

# Management of Falls After Total Knee Arthroplasty

RICHARD J. KEARNS, MD; DANIEL P. O'CONNOR, PHD; MARK R. BRINKER, MD

## abstract

This study evaluated 78 patients who fell after total knee arthroplasty. Eight patients (10.3%) had soft-tissue injuries that led to a poor clinical course (deep infection, unplanned return to the operating room, temporary or permanent resection arthroplasty, or knee arthrodesis). Factors related to a poor clinical course included copious bleeding from the surgical wound immediately after falling, falling within 8 weeks of arthroplasty, and rupturing the parapatellar surgical wound and quadriceps repair. Patients who fall and have bleeding from their surgical wound should receive emergency surgical irrigation and debridement. A treatment protocol for patients who fall after total knee arthroplasty is presented.

Falling after total knee arthroplasty (TKA) can cause potentially devastating problems, including periprosthetic fracture or severe soft-tissue injury.<sup>1-6</sup> Factors related to an increased risk of falling among older adults include quadriceps weakness, gait problems, use of various medications, and some musculoskeletal disorders.<sup>7-9</sup> Many patients who undergo TKA are >65 years and have several of these risk factors. The consequences of falling after TKA, however, have not been studied extensively.

No clinical series describes soft-tissue injuries in patients who fall with a TKA in situ. This study sought to identify soft-tissue injuries caused by a fall and the factors related to a poor clinical course after soft-tissue injury in a large consecutive series of patients who underwent TKA. We also describe a protocol to decrease the risk of a

poor clinical course after soft-tissue injury resulting from a fall in patients with TKA.

## MATERIALS AND METHODS

### Study Population

As part of an ongoing evaluation of total joint arthroplasty protocols at our institution, all TKA patients who presented with an ipsilateral knee complaint related to a fall were entered into a database. The potential participants for this study included a consecutive series of 1135 patients who received 1341 TKAs between January 1, 1995 and December 31, 2002. There were 1244 primary TKAs in 1040 patients and 97 revision TKAs in 95 patients.

All of the arthroplasties were performed by the senior author (R.J.K.) and were cemented, posterior-stabilized TKAs. Number 1 Vicryl interrupted sutures were used to close the quadriceps mechanism and the

skin. All patients were prescribed warfarin for 2 to 4 weeks postoperatively.

Falls were identified by patient self-report. A fall was defined as a loss of balance that caused the patient to collapse from a standing position to lying, kneeling, or sitting on the ground. Simple stumbles or missteps were not considered falls. Falls of patients who did not report the incident to the surgeon were not captured in the data. All of the falls occurred at home or in the community after the perioperative hospital stay.

From the consecutive series of 1341 TKAs, 78 patients (7%) reported falling. Median time from TKA to a fall was 507 days (range, 11-2852 days).

Seventeen of the 78 patients (21.8%) had fallen within 8 weeks of their TKA. The mean age of patients who fell was 67.6 years (SD, 12.4) at the time of arthroplasty. All of the patients who fell underwent clinical follow-up for at least 1 year after falling.

*Drs Kearns and Brinker are from the Fondren Orthopedic Group LLP, Texas Orthopedic Hospital, and the Joe W. King Orthopedic Institute, and Dr O'Connor is from the Joe W. King Orthopedic Institute, Houston, Texas.*

*Please provide financial disclosure information for all authors.*

*Correspondence should be addressed to: Daniel P. O'Connor, PhD, Joe W. King Orthopedic Institute, 7401 S Main St, Houston, TX 77030.*

Table 1	
Data Abstracted for 78 Patients Who Fell After Total Knee Arthroplasty	
Category	Variables
Demographics	Gender Age
History	Time from total knee arthroplasty to fall (days) Time from fall to clinical examination (days) Mechanism of injury (struck knee versus hyperflexion) Substantial bleeding from surgical wound at fall (yes or no)
Clinical examination following the fall	Knee joint effusion (yes or no)  Palpable extensor mechanism defect (yes or no) Knee extension range of motion (to nearest 5°) Ability to perform a straight-leg raise (yes or no) Weight bearing status (nonweight bearing, partial weight bearing, full weight bearing)
Radiographic examination following the fall	Patellar malalignment (Merchant view)  Femoral component lucency Tibial component lucency
Clinical course following the fall	Good: no deep infection, no unplanned returns to the operating room (excluding urgent operative treatment following the fall, such as for an open wound), and total knee arthroplasty remained in situ without revision  Poor: deep infection, required unplanned return to operating room, required temporary removal of the TKA, required permanent resection arthroplasty, or required knee arthrodesis

