

# Predictive Nomogram for Evaluating Survival in Patients with Spinal Metastases

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## ABSTRACT

**Introduction:** The decision of a surgical procedure and the surgical strategy are based on the life expectancies of the patients. The systems differ greatly in the parameters evaluated and in the result of the total score. Therefore, for the same patient, different survival periods can be calculated and contradictory treatment strategies suggested. **Objective:** To evaluate patients with spinal metastases who underwent surgery, evaluating survival according to the SORG (Skeletal Oncology Research Group) Nomogram. **Materiales and Methods:** Retrospective study, March 2017 to March 2019. 20 patients. Inclusion criteria: spinal metastases, with or without spinal compression. Evaluation parameters: the SORG Nomogram with probability of survival, at 30, 90 and 365 days, in the preoperative phase and the remote evaluation: survival to March 2020. **Results:** 14 women and 6 men, average age: 67.9 years. Follow-up 6 to 36 months. Average final score: 222.4 points, which would be equivalent to a survival of 99% after a month, 78% after 3 months and 50% after a year. **Conclusion:** In cancer patients with spinal metastases, the SORG nomogram would be useful to predict survival, especially at one year.

**Key words:** Spinal metastases; survival; spine surgery.

**Level of Evidence:** IV

## Normograma predictivo para evaluar la supervivencia en pacientes con metástasis vertebrales

## RESUMEN

**Introducción:** La decisión respecto al procedimiento quirúrgico y la estrategia operatoria se basa en las expectativas de vida de los pacientes. Los sistemas difieren mucho en los parámetros evaluados y en el resultado del puntaje total. Por lo tanto, para un mismo paciente, se pueden calcular diferentes períodos de supervivencia y sugerir estrategias de tratamiento contradictorias. **Objetivo:** Analizar pacientes con metástasis vertebrales que fueron operados y evaluar la supervivencia mediante el normograma del SORG (Skeletal Oncology Research Group). **Materiales y Métodos:** Estudio retrospectivo que incluyó a 20 pacientes, de marzo de 2017 a marzo de 2019. Los criterios de inclusión fueron metástasis vertebrales con compresión medular o sin ella. Parámetros de evaluación: el normograma del SORG con probabilidad de supervivencia a los 30, 90 y 365 días, en la fase prequirúrgica, y la evaluación alejada: supervivencia a marzo de 2020. **Resultados:** 14 mujeres y 6 hombres, edad promedio: 67.9 años. Seguimiento de 6-36 meses. El puntaje promedio final fue de 222,4, lo que equivaldría a una supervivencia del 99% al mes, 78% a los 3 meses y 50% al año. **Conclusión:** En pacientes oncológicos con metástasis vertebrales, el normograma del SORG sería útil para predecir la supervivencia, sobre todo, al año.

**Palabras clave:** Metástasis vertebrales; supervivencia; cirugía espinal.

**Nivel de Evidencia:** IV

## INTRODUCTION

Spinal metastasis prevails as great challenge for spinal surgeons. Proper treatment must be chosen in order to achieve the best control of the disease (pain relief, recovery of stability and function) with the least surgical mortality and morbidity.

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The decision of the appropriate surgical procedure and strategy often lies in the estimated life expectancy of the patient.

Several evaluation systems have been designed in order to predict survival and select the best therapeutic option for each patient. Authors such as Tokuhashi, Tomita, Bauer, Ghorri, just to name a few, have proposed said systems.

The parameters evaluated and the result of the scores vary greatly between each system. Therefore, for the same patient, different survival periods can be calculated and contradictory treatment strategies suggested.

Given that surgical treatment for spinal metastasis is generally palliative and would be aimed to improve the patient's quality of life, it is highly important to establish survival prognosis systems that can be reproduced.

The aim of our study was to evaluate patients with spinal metastases who had undergone surgery, evaluating survival with the nomogram previously established by SORG (Skeletal Oncology Research Group). This nomogram includes predictive parameters established in a common scoring scale, which oscillate from 0 to 100 for each individual parameter, and are then extrapolated to a final scoring scale which points out a survival approximation - it incorporates continuous variables into a final score, and the scale translates the score into individual survival probabilities.

### MATERIALS AND METHODS

A retrospective study was conducted over patients with spinal metastases who had undergone surgery between March 2017 and March 2019. The sampling included 20 patients treated in our facilities. The inclusion criteria were: spinal metastases, with or without spinal compression. Patients under 20 years old and patients with non-surgical oncology treatments were excluded.

