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Intermediate-Term Results of 142 Single-Design, Rotating-Hinge Implants: Frequent Complications May Not Preclude Salvage of Severely Affected Knees

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ABSTRACT

Rotating-hinge knee prostheses have low survivorship and high complications except in primary arthroplasties in elderly patients. We retrospectively reviewed 142 single third-generation design, rotating hinge prostheses (11 primary procedures and 131 revisions) at 57 months follow up. Implant survival was 73 %. Successful two-stage reimplantation for prosthetic infection was 78.4% but new infection rate was 22%. The tibial component was durable while the femoral component was problematic. We observed only one patellar maltracking and no polyethylene wear. A third generation rotating-hinge arthroplasty reconstruction was reliable in complex problems. Outcomes in primary situations were excellent. Complications were the rule rather than the exception in revisions. With timely intervention, attention to soft tissue coverage, and realistic expectations, complications were contained and functional benefits were appreciable.

Constrained condylar implants can restore stability and fixation in most knee arthroplasty revisions [1]. Joint stability remains dependent, at least in part, on soft tissue structures therefore, stress transfer to components and fixation interfaces is diminished. Total knee arthroplasty with hinge or rotating-hinge implants has been performed for several decades in primary and revision situations [2–4]. With few exceptions in which a hinge implant was the surgeon's choice [5], it was considered a design of necessity when severe bone and soft tissue loss makes mobile reconstruction of the knee unattainable with less constrained prostheses [4,6–10].

Posttraumatic arthritis with periarticular mal-union or non-union, severe deformity, skeletal dysplasias, neuromuscular disorders, and reconstruction following tumor resection are established indications [10–13]. On the other hand, prosthetic loosening, severe instability, infection, and periprosthetic fractures with severe bone loss are becoming more frequent challenges particularly with the increasing demand for total knee arthroplasty [6–9,13–16].

Hinge implants had a variety of articulating surface materials and geometry, mechanisms of weight transfer, amount of required bone resection, patellofemoral kinematics, as well as stem design and fixation techniques. First-generation hinge prostheses had one plane of motion and were truly linked implants with suboptimal designs and high failure rates [2,4]. In response to their poor outcomes, several implant modifications were introduced. Although rotation was incorporated in second-generation prostheses, their outcomes remained disappointing [17–19]. Third-generation implants featured further enhancement of tibiofemoral articular conformity and load transfer, adoption of a deep anatomic trochlear groove, improvement of biomaterials including metals and polyethylene, and expansion of modularity of stem fixation as well as the ability to reconstruct cavitary and segmental deficiencies to address a wide range of challenges [8,9,20,21,15,22].

Despite these improvements, rotating-hinge implants continue to have a reputation of low survivorship and high complications. Most literature on modern rotating-hinge implants included small series at short-term follow up.

This study is a retrospective report on complex knee problems in which implants with less constraint than a hinge were considered inadequate, fusion was inapplicable or refused by patients, and salvage of the extremity and its function was desired. We sought to clarify the role of a single third-generation rotating-hinge total knee arthroplasty in modern, non-oncologic reconstruction and to determine its indications, clinical and functional outcomes, complications, and implant survival.

Materials and Methods

Institutional review board approval was obtained and the departmental database was queried to identify patients who underwent

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primary or revision rotating-hinge total knee arthroplasty. Patients who received the Orthopedic Salvage System (OSS; originally: the Finn Knee, Biomet Inc, Warsaw, Indiana) for non-oncologic knee conditions between 1994 and 2011 were identified. Patients were included if they had a minimum follow up of 2 years and if they developed earlier complications or failure. Due to early design modifications, forty-four procedures in forty-two patients performed between 1989 and 1994 were excluded. Patients who received other rotating-hinge implants or had reconstruction following primary or metastatic tumor resection were also excluded. Patients who met the inclusion criteria had their charts reviewed to identify indications of the procedure, surgical data, and functional outcomes as well as complications and implant survival. Functional evaluation was performed utilizing the knee society score. Implant failure was defined as revision of femoral or tibial implants, or extremity amputation. Exchange of articulating hinge components with retention of well fixed femoral and tibial implants was reported as a complication and reoperation rather than failure. Two-proportion test based on chi-squared approximation was utilized to test the probability difference of complications between septic and aseptic revisions. When the approximation could fail due to small number of patients in groups of interest, a Fisher's exact test was utilized instead. A P value <0.05 was considered statistically significant. Kaplan–Meier method was utilized for implant survival analysis.

