

Scorpio Posterior-Stabilized Knee System: 5-Year Clinical and Functional Results

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Abstract: One hundred three primary total knee arthroplasties using the Scorpio posterior-stabilized total knee system were studied. Clinical, functional, and radiographic assessments were performed preoperatively and at 7 weeks, 6 months, and annually postoperatively. Standard knee scoring systems were used for clinical and functional evaluation. Radiographic assessment was characterized according to standard zones. Presence of anterior knee pain and patellar clunk was also noted. Mean follow-up was 5.25 years. At latest postoperative follow-up, follow-up was 89%. Knee Society scores were 91.3 clinical and 73.0 functional. Mean range of motion increased from a mean preoperative level of 96.5° to 124.5° at latest-year follow-up. There were 4 reports of anterior knee pain. One femoral and 1 tibial radiolucency were found. The Scorpio posterior-stabilized design (Stryker Orthopaedics, Mahwah, NJ) showed favorable midterm results compared with other posterior-stabilized designs. **Key words:** posterior-stabilized, total knee arthroplasty, single-radius, outcomes, Scorpio.
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Refinement of prosthesis design in posterior-stabilized (PS) total knee arthroplasty (TKA) is continually evolving. Changes in component geometry and modularity have led to improved short- and long-term results with the PS design [1-3], allowing greater surgical flexibility [2]. When compared with cruciate-retaining designs, PS designs have shown less flexion instability [4], less clinical and radiographic laxity [5], fewer complications [6], and greater range of motion (ROM), although survivorship is similar [6]. Despite the excellent clinical and functional results that have been reported with PS designs, some have been associated with postoperative problems such as patellofemoral symptoms [7], anterior knee pain [8,9], patellar clunk [10-12], and backside wear [13,14].

A new design has been implemented to address particular areas of susceptibility shown with previous PS models. The femoral component maintains a single sagittal radius from 15° of hyperextension to 75° of flexion, while incorporating a longer patellofemoral moment arm that places the center of rotation more posterior to the femoral condyles. A deepened, more distal patellofemoral groove has also been incorporated. This design has been reported to achieve full extension faster [15] while reducing quadriceps tension and patellofemoral compressive forces [16].

The present study sought to identify clinical, functional, and radiographic outcomes associated with the Scorpio PS knee system (Stryker Orthopaedics, Mahwah, NJ) at a mean 5-year follow-up.

Materials and Methods

A total of 101 primary, consecutive patients (103 knees) were enrolled at 2 centers between January 1998 and September 1999. Criteria for inclusion included a diagnosis of osteoarthritis, avascular necrosis, or posttraumatic arthritis; lack of morbid obesity; no prior history of joint replacement of the affected side; no neuromuscular of

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Table 1. Demographical Data

Demographics (n = 103)		
Age (y)	67.17 ± 9.5	
Height (cm)	169.30 ± 9.1	
Weight (kg)	88.0 ± 16.5	
BMI	31.49 ± 4.7	
Follow-up data:		
Evaluation interval	Actual follow-up (expected)	Percent follow-up
Preoperative	103 (103)	100
7 wk	102 (102)	100
6 mo	98 (101)	97
1 y	93 (100)	93
2 y	86 (100)	86
3 y	87 (99)	88
≥4 y (latest)	86 (97)	89
Reasons for withdrawal	n	%
Death	8	7.7
Revision	1	0.9
Unable to return	1	0.9
Unwilling to return	8	7.7
Lost to follow-up	3	2.9

neurosensory deficiency; and no immunologic suppression. Patients with a body mass index greater than 36 are sent to a weight loss program before joint arthroplasty surgery. All patients meeting the study inclusion criteria for TKA were encouraged to participate in this prospective study. The study was approved by the institutional review board of each participating center.