Two surgeons decided the type of surgical treatment considering the level of pain, the degree of spinal compression and mechanical instability.

The chosen surgical technique was decompression (if necessary) and percutaneous pedicular fixation, open surgery or balloon kyphoplasty.

The evaluation parameters were those established by the SORG nomogram (Figure 1) to estimate survival in the preoperative stage: hemoglobin, white blood cell count, age, previous systemic therapy, visceral/brain metastases, more than one mobile spine metastasis, primary tumor type, ECOG (Eastern Cooperative Oncology Group) performance scale (3-4 score), and survival at 30, 90 and 365 days. The remote evaluation considered whether the patient had survived or not, determined via phone inquiry in March 2020.

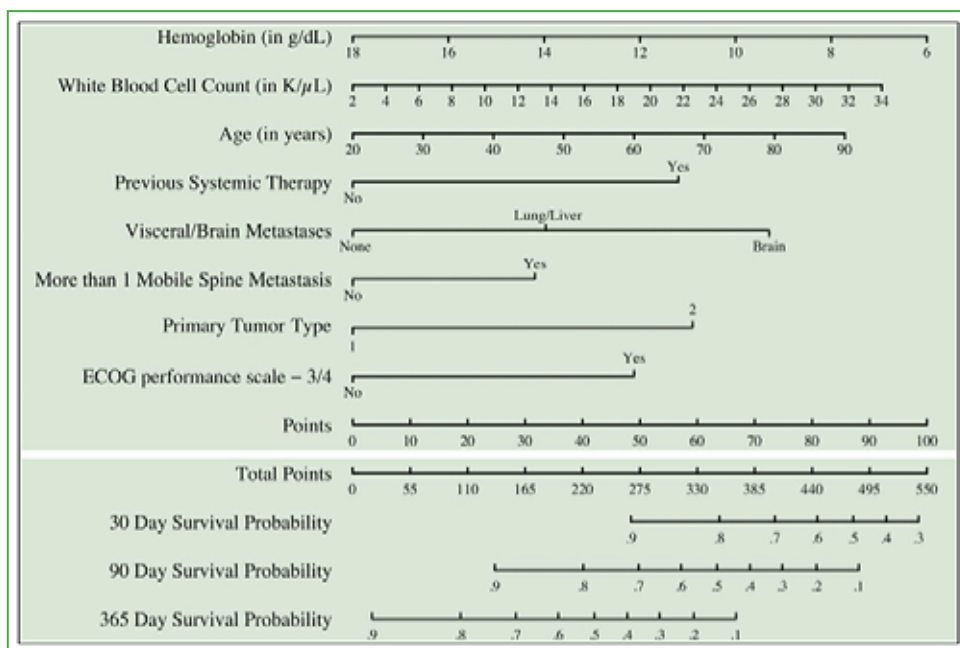


Figure 1. SORG (Skeletal Oncology Research Group) nomogram.

## RESULTS

14 women and 6 men were included, average age of 67.9 years (range 21-90). The minimum follow-up was of 6 months and the maximum of 36 months counting from the date of the surgery to the phone inquiry.

Breast tumors were the predominant type (6 patients), followed by multiple myeloma and lymphoma (4 patients each), kidney and lung (2 patients each), and lastly prostate and liver (1 patient each). The most affected area was the thoracolumbar junction.

The surgical techniques applied were: open surgery (8 patients), balloon kyphoplasty (2 cases), and minimally invasive surgery (10 cases). (Table 1)

**Table 1.** Characteristics of the patients.

	C.A.	G.M.	PP.	W.M.	E.D.	G.M.	G.M.	P.E.	G.M.	B.M.	D.N.	D.C.	C.N.	G.M.	R.A.	F.E.	F.Z.	M.G.	V.I.	B.A.
Age	68	63	79	68	42	78	67	90	74	80	78	84	21	65	81	67	70	81	72	37
Sex	M	F	M	F	F	F	F	F	F	F	M	M	M	F	F	F	F	M	F	F
Type of Tumor	Kidney	Breast	Lymphoma	Breast	Multiple Myeloma	Breast	Kidney	Lung	Breast	Multiple Myeloma	Multiple Myeloma	Prostate	Lymphoma	Breast	Breast	Lung	Lymphoma	Lymphoma	Multiple Myeloma	Liver
Type of Surgery	Minimally Invasive Surgery									Open Surgery									Kyphoplasty	

M = male, F = female.