**Data Analysis**

Data from the patients’ history, clinical and radiographic examinations, and entire course of treatment were used (Table 1). If patients underwent surgical treatment following their fall, the time from clinical presentation after falling to the surgical intervention was recorded. Patellar malalignment on a Merchant radiograph, a palpable defect in the extensor mechanism, or the presence of both were interpreted as signs of disruption of the closure of the surgical quadriceps wound (the quadriceps repair) that had been performed at the time of arthroplasty.

The clinical course following the fall was defined as “good” in patients who had all of the following: no deep infection, no

unplanned returns to the operating room, and the TKA in situ without revision.

The clinical course following the fall was defined as “poor” in patients who acquired a deep infection, acquired a residual extensor mechanism defect that affected function, required an unplanned return to the operating room (excluding emergency operative treatment following the fall, such as for irrigation of an open wound), required temporary removal of the TKA, required permanent resection arthroplasty, or required knee arthrodesis.

Patients were grouped according to their clinical course (good or poor) following their fall. Analysis of variance and chi-square tests were used to determine whether any of the historical or clinical variables were related to clinical course.

**RESULTS**

Twelve patients had signs of a ruptured quadriceps repair as indicated by patellar malalignment on a Merchant radiograph or a palpable defect in the region of the quadriceps tendon. Twenty-two patients had notable knee joint effusion, and 40 patients could not perform a straight-leg raise. No patient had radiolucency around the tibial or femoral components at the initial clinical examination after falling.

Eight patients (10.3%) reported they had a large amount of bloody drainage from their surgical wound immediately after their fall; 4 of these patients also had signs of a ruptured quadriceps repair. A careful history often was required to elicit a report of bleeding from the wound after falling.

In several patients, the operative site appeared to have only a small opening of the wound at the time of clinical examination. When specifically asked, however, these patients reported having a large amount of bleeding from the wound prior to their arrival to the hospital or the clinic. For example, several patients reported the blood had completely soaked through a towel or blood from the wound had “covered the rug.” Such a large volume of blood suggests dehiscence of both the operative skin wound and the underlying quadriceps repair, resulting in evacuation of the post-operative intra-articular hematoma.

**Clinical Course Following the Fall**

Seventy of the 78 patients (89.7%) had a good clinical course following their fall and 8 patients (10.3%) had a poor clinical course following their fall (Tables 2 and 3).

*Patients With a Good Clinical Course.* Of the 70 patients who had a good clinical course, 8 patients received operative treatment. Five patients who had ruptured their original parapatellar quadriceps repair during their fall had a good clinical course (patients 2, 5, 9, 14, and 15) after receiving nonemergent surgery to reconstruct the quadriceps repair that was disrupted during their fall.

Table 2

## Clinical Course for 78 Patients Who Fell After Total Knee Arthroplasty (TKA)

Time From Total Knee Arthroplasty to Fall	Bleeding From Surgical Wound at Fall	Signs of Quadriceps Rupture	Emergent Surgical Treatment (No. Patients)	Good Clinical Course	Poor Clinical Course
<8 weeks	Yes	Yes	Yes (1)	1 (100%)	0 (0%)
			No (3)	0 (0%)	3 (100%)
	Yes	No	Yes (2)	2 (100%)	0 (0%)
			No (2)	0 (0%)	2 (100%)
	No	Yes	Yes (0)		
			No (6)	4 (67%)	2 (33%)
	No	No	Yes (0)		
			No (3)	3 (100%)	0 (0%)
>8 weeks	No	Yes	Yes (0)		
			No (2)	1 (50%)	1 (50%)
	No	No	Yes (0)		
			No (59)	59 (100%)	0 (0%)

Three patients who reported copious bleeding from their surgical wound at the time of their fall, 1 of whom had also ruptured the quadriceps repair, had a good clinical course (patients 4, 8, and 13). These patients received emergent irrigation and debridement with wound closure, and the patient with a ruptured repair also received reconstruction of her extensor mechanism. The remaining 62 patients who had a good clinical course were treated nonoperatively with a knee immobilizer, limited weight bearing, and several weeks of clinical follow-up.

