

# Management of Total Knee Arthroplasty Periprosthetic Joint Infection with Concomitant Extensor Mechanism Disruption and Soft Tissue Defect: The Knee Arthroplasty Terrible Triad

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## INTRODUCTION:

Periprosthetic joint infection (PJI) with concurrent extensor mechanism disruption (EMD) and soft tissue defect requiring flap reconstruction – here termed the “Terrible Triad” – is a devastating complication following total knee arthroplasty (TKA). The purpose of this study was to define the surgical and clinical outcomes of the operative management of this constellation of complications.

## METHODS:

From 2000 to 2022, 127 patients underwent operative management for PJI, 25 for PJI with soft tissue defect, 14 for PJI with EMD, and 22 for the Terrible Triad. Outcomes were defined according to the 2018 ICM consensus statement for PJI management, and a composite outcome taking into account PJI outcome, range of motion (ROM), extensor lag, and ambulatory status at final follow up was used to determine the proportion of patients in each group with a favorable overall knee outcome and compared across groups (Table 1) [1]. Differences in continuous data were assessed using one-way ANOVA and Tukey’s post hoc test. Differences in categorical data were assessed using Pearson’s Chi-squared test or Fisher’s exact test. Odds ratios (OR) and 95% confidence intervals (CI) were used to compare the overall knee outcome between groups. The Kaplan-Meier survival analysis and log-rank test were used to assess patient survival. Statistical significance was set at  $\alpha=0.05$ .

## RESULTS:

Mean duration of follow up was 8.4 years and equivalent between groups ( $p=0.064$ ). Baseline characteristics including age, sex, BMI, diabetes status, smoking status, American Society of Anesthesiologists’ (ASA) classification, Charlson Comorbidity Index (CCI) score, and total number of surgeries prior to TKA were similar between groups ( $P>0.05$  for all) (Table 2). Patients in both the Terrible Triad group and PJI with soft tissue defect group demonstrated lower incidence of infection control with no continued antibiotic therapy (Tier 1) and higher incidence of amputation or arthrodesis (Tier 3E) compared to patients in both the PJI group and PJI with EMD group ( $p<0.001$ ), and higher incidence of limited ambulation compared to those in the PJI group ( $p<0.001$ ). Patients in the Terrible Triad and PJI with soft tissue defect groups demonstrated higher incidence of active ROM arc less than 90 degrees and extensor lag greater than 15 degrees than those in the PJI group ( $p<0.001$ ). Patients in the PJI with EMD group also demonstrated higher incidence of extensor lag greater than 15 degrees than those in the PJI group ( $p<0.001$ ). Patients in the PJI with soft tissue defect group demonstrated higher incidence of limited ambulation compared to those in the PJI group ( $p<0.001$ ) (Table 3). Compared to patients in the PJI group, patients in the PJI with soft tissue defect, PJI with EMD, and Terrible Triad groups showed higher odds of unfavorable overall knee outcome (OR=5.81, 95% CI 1.76-15.65,  $p<0.001$ ; OR=3.67, 95% CI 1.04-12.90,  $p=0.007$ ; OR=11.61, 95% CI 3.25-41.53,  $p<0.001$ ; respectively) (Table 4). Mean ten-year patient survival was 63.0% among patients with PJI, 52.0% among those with PJI and soft tissue defect group, 78.6% among those with PJI and EMD, and 77.3% among those with the Terrible Triad, with no statistically significant differences between groups ( $p=0.223$ ; Figure 1).

## DISCUSSION AND CONCLUSION:

This study demonstrates that the Terrible Triad of TKA is a dreaded diagnosis with poor outcomes, leaving the majority of patients with an unfavorable overall knee outcome. Special care in perioperative management and postoperative surveillance is warranted for patients presenting with the Terrible Triad of TKA, and patients should be warned of high risk for failure with multiple revisions in the course of their management. Early treatment with definitive fusion or amputation should be considered by patients and surgeons.

## References

[1] Fillingham AYJ, Valle CJ Della, Suleiman LI, Springer BD, Gehrke T, Bini S, et al. What is the definition of success of surgical treatment of a patient with a periprosthetic joint infection (PJI)? What clinical, operative, microbiological and functional metrics should be considered? *Int Consens Meet* n.d.:505–6. <https://doi.org/10.1093/cid/cir402.J>.

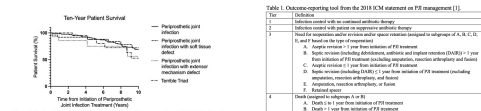


Figure 1. Kaplan-Meier survival analysis of patients presenting with PJI, PJI with soft tissue defect, PJI with EMD, and PJI with both soft tissue defect and EMD (“Terrible Triad”) at 10 years from time of infection of PJI treatment. Log-rank testing showed no statistically significant difference in patient survival between groups ( $p=0.223$ ).

