Original Article

Actual versus Predicted Overall Survival in Patients Treated Surgically for Metastatic Spinal Cord Compression

Zaid Sami Ullah, Oliver Bates, Namwa Wongkalasin, Jasmeet Dhir and Marcin Czyz

ABSTRACT

Objective: To compare the predicted survivals based on Tokuhashi and Tomita scores, as well as clinical estimates by the oncologist, with the actual observed survival

Study Design: A retrospective observational study

Place and Duration of Study: This study was conducted at the Queen Elizabeth Hospital, Birmingham, UK between 20th June 2025 to 19th October 2025.

Methods: This was a retrospective observational study was carried out at Queen Elizabeth Hospital, Birmingham, UK between 20th June 2025 to 19th October 2025 of 32 patients treated surgically for metastatic spinal cord compression.

Results: A Cox proportional hazards model found Tokuhashi and Tomita scores to have negative predictive values. Log-rank tests demonstrated p-values <0.05 in the comparison of outcomes with Tokuhashi, Tomita and oncological expert predictions, indicating significant differences between predicted and actual survival. Spearman's correlation coefficient showed a moderate positive correlation between Tokuhashi predictions and observed survival (p= 0.017), while Tomita predictions showed no correlation with observed survival (p = 0.893). The discriminatory predictive performance of the two scoring systems revealed areas under the curve of 0.57 and 0.369 for Tomita and Tokuhashi, respectively. Both showed slight non-specific agreement with actual survival outcomes, with kappa values of 0.04 and 0.07, respectively.

Conclusion: While both of these scoring system prognostic models can serve as guides to likely outcomes, they lacked predictive accuracy in our cohort. We recommend the development of more robust, individualised survival prediction tools for preoperative treatment planning in MSCC patients.

Key Words: Metastatic spinal canal compression, Prognostic assessment in oncology, Spinal metastasis, Survival estimation, Tokuhashi scoring system, Tomita scoring system

Citation of article: Ullah ZS, Bates O, Wongkalasin N, Dhir J, Czyz M. Actual versus Predicted Overall Survival in Patients Treated Surgically for Metastatic Spinal Cord Compression. Med Forum 2026;37(6):30-35. doi:10.60110/medforum.370606.

INTRODUCTION

Metastatic spinal canal compression (MSCC) is a serious, devastating complication of advanced-stage malignancy with an established primary site that can present as severe back pain and neurological deficits. Surgical treatment in terms of decompression and stabilization helps to relieve the pain, halt further neurologic deterioration, and restore the baseline functionality.

Department of Neurosurgery, Affiliated hospital of University Hospitals Birmingham, QEHB, B15 2GW, UK.

Correspondence: Dr. Zaid Sami Ullah, International Training Fellow Neurosurgery, Queen Elizabeth Hospital Birmingham, UK.
Contact No: 07446255730
Email: zaidsamiullah20@gmail.com

Received: January, 2026
Reviewed: February-March, 2026
Accepted: April, 2026

Pre-operative proper selection of patients for surgical intervention remains challenging to reduce the untoward risks of surgical morbidity and mortality.[1] Predicting the survival prognosis in MSCC patients is very crucial. For this, different prognostic prediction tools remain familiar to the Neurosurgeons, including Modified Tokuhashi, Tomita, and Bauer scoring systems, each incorporating variable characters and interpretation for survival predictions.[2] Although the old prognostic classification models for MSCC prognosis give an idea in preoperative decision making for management strategies for their continued correlation with actual observed survival needs revalidations and refinements to guide a more realistic prognosis.[3-5]

The purpose this study is to compare the survival predictions in surgically managed MSSC patients provided by the prognostic tools like Tokuhashi and Tomita, as well as by the oncological clinical estimates, with the actual observed survival, i.e., from the time of intervention till last follow-up or death. In this way, we also want to pinpoint the factors that could cause the discrepancies in prediction and reality and recommend

the further incorporation of broader parameters in these models to improve the survival predictions in MSCC patients.

METHODS

This retrospective study was at the Queen Elizabeth Hospital, Birmingham, UK, between November 2019 to December 2024 vide letter CPSP/REU/NSG-2023-250-964 dated June 16, 2025 and 32 adult patients who underwent surgery for metastatic spinal canal compression consecutive non-probability sampling was used. The clinical data of the patients were recorded. The Tokuhahsi and Tomita scores were calculated for all patients based on the individual parameters of the respective models. Pre- and postoperative neurological examination findings were recorded for Frankel grading.[6] Oncological estimates were recorded from oncology clinic letters, but they varied in format. Some of the patients had no documented oncological prognosis. Actual survival was defined as the time from surgery to death was recorded in months. Data were analysed using the SPSS-2025. The Cox's proportional hazards model to evaluate the predictive value of the scoring systems was used. Spearman's rank correlation coefficient to determine the correlations between the predictive approaches and the outcomes and Cohen's kappa to establish the level of agreement and Kaplan–Meier curves and the log-rank test to graphically plot survival distribution over time. The discriminatory performance of the prediction models by plotting the receiver operating characteristic (ROC) and area under the curve (AUC) values. *P*-values ≤0.05 were considered statistically significant.