The average hemoglobin was 9.96 g/dL (range 8-13), and the average white blood cell count was 9370/mL (range 5000-15,200). Only five patients had received treatment for the tumor before the surgery. Two patients had brain metastases and six had metastases in more than one area of the spine.

Ten patients had a 3-4 score in the ECOG scale; the rest, a favorable score of 1-2 (Figure 2).

The final average nomogram score of the whole series was of 222.4, which would translate to a 99% average survival rate after 1 month, 78% after 3 months and 50% after a year.

0	-	Fully active, able to lead same pre-disease activities without restriction.
1	-	Restricted in high-energy physical activity, but receives outpatient care only and is capable of doing light or sedentary work (such as simple household tasks or office work).
2	-	Receiving outpatient care and able to take care of self, but unable to do any type of work. Remains in bed <50% of waking hours.
3	-	Limited ability to take care of self, bed or chair-bound >50% of waking hours.
4	-	Fully disabled. Cannot take care of self. Fully bed or chair-bound.

**Figure 2.** ECOG (Eastern Cooperative Oncology Group) performance status scale.

By March 2020, according to the phone inquiry, six patients (30%) had died from systemic complications of the tumor and two (10%) from causes not related to the base disease (cardiopulmonary arrest, one patient 5 days after the surgery and the other 2 months after, previously determined in the follow-ups and thus not needing the phone inquiry). The remaining 12 patients (60%) remained alive.

Five (25%) of the 6 patients who died from the tumor were deceased between 6 to 12 months after the surgery, except for one with multiple myeloma who survived for two years. All of them scored >280 in the SORG nomogram (285-320 range), which translates to a 25% approximate survival estimate after a year.

The average SORG nomogram score of the remaining 12 live patients was of 190.4 (range 110-310), which would translate to an estimated survival of over 55% after a year. The average percentage of those who are still alive up to the moment of the phone inquiry is of 22.2 months (range 12-36). (Table 2)

**Table 2.** Evaluated pre and postoperative parameters.

	F.Z.	B.M.	D.N.	E.D.	D.C.	G.M.	C.N.	F.E.	G.M.	M.G.	G.M.	P.E.	C.A.	R.A.	P.P.	W.M.	G.M.	V.I.	G.M.	B.A.
Hemoglobin	9	8	11	10	11	9	9	10	9	9	10	9	11,1	13	9.8	11,4	9	9	11,9	10
White Blood Cell Count	8300	15.200	10.500	7000	8100	9000	14.000	8000	7300	5000	8000	8300	7200	15.000	7300	7400	7500	11.000	15.200	8000
Age	70	80	78	42	84	78	21	67	67	81	63	90	68	81	79	68	74	72	65	37
Previous Systemic Therapy	No	No	No	No	No	No	Yes	No	No	No	No	Si	No	No	No	Yes	Yes	No	No	Yes
Visceral/ Brain Metastasis	No	No	No	No	No	No	No	Brain	No	No	No	No	No	No	Brain	No	No	No	No	No
More than 1 Mobile Spine Metastasis	No	Yes	No	No	No	No	No	No	No	Yes	No	No	No	Yes	No	No	Yes	No	Yes	Yes
Primary tumor type	Lymphoma	Multiple Myeloma	Multiple Myeloma	Multiple Myeloma	Prostate	Breast	Lymphoma	Lung	Kidney	Lymphoma	Breast	Lung	Kidney	Breast	Lymphoma	Breast	Breast	Multiple Myeloma	Breast	Liver
ECOG	1	2	1	1	1	1	2	2	1	1	2	2	2	2	2	1	1	1	2	2
Score	155	285	155	110	160	170	290	320	195	183	190	300	185	235	285	190	305	195	230	310
30-Day Survival Probability	99%	85%	99%	99%	99%	99%	85%	85%	99%	99%	99%	85%	99%	99%	85%	99%	85%	99%	99%	85%
90-Day Survival Probability	85%	60%	85%	90%	85%	85%	60%	60%	80%	85%	85%	60%	85%	75%	65%	85%	65%	85%	75%	60%
350-Day Survival Probability	70%	25%	70%	80%	65%	60%	25%	25%	60%	60%	60%	25%	60%	45%	20%	60%	30%	60%	45%	25%
Date of Surgery	March 2017	May 2017	June 2017	July 2017	July 2017	September 2017	December 2017	Enero 2018	March 2018	Abril 2018	May 2018	August 2018	September 2018	October 2018	December 2018	Febrero 2019	February 2019	March 2019	March 2019	March 2019
Phone Inquiry	Alive	Deceased	Alive	Alive	Alive	Alive	Deceased	Deceased	Deceased	Deceased	Alive	Deceased	Alive	Alive	Deceased	Alive	Deceased	Alive	Alive	Alive
Postoperative Follow-up	36 months	24 months	31 months	32 months	32 months	30 months	9 months	6 months	5 days (cardiopulmonary arrest)	2 months (cardiopulmonary arrest)	22 months	12 months	18 months	17 months	6 months	13 months	13 months	12 months	12 months	12 months

ECOG = Eastern Cooperative Oncology Group.