**Patients With a Poor Clinical Course.** Of the 8 patients who had a poor clinical course, 5 patients (patients 1, 3, 7, 10, and 16) had reported copious bleeding from the surgical wound at the time of the fall. Three of these 5 patients also had ruptured their original parapatellar quadriceps repair (patients 7, 10, and 16). These 5 patients received operative treatment >24 hours after falling, and all 5 patients developed a deep infection.

The remaining 3 patients with a poor clinical course (patients 6, 11, and 12) had not reported bleeding from the surgical wound at the time of the fall but did

have a ruptured quadriceps repair. These 3 patients received nonemergent surgery to reconstruct the disrupted quadriceps repair. The poor clinical courses in these 3 patients were related to subsequent rupture of the second quadriceps repair in 2 patients (patients 6 and 12) and chronic deep infection after revision TKA in the third patient (patient 11).

#### Factors Affecting Clinical Course

The clinical course following the fall was significantly related to 3 historical or clinical findings: copious bleeding from the surgical wound immediately after falling ( $P=.001$ ), falling within 8 weeks of undergoing arthroplasty ( $P=.01$ ), and disruption of the closure of the surgical parapatellar quadriceps wound ( $P=.002$ ). The other historical and clinical findings listed in Table 1 were not related to status at final follow-up.

Table 2 shows the significant variables and associated clinical course for all 78 patients who fell. Five of the 8 patients (63%) who reported copious bleeding from the surgical wound at the time of their fall had a poor clinical course (patients 1, 3, 7, 10, and 16). Six of the 12

patients (50%) who had signs of a ruptured quadriceps repair had a poor clinical course (patients 6, 7, 10, 11, 12, and 16). Three patients with a poor clinical course had both bleeding and signs of a ruptured quadriceps repair (cases 7, 10, and 16).

The timing of subsequent operative treatment also appeared to be important. Six of the 13 patients (46.2%) who received operative treatment >24 hours after falling had a poor clinical course. None of the 3 patients who received emergency operative treatment within 6 hours of falling had a poor clinical course. All 5 patients who had copious bleeding after falling and who received operative treatment >24 hours after falling had a poor clinical course.

#### DISCUSSION

Emergent irrigation and debridement is recommended for patients with TKA who report copious bleeding from their surgical wound after falling. In our cohort, copious bleeding from the surgical wound at the time of falling increased the risk of a poor clinical course unless emergency irrigation and debridement of the joint was performed.

Rupture of the original parapatellar quadriceps repair also increased the risk

Table 3

**Chronologic Presentation of Outcomes for Patients Who Underwent Operative Treatment Following a Fall After Total Knee Arthroplasty (TKA)**