Preoperative evaluation included the collection of demographical data, medical history, primary diagnosis, concurrent medical problems, and prior treatment of the affected joint. All procedures were performed by 1 of 2 surgeons (FK or CB). The Scorpio PS knee system (Stryker Orthopaedics) was used in all cases. Intravenous cefazolin (Kefzol [Lily, Indianapolis, IN], 1 g) was used for presurgical prophylaxis. Spinal anesthesia, including intrathecal bupivacaine (Marcaine [Bristol Meyers Squibb, New York, NY], 10.5-12.0 mg) and morphine (Duramorph [Elkins-Sinn, Inc, Cherry Hill, NJ], 0.4-0.7 mg), was used for all patients. A medial parapatellar approach with posterior cruciate excision was used in all cases. No other ligament releases were performed. Components were cemented, and patellae were resurfaced. Passive extension and flexion against gravity were checked intraoperatively, and all knees were closed in extension. All knees were closed in the usual fashion. The dressing and thromboembolic disease stocking were applied before deflation of the

tourniquet. Postoperative drains were not used. Surgical details such as operative and tourniquet time, preclosure ROM, prosthetic components, soft tissue release, and bone-graft details were recorded. All soft tissue releases were performed as necessary during the trial reduction and ROM and stability test to balance the knee appropriately.

Average tourniquet time was 54 minutes. No surgical complications or blood transfusions were noted. Patients at both sites were treated for postpain using a combination of intramuscular ketorolac (Toradol [Hoffmann-La Roche Inc, Nutley, NJ], 15 or 30 mg), oral hydrocodone and acetaminophen (Lortab [Watson Pharm, Corona, Calif], 5 or 7.5 mg) a peripheral continuous analgesia as necessary. Pre-discharge information was collected, including ROM, complications, ambulatory status, and knee manipulation. Postoperative care and rehabilitation followed a previously established protocol designed to achieve optimal ROM [17]. Continuous passive motion was left to the discretion of the surgeon and was used in approximately 50% of cases.

Demographical and follow-up data are presented in Table 1. The mean age of subjects in the study was 67.17 ± 9.5 years. Of patients, 67% (69/103) were women and 33% (34/103) were men. Percent follow-up throughout the duration of the study ranged from 88.7% to 100%. Before discharge, a mean hospital stay of 3.42 days (range, 2-5 days) was noted. Patients reached ambulatory status in a mean of 0.7 days (range, 0-1 day).

Clinical, functional, and radiographic assessments were performed by the surgeon preoperatively and at 7 weeks, 6 months, and annually postoperatively (subject results are presented at a mean 5.25-year follow-up and continue to be monitored). Latest follow-up was ≥4 years postoperative. The Hospital for Special Surgery and Knee

Table 2. Clinical and Functional Components of the KS Score

Evaluation Interval	KS Score			
	Clinical		Functional	
	Mean (range)	n	Mean (range)	n
Preoperative	28.4 (0-83)	91	50.24 (0-80)	103
7 wk	66.8 (18-100)	95	47.8 (0-100)	101
6 mo	83.5 (39-100)	96	71.8 (0-100)	98
1 y	87.4 (35-100)	90	80.4 (0-100)	93
2 y	88.4 (55-100)	85	80.1 (15-100)	86
3 y	89.8 (26-100)	85	76.1 (0-100)	87
≥4 y (latest)	91.3 (39-100)	78	73.0 (10-100)	86

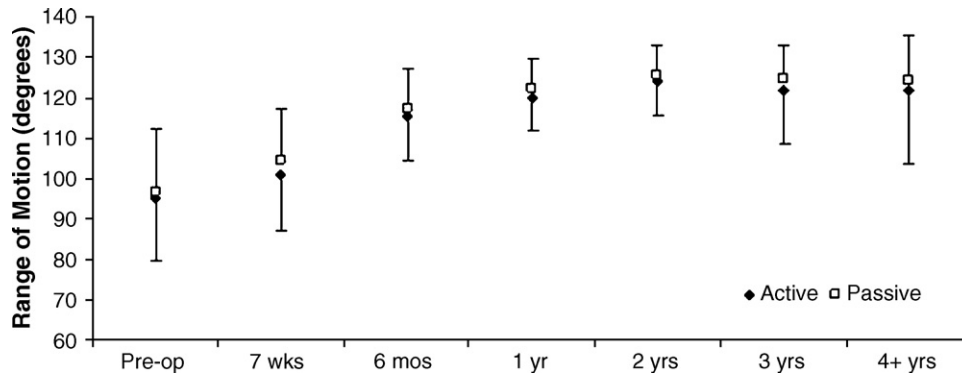


Fig. 1. Active and passive ROM (mean \pm SD) from preoperative to latest follow-up.