Table 1. Outcome reporting tool from the 2018 ICM consensus on PJI management [1].

Outcome	Definition
1. Infection control	1. No continued antibiotic therapy
2. Functional outcome	2. Active ROM arc less than 90 degrees
3. Extensor lag	3. Extensor lag greater than 15 degrees
4. Ambulation	4. Limited ambulation
5. Overall knee outcome	5. Composite of 1-4

Table 2. Baseline characteristics of patients undergoing surgical management for PJI, PJI with soft tissue defect, PJI with EMD, and PJI with both soft tissue defect and EMD (“Terrible Triad”).

	PJI	PJI with soft tissue defect	PJI with EMD	Terrible Triad	P-value
Number of patients, N	127	25	14	22	
Age, mean (SD)	68.2 (12.2)	68.4 (12.1)	68.4 (12.1)	67.2 (12.1)	0.806
Female, N (%)	66 (52.0)	13 (52.0)	11 (78.6)	13 (59.1)	0.141
BMI, mean (SD)	30.4 (4.1)	30.1 (4.1)	30.1 (4.1)	30.1 (4.1)	0.838
Diabetes, N (%)	31 (24.4)	6 (24.0)	4 (28.6)	5 (22.7)	0.527
Current smoker, N (%)	19 (15.0)	4 (16.0)	3 (21.4)	3 (13.6)	0.287
ASA classification, N (%)					0.889
1	1 (0.8)	1 (4.0)	1 (7.1)	1 (4.5)	
2	11 (8.7)	2 (8.0)	2 (14.3)	2 (9.1)	
3	108 (84.3)	22 (88.0)	11 (78.6)	19 (86.4)	
CCI score, N (%)					0.985
0	1 (0.8)	1 (4.0)	1 (7.1)	1 (4.5)	
1	11 (8.7)	2 (8.0)	2 (14.3)	2 (9.1)	
2	108 (84.3)	22 (88.0)	11 (78.6)	19 (86.4)	
3	1 (0.8)	1 (4.0)	1 (7.1)	1 (4.5)	
4	1 (0.8)	1 (4.0)	1 (7.1)	1 (4.5)	
5	1 (0.8)	1 (4.0)	1 (7.1)	1 (4.5)	
Number of surgeries prior to PJI diagnosis, mean (SD)	1.7 (1.0)	1.7 (1.0)	1.7 (1.0)	1.7 (1.0)	0.976
Follow-up in years, mean (SD)	8.7 (4.3)	8.4 (4.4)	8.0 (3.4)	7.0 (4.3)	0.064

Table 3. Infection, functional and overall knee outcome for patients in the PJI, PJI with soft tissue defect, PJI with EMD, and Terrible Triad groups.

	PJI	PJI with soft tissue defect	PJI with EMD	Terrible Triad	P-value
2018 ICM infection tier, N (%)					0.001
1	11 (8.7)	4 (16.0)	1 (7.1)	1 (4.5)	
2	116 (91.3)	21 (84.0)	13 (92.9)	21 (95.5)	
3	0	0	0	0	
3E	0	0	0	0	
Active ROM arc less than 90 degrees, N (%)	11 (8.7)	14 (56.0)	11 (78.6)	13 (59.1)	<0.001
Extensor lag greater than 15 degrees, N (%)	11 (8.7)	14 (56.0)	11 (78.6)	13 (59.1)	<0.001
Limited ambulation, N (%)	11 (8.7)	14 (56.0)	11 (78.6)	13 (59.1)	<0.001
Overall knee outcome, N (%)	11 (8.7)	14 (56.0)	11 (78.6)	13 (59.1)	<0.001
1	11 (8.7)	14 (56.0)	11 (78.6)	13 (59.1)	
2	116 (91.3)	11 (44.0)	3 (21.4)	9 (40.9)	
3	0	0	0	0	
3E	0	0	0	0	
Number of patients with overall knee outcome, mean (SD)	1.7 (1.0)	1.7 (1.0)	1.7 (1.0)	1.7 (1.0)	0.223

Table 4. Multivariate analysis of overall knee outcome for patients in the PJI, PJI with soft tissue defect, PJI with EMD, and Terrible Triad groups.

	OR	95% CI	P-value
Overall knee outcome (vs. PJI)			
PJI with soft tissue defect	5.81	1.76-15.65	<0.001
PJI with EMD	3.67	1.04-12.90	0.007
Terrible Triad	11.61	3.25-41.53	<0.001

\* Denotes no non-ambulatory or ambulating in the community with a wheelchair or assistance from others.  
 † Fisher’s exact test was used to determine statistically significant differences between two groups as determined by Chi-squared test but having low cell counts. ANOVA for continuous data and Fisher’s exact test for categorical data.