

# Postoperative Outcomes of Total Femur Replacement in Oncologic and Non-Oncologic Patients: A Systematic Review of the Literature

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**INTRODUCTION:** Total femur replacement (TFR) is used for primary reconstruction after extensive tumor resection or as a revision surgery due to prosthetic failure. Studies on TFR rates of failure and functional outcomes are scarce and none have compared outcomes between oncologic and non-oncologic TFRs. We sought to answer the following questions: **1)** What are the modes of failure after TFR in oncologic and non-oncologic patients? **2)** What is the overall amputation rate and amputation rate per mode of failure after TFR in oncologic and non-oncologic patients? **3)** What are the functional outcomes after TFR in oncologic and non-oncologic patients?

**METHODS:** A systematic review was performed following PRISMA guidelines. We conducted a comprehensive search of the PubMed and Embase databases from inception to March 1. Our study was registered on PROSPERO (413582). Thirty-nine manuscripts were reviewed for eligibility. To be included, articles had to **1)** describe TFR as either a primary reconstruction procedure after tumor resection (oncologic) or revision surgery for extensive prosthetic failure (non-oncologic), **2)** describe modes of failure of TFRs according to the Henderson classification, **3)** include at least 5 patients undergoing TFR, and **4)** be published in a peer-reviewed journal. We excluded case reports, case series, and non-peer-reviewed publications. Quality assessment of all studies was performed using the STROBE checklist. We finally included 33 studies in our analysis (Figure 1). The outcomes of interest were TFR failure, amputation, and functional outcome at last follow up. Endoprosthesis failure was assessed using the Henderson classification and functional outcomes using the Musculoskeletal Tumor Society (MSTS) score. Weighted means and standard deviations were calculated. The chi-square test was used to compare differences between categorical values. T-test was used to compare mean values of continuous variables. A p value  $\leq 0.05$  was considered statistically significant.

**RESULTS:** A total of 844 patients undergoing TFR were finally included in our study. TFR was performed for oncologic indications in 455 patients, and for non-oncologic indications in 389 patients. Overall failure rate was similar between groups. Henderson type 4 failures (prosthetic infection) were more common within the non-oncologic group (18.8%) than in the oncologic one (8.1%) ( $p < 0.001$ ) while the others were more frequently found in the oncologic group (Table 2). Overall amputation rate was higher in the oncologic group mainly due to type 5 failure (tumor progression). For type 4 failure, the amputation rate was almost twice as higher in the oncologic group (39%) than in the non-oncologic one (20.9%) ( $p < 0.001$ ). Amputations occurred mainly after type 4 and type 5 failures (Table 3). Functional outcome was better within the oncologic group (70.5 vs. 61.7; respectively  $p < 0.001$ ) (Table 4).

## DISCUSSION AND CONCLUSION:

TFR in the oncologic and non-oncologic group is associated with a high rate of failure (31% and 32.5%, respectively). Excluding type 5 failures, the overall failure rates were higher in the non-oncologic group, primarily due to a greater risk of developing type 4 failures. The oncologic group had a higher overall amputation rate, mainly driven by type 5 failure. Despite its impact on patient mobility and function, amputation serves as an option to eliminate prosthetic joint infection in the short term or remove recurring tumors, reducing the risk of further recurrence. The oncologic group experienced better functional outcomes, likely attributed to better soft tissue condition compared to non-oncologic patients.

FIG 1. Flowchart of our literature search and selection of relevant articles



Table 2. Rates of failure by group according to the Henderson classification using weighted means of aggregate data.

|                        | Non-oncologic (n=389) | Oncologic (n=455) | p      |
|------------------------|-----------------------|-------------------|--------|
| Henderson type 1       | 8.2% ± 2.2%           | 16.2% ± 10.0%     | 0.001  |
| Henderson type 2       | 2.1% ± 2.8%           | 2.6% ± 3.8%       | 0.912  |
| Henderson type 3       | 2.2% ± 3.1%           | 4.4% ± 4.4%       | <0.001 |
| Henderson type 4       | 18.8% ± 13.4%         | 8.1% ± 5.4%       | <0.001 |
| Henderson type 5       | —                     | 70% ± 4%          | —      |
| All Henderson types    | 31.4% ± 23.1%         | 32.8% ± 17.6%     | 0.4    |
| Henderson types 1 to 4 | 31.4% ± 23.1%         | 25.8% ± 16.0%     | <0.001 |

\*The values are given as the mean and the standard deviation.

Table 3. Rate of amputation by group as a percentage of each type of failure and the overall failure rate.

|  | Non-oncologic (n=389) | Oncologic (n=455) | p      |
|--|-----------------------|-------------------|--------|
| Amputation (% of Henderson type 1)       | 0.0% ± 0.0%           | 2.7% ± 7.7%       | <0.001 |
| Amputation (% of Henderson type 2)       | 0.0% ± 0.0%           | 0.0% ± 0.0%       | —      |
| Amputation (% of Henderson type 3)       | 0.0% ± 0.0%           | 0.0% ± 0.0%       | —      |
| Amputation (% of Henderson type 4)       | 20.9% ± 21.8%         | 39.0% ± 45.4%     | <0.001 |
| Amputation (% of Henderson type 5)       | —                     | 49.5% ± 45.9%     | —      |
| Amputation (% of all Henderson types)    | 15.2% ± 20.3%         | 28.8% ± 24.6%     | <0.001 |
| Amputation (% of Henderson types 1 to 4) | 15.2% ± 20.3%         | 15.4% ± 19.0%     | 0.88   |

\*The values are given as the mean and the standard deviation.

Table 4. Functional outcomes at last follow-up measured MSTS score.

|                            | Non-oncologic (n=389) | Oncologic (n=455) | p      |
|----------------------------|-----------------------|-------------------|--------|
| MSTS (%) at last follow-up | 61.7 ± 19.9           | 70.5 ± 8.7        | <0.001 |

MSTS: Musculoskeletal Tumor Society.