Society (KS) [18] rating systems were used for evaluation of pain, ROM, stability, and function. Standard scoring was used to classify subjects into excellent, good, fair, and poor categories.

Outcomes assessment was done by means of the Short Form (SF)-12 and SF-36 Health Surveys. Scores from the SF-36 were converted into SF-12 for reporting purposes. Radiographic assessment included review of standing anteroposterior, lateral, and merchant (skyline) views and was performed by independent contractors. The KS system using zonal analysis was used to categorize all radiolucencies [19]. Radiolucencies were reported when they encompassed at least 50% of a respective zone and were at least 0.5 mm in width.

Results

Scores for clinical and functional components of the KS score are presented in Table 2. The KS score was represented by early and sustainable improvement over time. Approximately 88% of the improvement (at latest follow-up) in the clinical score was observed at 6 months postoperative; subsequently, approximately 95% of the improvement

(at latest follow-up) in the functional score was seen at 6 months postoperative. The percentage of patients reporting pain as “none” or “mild-occasional” increased from the preoperative session (1%) to 3 years postoperative (93%), with a 90% rate observed at latest follow-up. Good to excellent Hospital for Special Surgery scores were exhibited in 96.1% of subjects at 4 years postoperative. Scores in this category peaked at 2 years postoperative when 97.7% of subjects showed good to excellent results.

Active and passive ROM of the involved knee across the testing sessions are presented in Fig. 1. Range of motion peaked at 2 years postoperative and was maintained at the latest testing session. The mean active and passive ROM preoperatively were 95.05° and 96.54° , respectively. At the latest follow-up, flexion increased to 121.73° and 124.53° , respectively.

Reports of anterior knee pain and patellar clunk are presented in Table 3. Incidence of anterior knee pain ranged from 3% ($n = 4$) to 5% ($n = 4$) across the follow-up sessions. No reports of patellar clunk were noted within the first year postoperative; 1 case was reported at the 2-year, 3-year, and latest follow-up periods, respectively.

Table 3. Incidences of Anterior Knee Pain and Patellar Clunk

Anterior knee pain	7 wk (n [%])	6 mo (n [%])	1 y (n [%])	2 y (n [%])	3 y (n [%])	≥ 4 y (latest) (n [%])
Absent	98 (96)	95 (97)	93 (100)	85 (100)	82 (97)	82 (95)
Present	4 (4)	3 (3)	0	0	3 (4)	4 (5)
Unspecified	0	0	0	1	2	0
Patellar clunk	7 wk (n [%])	6 mo (n [%])	1 y (n [%])	2 y (n [%])	3 y (n [%])	≥ 4 y (n [%])
Absent	102 (100)	97 (100)	93 (100)	84 (99)	84 (99)	84 (99)
Present	0	0	0	1 (1)	1 (1)	1 (1)
Unspecified	0	1	0	1	2	1

