the risk of fracture at the bone-plate junction, and patients are often immobilised in an above-knee cast until fusion has occurred.\textsuperscript{14} Ilizarov techniques have been used more recently,\textsuperscript{6,28} but require further operative procedures, and again have many complications such as pin track infection, nonunion, fracture of the femur and tibia (Table III). Arthrodesis using cannulated screws is generally straightforward, convenient for patients, has a low rate of delayed union and of recurrence of infection, and compression can be obtained. The disadvantages of this technique are the need of immobilisation and delayed weight-bearing.

The causes of nonunion include poor bone stock, inadequate fixation, persistent infection, and lack of bony contact.\textsuperscript{23} Several authors have recommended iliac crest bone grafting when no signs of healing are present four months after the procedure.\textsuperscript{10,26,29,30} Arthrodesis using cannulated screws should be considered when there is minimal bone loss and broad cancellous surfaces with adequate cortical bone to allow good bony apposition and compression. Two patients with severe bone loss in our study achieved primary union without additional surgery.

The technique using cannulated screws is based on several studies of screw fixation for ankle arthrodesis. Ogilvie-Harris, Fitsialos and Hedman,\textsuperscript{31} in a biomechanical cadaver study, showed that three crossed screws generated significantly more compression and resistance to torque across the arthrodesis site than did two screws. They also found that better compression was obtained when the lateral screw was inserted first, and recommended placing one screw laterally, one medially and one anteriorly from the tibia to the talus. Mann et al\textsuperscript{32} also recommended two parallel cancellous screws, emphasising the excellent compression obtained by the parallel orientation of the screws. Friedmann, Glisson and Nunley,\textsuperscript{33} however, found that crossed screws were more rigid than parallel screws, especially in resisting the torsional stress. We recommend three crossed cannulated screws for arthrodesis of the knee. First, two parallel screws are inserted to obtain compression; a further crossed screw is then placed to obtain resistance to shear stress across the site of arthrodesis.

A limitation of our study is that the pre-operative SF-36 scores were not recorded.

We believe that arthrodesis of the knee using cannulated screws provides a high rate of union, minimal complications, patient convenience, and is a simple surgical technique. It may reduce the need for additional surgery or extensive post-operative rehabilitation. It is now our practice to use cannulated screws for arthrodesis of the knee, although alternative methods, such as intramedullary nailing, are considered when there is extensive bone loss and poor bone stock.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References

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