RESULTS

The mean age was 59.9±11.8 years and 19 (59.4%) of the 32 patients were male. The most common primary cancer was renal cell carcinoma, accounting for 21.88% of cases, followed by prostate and rectal cancer. Preoperative neurological function was assessed using the Frankel scale. There were 18 (56.25%) of the cases had Frankel grade E, 7 (21.88%) had Frankel grade D, 4 (12.5%) had Frankel grade C and 3 (9.38%) had Frankel grade B. The mean postoperative survival time was 9.73±10.6 months. At the mean final follow-up of 6-12 months, 50% of the patients were alive and 50% were deceased. (Tables 1-2).

Table No. 1: Demographic and clinical characteristics of the cohort (n = 32)

Variable	No.	%
Gender		
Male	19	59.40
Female	13	40.63
Visceral metastasis		
Present	15	46.90
Absent	17	53.13
Preoperative Frankel grade		
Grade B	3	9.38
Grade C	4	12.50
Grade D	7	21.88
Grade E	18	56.30
Postoperative Frankel grade		
Grade C	5	15.63
Grade D	9	28.13
Grade E	18	56.25
Survival status at last follow-up		
Alive	16	50.00
Deceased	16	50.00
Primary cancer site		
Renal cell carcinoma	7	21.88
Prostate	4	12.5
Colorectal	4	12.5
Thyroid	3	9.38
Lung	2	6.25
Other (each <5%)*	12	37.49

Cox proportional hazards modelling revealed a regression coefficient of −1.82 and a hazard ratio (HR) of 0.16 (p = 0.205) for the Tokuhashi predictions. The Tomita predictions had a regression coefficient of 0.42 and an HR of 1.52 (p= 0.759). Both demonstrated negative prognostic predictive value. Log-rank tests found p-values of <0.001, 0.01 and 0.04 for the Tokuhashi, Tomita and oncological expert predictions and therefore rejected the null hypothesis that there was no difference between the survival predictions of these model groups. However, it should be borne in mind that there was some bias in the oncology predictions due to variations in the data format used in the medical records and our arbitrary selection of the values (some patients had no documented oncological prognosis) Figures.1-2. Spearman's rank correlation coefficients showed a moderate, positive correlation between Tokuhashi scores and real survival outcomes (r[30] = 0.38, p = 0.017). Tomita predictions were negatively correlated with survival outcomes (r[30] = −0.02, p = 0.893) Figures. 3-4.

Table No. 2: Patient variables, predictive system scores and survival outcomes

Variables	Mean±SD	Median	Range (min–max)
Age (years)	59.9±11.77	61	31–82
No. of spinal levels affected	2.09±1.35	2	1–6
Tokuhashi score	9.53±2.63	9	4–15
Tomita score	5.75±2.62	6	2–10
Postoperative survival time (months)	9.73±10.6	7	1–51

The discriminatory performance of each prediction system revealedthe Tokuhashi system to have higher

sensitivity and specificity (93% each) for survival predictions <6 months (AUC = 0.369). Comparatively, the Tomita system showed better sensitivity (81%) and specificity (93%) in predicting survival >24 months (AUC = 0.57) [Figs. 5-6]. Higher AUC values based on ROC curves indicate a better overall classification model.

Cohen's kappa revealed slight non-specific agreement for Tokuhashi and Tomita scores, with kappa values of 0.05 (p= 0.415) and 0.07 (p= 0.256), respectively. However, the non-significant p-values indicate that the observed concordance is likely attributable to chance.