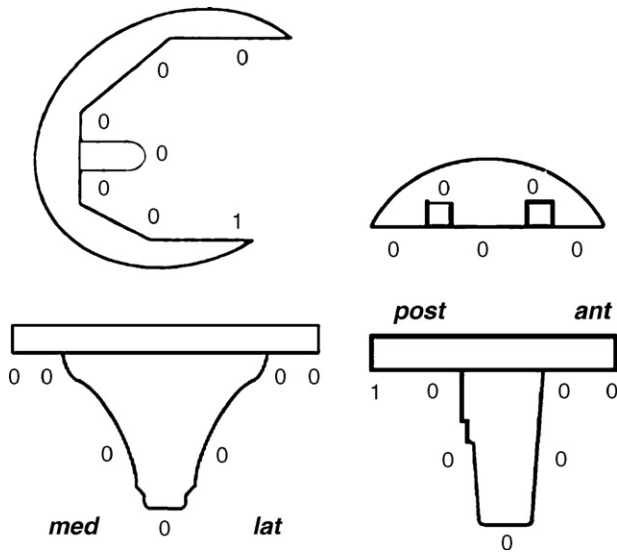


Fig. 2. Radiolucencies associated with KS zones at latest follow-up.

Scores on the physical component of the SF-12 Health Survey increased from a mean of 29.95 preoperative to 40.67 at latest follow-up. Scores for the mental component remained virtually unchanged throughout the duration of the study (range, 50.75-54.33). Radiographic evaluation

results are presented in Fig. 2, with the number of radiolucencies in each respective zone labeled. No progressive radiolucencies were noted, and no component showed migration. At the latest follow-up, 1 femoral (zone 7, 1 mm) and 1 tibial anteroposterior (zone 1, 1 mm) radiolucency were noted, whereas none were noted for tibial-lateral or patellar views.

The complication rate in this study was 4.9% (5/103). Specific complications included 1 postoperative patellar fracture, 1 deep joint infection, 1 wound-related, 1 excessive knee pain, and 1 transient peroneal nerve palsy.

Discussion

The type of TKA design can have a significant impact on knee kinematics and subsequent function [20]. One example is the predictable posterior femoral rollback produced with flexion that makes PS designs more similar to an intact knee [20,21] than cruciate-retaining designs. This feature is desirable in producing high-flexion ROM [21]. The Scorpio PS design has shown as much as 117° flexion ROM intraoperatively (assessed by computer-assisted navigation) [22]. The mean 4-year flexion ROM in our study was 124.5°, which is higher than that previously reported in

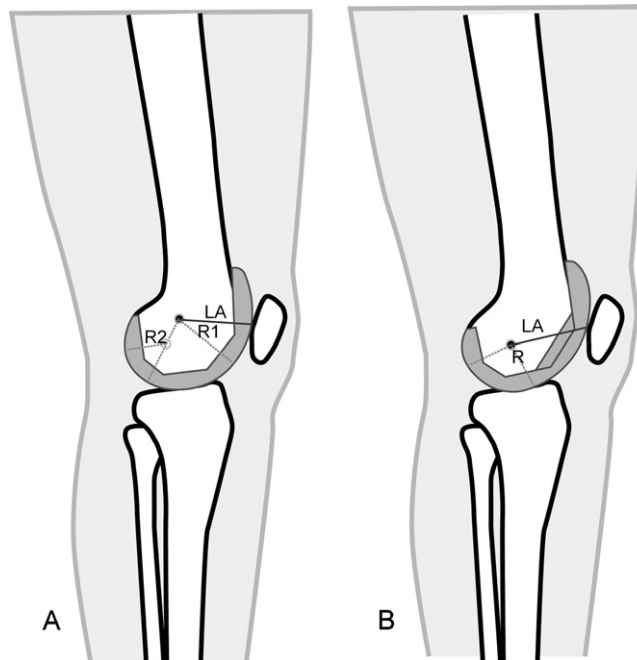


Fig. 3. The effective lever arm (LA) for the extensor mechanism is impacted by the sagittal profile of the implant (A). By keeping the axis more posterior as in design B, the distance to the patella is increased thereby increasing the lever arm (B).

PS designs with similar follow-up time [6,23]. At a mean of 5.9 years of follow-up, Bozic et al [6] reported flexion of 108.6°. At 5 to 9 years of follow-up, Indelli et al [23] reported flexion of 116°, although 4 knees had flexion less than 90°. The postoperative flexion in our study was similar to that reported by Mahoney et al [24], who also used a single-radius prosthetic design. At 2-year follow-up, flexion was approximately 120°. Argenson et al [21] has hypothesized that one of the main predictors of postoperative ROM is preoperative ROM. In our study, preoperative ROM was 96.5° and increased nearly 30° at peak postoperative flexion (125.5° at 2-year follow-up).

