Receptor Status and Demographics Linked to Timing of Spinal Bone Metastasis Surgery in Breast Cancer

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INTRODUCTION: About 1 in 8 women will be diagnosed with breast cancer during their lifetime. Breast cancer subtypes: hormone receptor–positive (HR+), HER2-positive, and triple-negative (TNBC) exhibit distinct patterns of progression and treatment response. Among patients with metastatic disease, bone is a common site of spread, and the spine is most frequently affected, leading to severe pain, nerve compression, and loss of function that may require surgery. The determinants of when patients progress to a spinal bone metastasis requiring surgery are not well defined. This study evaluates how receptor status (ER, PR, HER2) and demographic factors (age, sex, race/ethnicity) are associated with the timing of spine-involving bone metastasis, and summarizes the geographic distribution of the cohort.

METHODS: Using the TriNetX Research Network (103 healthcare organizations), we assembled a retrospective cohort of adults (n=27,843) with incident breast cancer diagnosed within the last 20 years. The primary endpoint was the time from the index breast-cancer diagnosis to the first spinal bone metastasis that required spine surgery, evaluated over a 5-year window. Multivariable Cox proportional hazards models estimated adjusted hazard ratios (HRs) with 95% CIs for receptor status (ER, PR, HER2) and demographics (age, sex, race/ethnicity). The cohort's geographic distribution was summarized by the healthcare-organization region.

RESULTS SECTION: We identified 27,843 patients (female=27,553; male=290). Most were from the United States (94.3%). Time to spinal bone metastasis requiring surgery: In adjusted Cox models, men had a higher hazard than women (HR 1.735). Older age was associated with a lower hazard (HR 0.991). Compared with the reference group, Not Hispanic/Latino ethnicity showed a higher hazard (HR 1.434), whereas Asian race showed a lower hazard (HR 0.584). By receptor status, PR-positive disease had a higher hazard (HR 1.590); ER-positive and HER2-positive had HRs of 1.522 and 1.107.

DISCUSSION: PR-positive tumors were linked to an earlier need for spine surgery, suggesting tumor biology matters. Men and non-Hispanic patients reached surgery sooner, while older and Asian patients reached it later. These patterns may reflect a mix of biology, stage at diagnosis, treatment exposure, and access to care, so in practice we would watch these patients more closely and move to spine imaging and referral sooner. The large, multi-center U.S. dataset supports generalizability. Key Limitations: We relied on EHR codes (ICD/CPT), and coding practices vary across sites, which can misclassify diagnoses/procedures.

SIGNIFICANCE/CLINICAL RELEVANCE: Understanding the impact of receptor status and demographic factors on relate to the timing of spinal metastasis that requires surgery can help clinicians better stratify risk and personalize surgical decision-making for patients with spinal metastases from breast cancer.

Covariate	Hazard Ratio	P> |z|	95% CI
M: Male	1.735	.041	(1.023,2.945)
AI: Age at Index	0.991	0.0002	(0.986, 0.996)
Hispanic or Latino	0.747	0.1676	(0.494, 1.13)
Not Hispanic or Latino	1.434	0.0003	(1.179, 1.744)
American Indian or Alaska Native	|HR| < 0.0001	.988	(0,0)
Asian	0.584	.0124	(0.384, 0.89)
Black or African American	1.008	0.9609	(0.724, 1.405)
Native Hawaiian or Other Pacific Islander	0.684	0.3154	(0.326, 1.435)
Other Race	0.766	0.4051	(0.41, 1.434)
White	1.129	0.3906	(0.856, 1.491)
Estrogen Receptor Positive	1.522	0.1109	(0.908, 2.55)
HER2 Positive	1.107	0.6011	(0.756, 1.62)
Progesterone Receptor Positive	1.59	0.0002	(1.249, 2.023)

Table 1. Cox Proportional Hazards Model for patients with breast cancer bone metastases requiring spine surgery.

Geographic Distribution of Patients (N=27,843)

Region	Patients
Middle Atlantic	5,663 (20.3%)
East North Central	5,244 (18.8%)
South Atlantic	4,166 (15.0%)
West South Central	3,844 (13.8%)
New England	2,393 (8.6%)
Pacific	2,006 (7.2%)
Ex-US	1,361 (4.9%)
West North Central	1,229 (4.4%)
Mountain	1,153 (4.1%)
East South Central	567 (2.0%)
Unknown	217 (0.8%)