Implant Design Features

The design is that of metal on polyethylene rotating-hinge with an axle and yoke mechanism (Fig. 1) with the following features:

1) Since 1991, all articulating components were cast of chromium–cobalt–molybdenum except the proximal tibial replacement segment, which continues to be made of titanium to maintain acceptable weight.
2) The resurfacing femoral component (28 mm in length) has a 5° valgus alignment and approximates the anatomic geometry of the distal femur with posteriorized femoral axle to reproduce the knee center of rotation. The implant is available in a reduced size suitable for smaller anatomy and conditions with compromised soft tissues to facilitate closure.
3) The tibial component is available in variable diameters, modular and non-modular stems. In 1994, lateral fins were incorporated along with cemented augments, and titanium plasma-spray backing to enhance fixation.
4) In 1991, modularity was introduced to allow variable segmental arthroplasties. Segmental components and all modular stems connect through large morse tapers (16.6 and 12.6 mm in diameter respectively) to minimize fatigue fracture and are further secured with a locking spiral mark screw after impaction. In addition, the component/stem junction has a solid, gradual radius change to increase the strength.
5) Modular stems for femoral and tibial fixation have variable lengths and diameters for cemented and cementless fixation with fully porous or grit-blast surfaces. Bowed 150, 225 and 300 mm stems are available.
6) The femoral/tibial articulation allows 0–130° degrees in flexion-extension and 20° of both internal and external rotation.
7) The posterior femoral condyles accept an axle, which rotates on ultrahigh molecular weight polyethylene femoral condyle bushings and the axle is locked within the yoke with a polyethylene pin. The yolk is inserted within an ultrahigh molecular weight polyethylene bushing in the tibial component.
8) The polyethylene bearing provides a flat rotating tibial platform and a highly congruent femoral surface and has variable thicknesses. It was modified in 1994 to accept larger lateral phalanges of the tibial yoke to decrease risk of yoke disassembly. There is a broad surface contact of 4.5 cm^2 between each of the femoral and

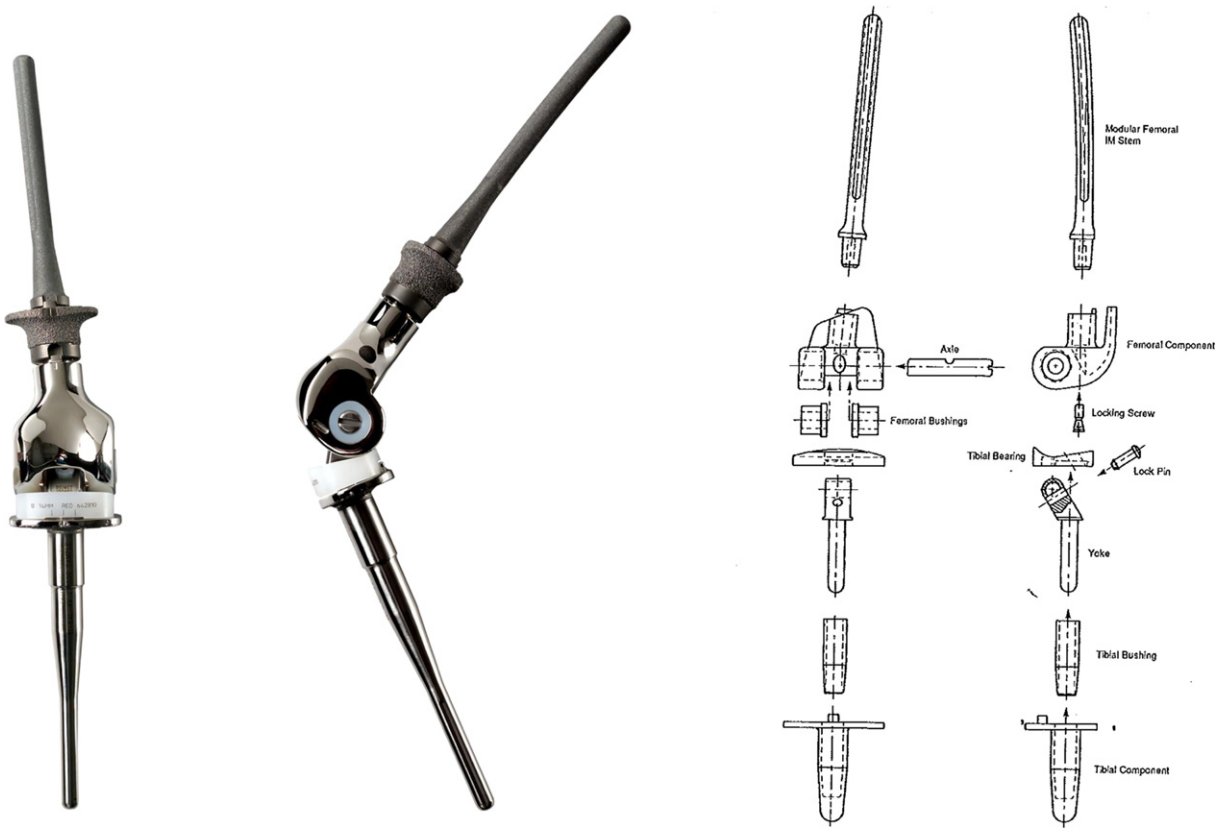

Fig. 1. The Orthopedic Salvage System: OSS; originally the Finn Knee, Biomet Inc, Warsaw, Indiana.