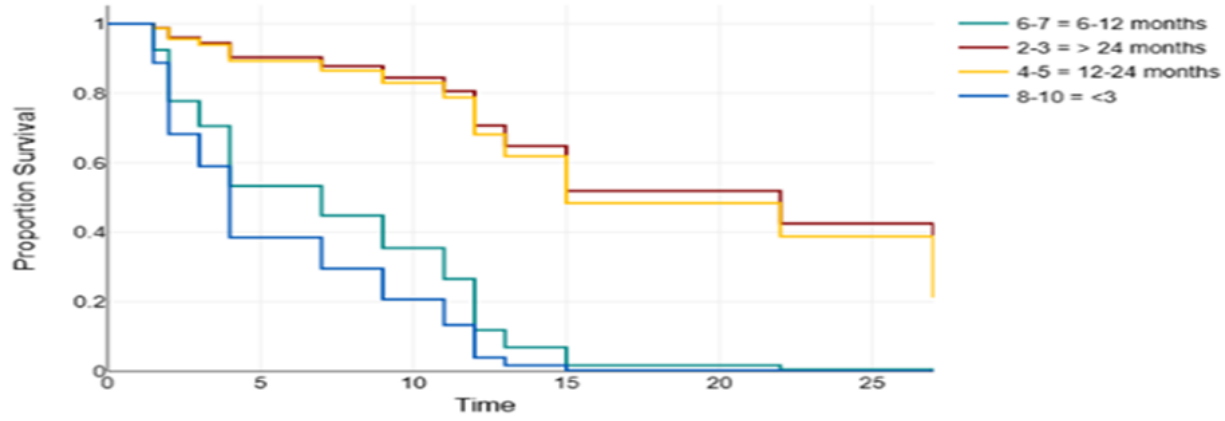

Figure No. 1: Kaplan–Meier curves showing Tomita system survival predictions for surgically-treated patients with metastatic spinal cord compression

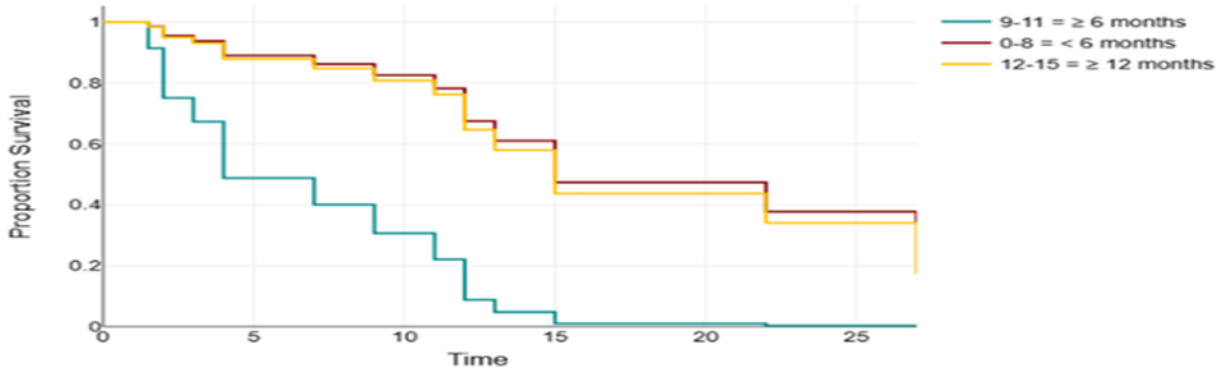

Figure No. 2: Kaplan–Meier curves showing Tokuhashi system survival predictions for surgically-treated patients with metastatic spinal cord compression

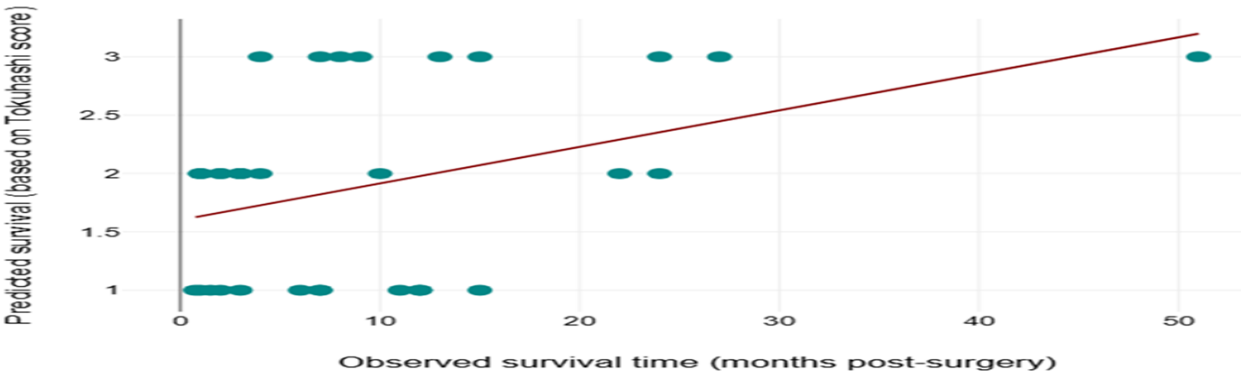

Figure No. 3: Spearman's rank correlation coefficients showing a moderate positive correlation between postoperative survival outcomes and Tokuhashi system survival predictions for surgically-treated patients with metastatic spinal cord compression