The finding of decreased functional KS scores with time is not surprising. Benjamin et al [25] reported declining functional scores over a 7-year period, peaking at 1 to 2 years postoperative. Functional scores in our study were highest (80.4 and 80.1) at 1 and 2 years postoperative, respectively, and were slightly decreased at latest follow-up (73.0). A decline in this score may be more representative of natural morbidity compared with problems with the knee. At an average of 30.6 months postoperative, Maruyama et al [26] reported clinical and functional scores of 89.5 and 83.3, respectively (preoperative scores of 43.6 and 55.3). These scores correspond well to the present results at similar time points, although subjects in our study exhibited lower preoperative scores (clinical, 28.4; functional, 50.2).

Significant patellofemoral complications that have been reported with the use of PS designs [12,27,28] can impact functional activities such as stair climbing and squatting [16,24,29]. Occurrence of such problems, including anterior knee pain and patellar clunk, can lead to correction via arthroscopic debridement, arthrotomy, or component revision. Development of patellar clunk, in particular, has been associated with femoral component design [12] and typically occurs when a nodule develops above the superior pole of the patella and wedges into the intercondylar notch of the femoral component [12,28]. A deepened, more distal patellofemoral groove has been shown to greatly reduce patellar clunk (from 3.9%-0%) [16]. This design feature is incorporated into the Scorpio PS. In our study, the trochlear bone is removed with a rasp to allow for clearance of the deepened patellofemoral groove. The amount of bone varies depending on how the femoral component fits the distal femur of the patient, but it is never more than 3 mm. The patellar geometry features the same single medial lateral radius as the femoral and tibial insert components for maximum contact

area. There is a medialized offset dome option to optimize patellar tracking. There is also a superior medialized option that offsets the effect of an elevated joint line. The authors used the medialized offset dome patellar component.

Patellar clunk has also been associated with high knee flexion [12,27] (greater than 120°). Subjects in our study achieved this range of flexion at 1 year postoperative and maintained it until latest follow-up, with only 1 incidence of patellar clunk during this time. This incidence is much less than that seen with other PS models at similar follow-up, which ranges from 4% to 14% [8,12,27,28,30].

Another factor affecting patellofemoral kinematics is the extensor moment arm, as shown in Fig. 3. In studies by D'Lima et al [29] and Browne et al [16], a prosthetic design was examined that incorporated an extensor moment arm that was approximately 1 cm longer than control designs. This increase in length was due to the center of flexion being located more posterior. At angles of 40° or greater, the design with the longer moment arm significantly reduced quadriceps tension by 5 to 20%, compared with control designs [16,29], while generating significantly lower patellofemoral compressive forces (8%-18%) at angles greater than 50° [16]. These flexion angles are associated with high-knee moments and are necessary for activities such as stair-climbing and chair-rising. Reduction in quadriceps and patellofemoral forces should facilitate such activities and possibly accelerate postoperative rehabilitation. Mahoney et al [24] examined this hypothesis using a longer-moment-arm TKA design and found that subjects were able to rise from a chair without using their arms (compared with a control group).

A longer moment arm that reduces quadriceps and patellofemoral forces should also help to reduce incidence of anterior knee pain. Ranawat et al [9] found an incidence of anterior pain in 2 PS designs of 39% and 33%, respectively, at 1 year postoperative that continued through a 10 year follow-up (18% and 19%, respectively). Interestingly, 30% of previously symptomatic subjects continued to have some anterior knee pain at 10-year follow-up, whereas new-onset anterior pain was noted in 10% of previously asymptomatic knees.

Our study found good-to-excellent KS scores, high flexion, and low incidence of anterior knee pain with the Scorpio PS prosthetic at latest follow-up. This cohort continues to be followed up. Use of the single-radius design using modified knee kinematics can lead to improved subject outcomes.

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