## DISCUSSION

The current treatment of spinal metastasis is focused on prolonging life expectancy and improving quality of life. When choosing the type of procedure to be performed, it is essential to evaluate whether the patient will tolerate it, bearing in mind the patient's condition and survival potential. Generally, this survival estimate is based on the surgeon's experience rather than on pre-established algorithms.

The importance of obtaining this information relates to establishing appropriate expectations for the patient, the family and the professional. Data on costs, risks and quality of life are not always accurate, but if these data can be adequately gathered, risk is reduced and the most proper treatment for the patient can be determined.

Numerous studies have identified risk factors and created predictive systems to evaluate survival. In 1990, Tokuhashi et al.<sup>1</sup> created the first algorithm based on 64 patients who had undergone spinal metastasis surgery. They chose six parameters for the survival algorithm in terms of their experience with surgically-treated patients. The score oscillated between 0 and 12. These authors suggested excisional surgery for patients with >9 points and palliative surgical methods for those with <5 points. In 2005, they modified the algorithm to assign more importance to specific primary types of cancer.<sup>2</sup> This scoring is amongst the most applied nowadays. In 1995, Bauer et al.<sup>3</sup> reported another evaluation system from the study of 241 patients' survival of spine and limb metastases. They assigned 1 point for each selected parameter and categorized the patients in three groups, each group belonging to one suggested surgical strategy (no surgery, posterior surgery and combined surgery).

In 2001, Tomita et al.<sup>4</sup> presented a survival algorithm as a guide to decide the type of treatment in 67 patients with spinal metastases. Considering the total final score, the patients were classified in four groups, each one belonging to a suggested surgical strategy (wide or marginal excision, marginal or intralesional excision, palliative surgery and non-surgical oncology treatment, only as an aid).

In 2015, Ghori et al.<sup>5</sup> studied the one-year survival rate in 307 patients with spinal metastases. Their survival algorithm covered two risk factors recently identified in patients with spinal metastases (ambulatory status and serum albumin).

All of these predictive systems often deliver results that may vary in a single patient and lead to incorrect treatment choices.<sup>6</sup>

Efficient scoring systems reduce the risk of administering an insufficient treatment to patients with higher chances of survival, or an excessive treatment to patients with a less favorable prognosis.<sup>7</sup> Radical surgery can often induce stress, cause postoperative complications and lead to setbacks in complementary systemic treatments, which is far from ideal, considering the improvement these treatments currently achieve in curbing tumor growth. As an alternative, minimally invasive surgery on a patient with long-term survival prognosis may not be enough to ensure good quality of life in the long term.

In 2016, SORG<sup>8</sup> developed a nomogram with additional factors besides those previously proposed, such as hemoglobin, white blood cell count and the patient's health according to ECOG (Figure 1). The nomogram achieved positive results, particularly in relation to 30, 90 and 365-day survival prognosis.

In our case series, according to this system, patients with the highest scores (>285) had an estimated survival average of <25%, which coincides with the 5 patients (25%) who died within the first year. Likewise, according to the nomogram, the remaining live patients scored an average survival rate of >60% (190 points) per year and, in comparison to the real findings of our study, 12 patients (60%) were alive at the conclusion of the time considered. We can establish coincidence in both groups.

This study presents three major limitations: 1) a small number of cases (20), 2) the diversity of metastases, and 3) metastases treated with three different surgical techniques: open surgery, percutaneous fixation or kyphoplasty. Accordingly, we believe it necessary to conduct further studies with a higher number of cases and, in turn, to group the different metastases and surgical techniques applied in order to achieve a more precise validation of this novelty prognosis scoring.

## CONCLUSIONS

The SORG nomogram could be useful to predict survival in oncology patients with spinal metastases, particularly after a year, and to help with preoperative planning.

Conflict of interests: Authors claim they do not have any conflict of interest.

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