Patient No.	Age (y), Gender	TKA Surgery Date	Days From TKA to Fall	Bleeding at Fall	Quadriceps Rupture	Hours From Fall to Office Visit	Time From Fall to Surgery	Outcome
1	82, M	7/30/1997	11	Yes	No	112	21 days	Poor: required serial debridement for joint infection, 2 revision TKAs, and knee arthrodesis
2	70, F	7/30/1997	169	No	Yes	1836	118 days	Good: underwent nonemergent quadriceps repair
3	52, F	11/24/1997	17	Yes	No	26	79 days	Poor: required serial debridement for joint infection, 1 revision TKA, and knee arthrodesis
4	55, F	3/8/1999	11	Yes	No	2	6 hours	Good: underwent emergent irrigation and debridement
5	74, M	3/30/2000	35	No	Yes	18	21 days	Good: Underwent nonemergent quadriceps repair
6	70, M	7/27/2000	150	No	Yes	30	151 days	Poor: underwent nonemergent quadriceps repair but subsequently reruptured repair
7	62, F	10/26/2000	15	Yes	Yes	54	6 days	Poor: waited 2 days to call office, required serial debridement for joint infection and revision TKA
8	64, F	3/15/2001	13	Yes	Yes	1	4 hours	Good: underwent emergent irrigation and debridement
9	79, M	5/10/2001	52	No	Yes	46	158 days	Good: underwent nonemergent quadriceps repair
10	75, M	7/15/2001	17	Yes	Yes	90	4 days	Poor: waited 4 days to call office, underwent open debridement and quadriceps repair but developed chronic joint infection
11	61, F	11/1/2001	12	No	Yes	84	6 days	Poor: underwent nonemergent quadriceps repair but subsequently reruptured the repair, underwent revision TKA, and developed chronic joint infection
12	66, M	11/21/2001	15	No	Yes	3	6 days	Poor: underwent nonemergent quadriceps repair but subsequently reruptured repair
13	77, F	12/19/2001	40	Yes	No	2	5 hours	Good: underwent emergent irrigation and debridement
14	77, F	2/21/2002	34	No	Yes	322	15 days	Good: underwent nonemergent quadriceps repair
15	54, F	4/29/2002	22	No	Yes	2	2 days	Good: underwent nonemergent quadriceps repair
16	58, M	5/27/2002	29	Yes	Yes	64	3 days	Poor: waited 3 days to call office, underwent open debridement and quadriceps repair but developed chronic joint infection and required revision TKA

of a poor clinical course but primarily when bleeding from the surgical wound also was present. Rupture of the quadri-

ceps repair without bleeding from the surgical wound responded well in most cases to nonemergent surgical reconstruction.

Our current treatment protocol for patients who fall after TKA is presented in the Figure. The protocol was developed

empirically by the senior author (R.J.K.) from observing the recovery of patients after they fell. Early in the series, 2 patients had copious bleeding from the surgical wound, and both developed chronic knee joint infections and ultimately underwent knee arthrodesis (patients 1 and 3). Neither of these patients received any operative treatment until the onset of infection. By contrast, a third patient early in the series who reported copious bleeding from the surgical wound received emergency irrigation and debridement within 6 hours of falling (patient 4). This patient recovered fully with no further treatment. The following practice guideline was established by the senior author based on these first few cases.

Patients who report copious bleeding from their surgical wound at the time of their fall receive emergency operative treatment to irrigate and debride the joint. Emergency operative treatment is required most often for patients who fall within 8 weeks of their arthroplasty, as patients who fall later rarely have dehiscence of their parapatellar operative skin wound and quadriceps repair. None of the 61 patients in this series who fell >8 weeks after their arthroplasty had traumatic dehiscence of their surgical wounds.

Nonemergent operative treatment is provided for patients who have signs of a ruptured quadriceps repair after a fall but do not have bleeding from their surgical wound. The operative treatment is reconstruction of the ruptured quadriceps repair. A ruptured quadriceps repair is also relatively rare >8 weeks after arthroplasty. Only 2 of the 61 patients in this series who fell >8 weeks after their arthroplasty ruptured their quadriceps repair. We found no cases of quadriceps tendon rupture in this series. The patients with quadriceps defects had all ruptured the quadriceps sutures that were placed while closing the arthroplasty surgical wounds.

Patients who fall but have no bleeding from the surgical wound and no signs of a ruptured quadriceps repair receive