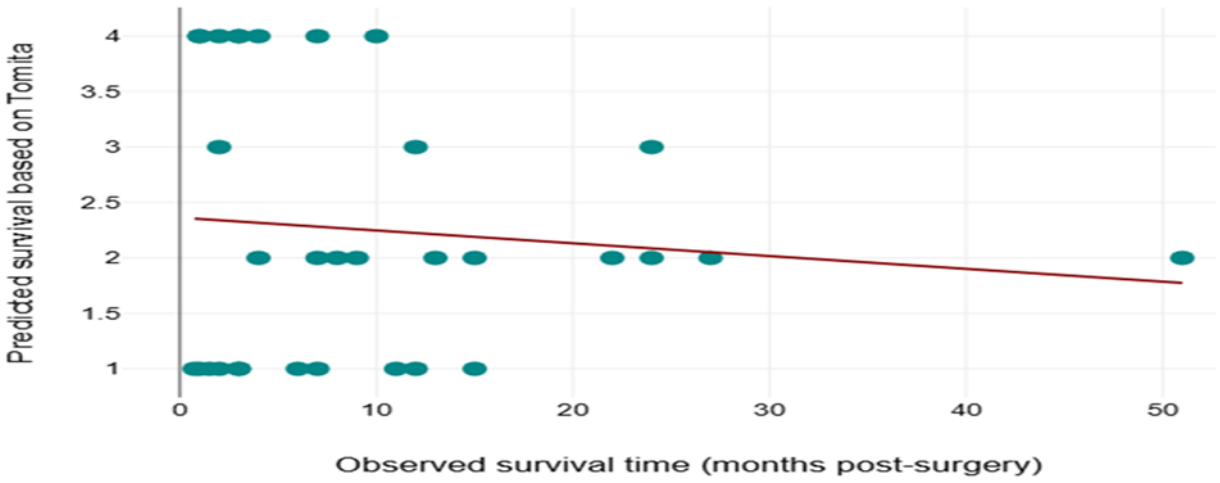

Figure No. 4: Spearman's rank correlation coefficients showing a negligible negative correlation between postoperative survival outcomes and Tomita system survival predictions for surgically-treated patients with metastatic spinal cord compression

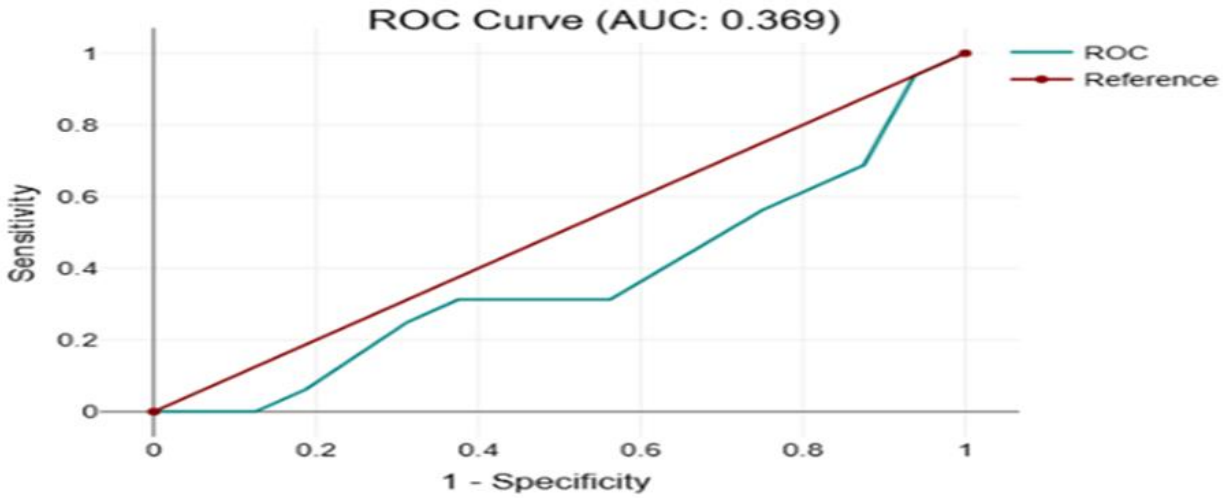

Figure No. 5: Discriminatory performance of Tokuhashi score survival predictions for surgically-treated patients with metastatic spinal cord compression AUC, area under the curve; ROC, receiver operating characteristic.