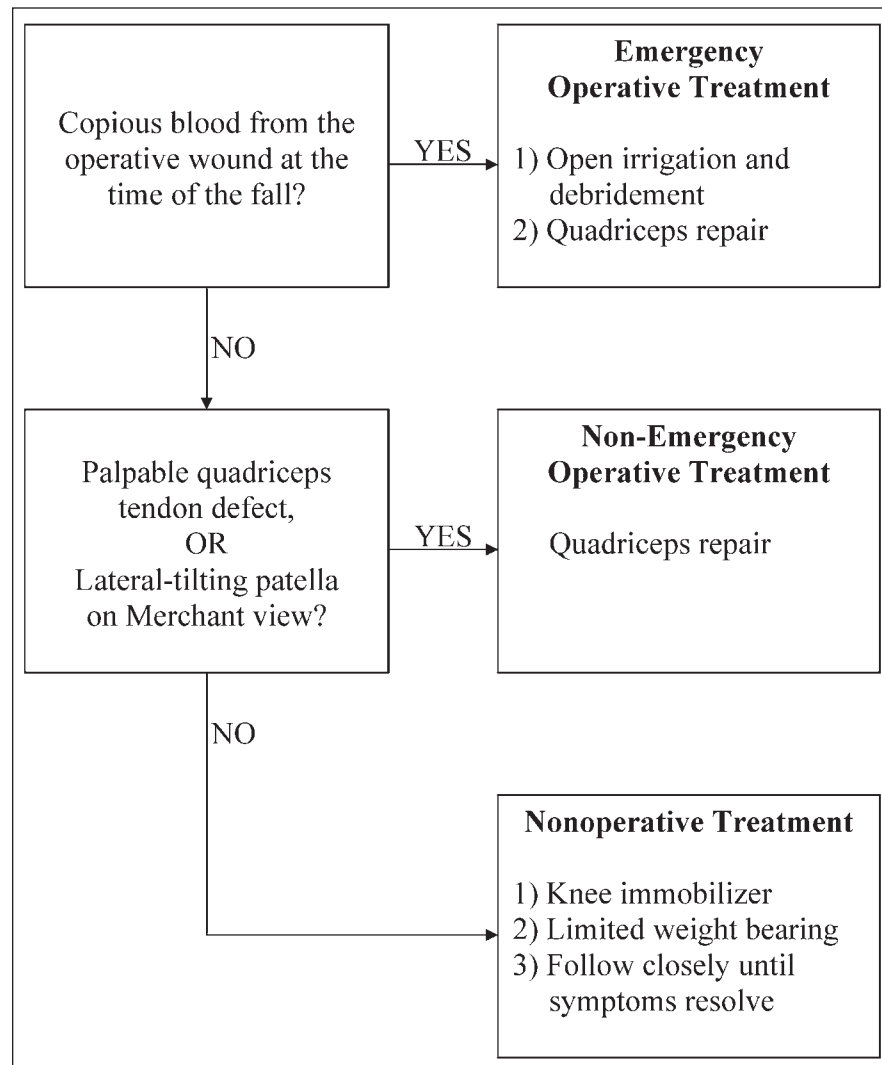


Figure: Treatment algorithm showing protocol for patients who fall after total knee arthroplasty.

nonoperative treatment. Nonoperative treatment consists of wearing a knee immobilizer and limiting weight bearing until symptoms subside. Patients are monitored closely for at least 3 months, although pain and disability should both abate within a few weeks. If symptoms do not improve, further workup for joint infection, component loosening, and occult fracture is performed.

Since establishing this protocol, patients are instructed that if they fall and have bleeding from their surgical wound, they are to treat it as an emergency and contact the office immediately. Five patients have fallen after TKA and experi-

enced bleeding from the surgical wound since establishing this protocol. Contrary to the explicit instructions, 3 patients (patients 7, 10, and 16) waited 2 to 4 days before calling the office; all 3 patients developed a deep infection, and 2 required revision arthroplasty (Table 3). By contrast, the remaining 2 patients who fell since the protocol was established (patients 8 and 13) called the office immediately and underwent emergency irrigation and debridement within 6 hours of falling. Neither of these patients required any additional treatment.

Treatment of a chronic joint infection often requires multiple operative interven-

tions, including soft-tissue debridement, synovectomy, prosthesis removal, placement of antibiotic-impregnated implants, and revision TKA.<sup>10-12</sup> In our patients who fell, knee joint infections occurred only in those patients who had fallen within 8 weeks of arthroplasty and who reported copious bleeding from their surgical wound immediately after falling. None of these patients had signs of infection (eg, fever, erythema, or delayed wound healing) prior to falling. A large amount of bloody drainage after a fall in the early postoperative period represents a traumatic dehiscence of the operative wound and evacuation of the intra-articular hematoma. Dehiscence allows the environment to communicate with the joint (direct inoculation) and thus increases the risk of deep infection.

Early open debridement of an infected joint arthroplasty often precludes the need for multiple surgeries and allows retention of the original prosthesis.<sup>10,11</sup> Performing an emergent same-day debridement when the surgical wound has been exposed to the environment also should prevent a complicated and lengthy course treatment.

Extensor mechanism problems are the most common aseptic complications following TKA.<sup>13,14</sup> Direct trauma to the knee or hyperflexion of the knee, either of which might occur during a fall, can cause injury to the extensor mechanism after TKA.<sup>15</sup> Extensor mechanism problems occur almost exclusively in the early postoperative period.<sup>16,17</sup> In our study, most

ruptures of the quadriceps tendon repair occurred within 8 weeks of arthroplasty. Reconstruction of the quadriceps repair to preserve function can be performed on a nonemergent basis.

### Conclusion

Patients with a recent TKA who fall and have substantial bleeding from the surgical wound should undergo open joint irrigation and debridement on an emergent basis. This type of injury is more likely to occur in the first 8 weeks after arthroplasty. Patients who rupture the original parapatellar quadriceps repair but who have no drainage from the surgical wound can undergo surgical reconstruction on a nonemergent basis. Patients who do not have bleeding or quadriceps injury can be treated nonoperatively.

### REFERENCES

1. Grace JN, Sim FH. Fracture of the patella after total knee arthroplasty. *Clin Orthop Relat Res.* 1988; (230):168-175.
2. Hanssen AD, Rand JA. Evaluation and treatment of infection at the site of a total hip or knee arthroplasty. *Instr Course Lect.* 1999; 48:111-122.
3. Konrath GA, Bahler S. Endosteal substitution with an allograft cortical strut in the treatment of a periprosthetic femur fracture: a case report. *J Orthop Trauma.* 2002; 16(5):356-358.
4. Merkow RL, Soudry M, Insall JN. Patellar dislocation following total knee replacement. *J Bone Joint Surg Am.* 1985; 67(9):1321-1327.
5. Weber D, Peter RE. Distal femoral fractures after knee arthroplasty. *Int Orthop.* 1999; 23(4):236-239.
6. Windsor RE, Scuderi GR, Insall JN. Patellar fractures in total knee arthroplasty. *J Arthroplasty.* 1989; 4(suppl):S63-S67.
7. Edelberg HK. Falls and function: how to prevent falls and injuries in patients with impaired mobility. *Geriatrics.* 2001; 56(3):41-45.
8. Nordell E, Jarnlo GB, Jetsen C, Nordstrom L, Thorngren KG. Accidental falls and related fractures in 65-74 year olds: a retrospective study of 332 patients. *Acta Orthop Scand.* 2000; 71(2):175-179.
9. Tibbitts GM. Patients who fall: how to predict and prevent injuries. *Geriatrics.* 1996; 51(9):24-28, 31.
10. Borden LS, Gearen PF. Infected total knee arthroplasty: a protocol for management. *J Arthroplasty.* 1987; 2(1):27-36.
11. Hanssen AD. Managing the infected knee: as good as it gets. *J Arthroplasty.* 2002; 17(4 suppl 1):98-101.
12. Tsukayama DT, Goldberg VM, Kyle R. Diagnosis and management of infection after total knee arthroplasty. *J Bone Joint Surg Am.* 2003; 85(suppl 1):S75-S80.
13. Lonner JH, Lotke PA. Aseptic complications after total knee arthroplasty. *J Am Acad Orthop Surg.* 1999; 7(5):311-324.
14. Saleh KJ, Clark CR, Sharkey PF, Goldberg VM, Rand JA, Brown GA. Modes of failure and preoperative evaluation. *J Bone Joint Surg Am.* 2003; 85(suppl 1):S21-25.
15. Stulberg SD. Extensor mechanism complications after total knee arthroplasty. *Orthopedics.* 1995; 18(9):919-920.
16. Fehring TK, Odum S, Griffin WL, Mason JB, Nadaud M. Early failures in total knee arthroplasty. *Clin Orthop Relat Res.* 2001; (392):315-318.
17. Sharkey PF, Hozack WJ, Rothman RH, Shastri S, Jacoby SM. Insall Award paper: why are total knee arthroplasties failing today? *Clin Orthop Relat Res.* 2002; (404):7-13.

Copyright of Orthopedics is the property of SLACK Incorporated and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.