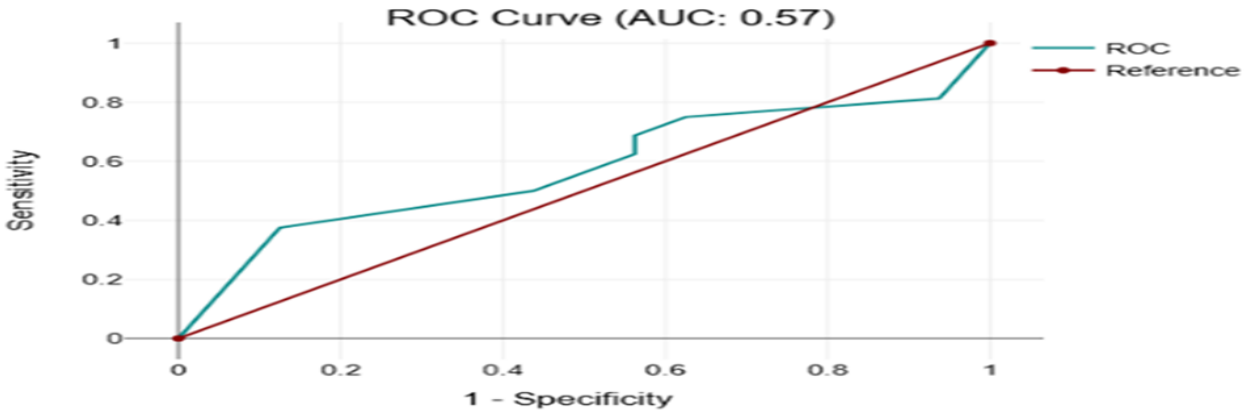

Figure No. 6: Discriminatory performance of Tomita score survival predictions for surgically-treated patients with metastatic spinal cord compression AUC, area under the curve; ROC, receiver operating characteristic

DISCUSSION

The comparisons of real survival outcomes with the predictive approaches used indicated that the Tokuhashi system had negative predictive value in our cohort. This conflict with the findings of Aoude et al[7] and Papastefanou et al[8], they found that, for patients with favourable prognoses, the modified Tokuhashi score demonstrates superior accuracy in survival duration prediction over the Tomita score. However, like us, Park et al[9], Quraishi et al[10] and Wang et al[11] found the predictive accuracy of the Tokuhashi system to be suboptimal (57.2%). They recommend the refinements of this system through the inclusion of more predictive parameters.

Tan et al[12,] Dardic et al[13] and Wibmer et al[14] compared four scoring systems and found the modified Tokuhashi score to exhibit the greatest predictive accuracy for survival. In the present study, both Tokuhashi and Tomita scores had negative predictive value but showed moderate, statistically significant correlations with actual survival. However, its overall discriminatory power was low (AUC = 0.369).[15,16]

We found that the survival estimates of attending oncologists lacked standardisation and were poor predictors of real-world outcomes. This contrasts with the findings of a previous report in which the prognostic assessments of oncologists accurately reflected the survival outcomes of consecutive MSCC patients.[17]

In concordance with our observations, Majeed et al[18] and Popovic et al[19] reported that prognostic scoring systems like Tokuhashi and Tomita are not uniformly accurate across all primary tumour types. Nevertheless, their integration of critical factors such as patient age, tumour type and stage and general health can facilitate surgical decision-making. In the present era of targeted therapies and immunotherapies, the variable performance of existing scoring systems observed in the present study highlights the need for more refined prognostic tools for use with this patient population.

CONCLUSION

While the Tokuhashi and Tomita prediction models offer reasonable general frameworks for preoperative survival predictions in surgically-treated patients with metastatic spinal canal compression, we found both to lack predictive accuracy in our cohort. We recommend re-auditing, ongoing refinement and standardisation of these approaches. Future research should focus on the development of more robust and accurate survival prediction tools, incorporating recent oncological treatment advances to optimise the selection of metastatic spinal canal compression patients for surgery.

Author's Contribution:

Concept & Design or acquisition of analysis or interpretation of data:	Zaid Sami Ullah, Oliver Bates
Drafting or Revising Critically:	Namwa Wongkalasin, Jasmeet Dhir, Marcin Czyz
Final Approval of version:	All the above authors
Agreement to accountable for all aspects of work:	All the above authors

Conflict of Interest: The study has no conflict of interest to declare by any author.

Source of Funding: None

Ethical Approval: No. CPSP/REU/NSG-2023-250-964 dated 16.06.2025

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