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Original Article

Predictive Factors for Sentinel Lymph Node Metastasis and Validation of Memorial Sloan–Kettering Cancer Center Nomogram in Thai Breast Cancer Patients

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Abstract

Objectives: To evaluate risk factors for sentinel lymph node (SLN) metastasis and validate value of the Memorial Sloan–Kettering Cancer Center (MSKCC) nomogram for the prediction of sentinel lymph node metastasis in Thai breast cancer patients.

Materials and Methods: Sentinel lymph node biopsy (SLNB) database containing 760 consecutive breast cancer patients was retrospectively analyzed. The predictive value of MSKCC nomogram was calculated by the trend line and the area under the receiver-operator characteristic curve. Meanwhile, predictors for SLN metastasis were also evaluated.

Results: Tumor size, tumor type, tumor location, lymphovascular invasion, perineural invasion, multifocality, and progesterone receptor status were significant independent predictors for SLN metastasis (all $p < 0.05$). The MSKCC nomogram presented an area under the receiver–operator characteristic curve value of 0.73. Patients with predictive value less than 12% had a frequency of SLN metastasis of 0%. Those with values higher than 80% had a chance of SLN metastasis of 78.3%.

Conclusions: The risk factors for SLN metastasis in our study were partly similar to those in the MSKCC nomogram. The MSKCC nomogram is a useful tool that could accurately predict the probability of SLN metastasis in our breast cancer patients. Axillary surgical staging might be avoided in patients with a predictive value of < 12% and axillary lymph node dissection (ALND) might be performed in those with a predictive value of > 80%, while other patients should still require SLNB.

Keywords: Axillary staging, Breast cancer, Nodal metastasis, Nomogram, Sentinel lymph node

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Introduction

Axillary lymph node status is the most influential prognostic factor in patients with invasive breast cancer[1-3]. Sentinel lymph node biopsy (SLNB) is a standard of care for patients with early breast cancer, replacing traditional axillary lymph node dissection (ALND) when the sentinel lymph node (SLN) is negative[4,5]. The early and late postoperative morbidity of SLNB is significantly lower than that of ALND, but the morbidity is not nil, especially in elderly patients with comorbid conditions[5-9].

Lymphedema occurs in 2–8% after SLNB compared to 8–19% after ALND. Arm paresthesia occurs in 4–22% after SLNB compared to 39% to more than 80% in ALND[5,6,9-13]. In a prospective multicenter comparison of intermediate morbidity and mortality in 635 patients receiving either SLNB alone or with completion by ALND, 10.9% of the patients who underwent SLNB alone (n = 431) complained about numbness compared to 37.7% of the patients who underwent ALND, 8.1% had arm/shoulder pain compared to 21.1%, 3.5% had lymphedema compared to 19.1%, respectively[11]. The postoperative complications and relative medical burden of SLNB could not be neglected. In the preoperative phase, these morbidities need to be reflected, especially in patients with a very low probability of positive SLN.

Over the past decade, several variables have been identified as predictors for lymph node metastases in breast cancer including tumor size, tumor grade, tumor location, presence of lymphovascular invasion, high Ki67 proliferative index, age at diagnosis, estrogen receptor (ER) status, progesterone receptor (PR) status, and Human epidermal growth factor receptor 2 (HER2)[8,14-22]. Lymph node metastasis (LNM) is a multifactorial event. Several variables have been described as predictors of LNM in breast cancer. Usually the results of multivariate analyses of predictors of LMN are expressed as odds ratios, which markedly difficult to apply and calculate the probability of SLN metastases for a specific patient.

Bevilacqua et al. developed a nomogram to help estimate the risk of sentinel metastasis. The nomogram developed in the Memorial Sloan-Kettering Cancer Center (MSKCC) is based on nine factors, which were found to be predictive; age, tumor size, tumor type, tumor location, lymphovascular invasion, multifocality, histologic grade, ER and PR status[15]. Among the limitations of this initial model, the new biologic prognostic factor could not historically be included in the parameters analyzed, i.e. HER2 overexpression which is present in about 7-10% of patients. Fabien Reyal et al. developed a new nomogram that included HER2 status and was demonstrated as a major prognostic factor to predict the presence of a positive axillary node[23]. Predicting the SLN positivity can be useful for physicians to take more individualized preoperative decisions in early breast cancer, in that trail they consider that risk of SLN involvement <10% is acceptable cut-off to avoid SLNB.

The present study aimed to evaluate the risk factors for SLN metastasis and to validate the value of the MSKCC nomogram for the prediction of SLN metastasis in Thai population.

Materials and Methods

Patients

Seven hundred and sixty consecutive breast cancer patients who underwent breast conservative surgery or mastectomy with SLNB at the Division of Head Neck and Breast Surgery, Department of Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University, Thailand from 1st January 2009 to 31st December 2011 were enrolled. The inclusion criteria included invasive breast cancer, clinical axillary node negative (negative axillary lymph node by palpation and breast imaging). Exclusion criteria composed of previous ipsilateral axillary surgery, neoadjuvant chemotherapy, failure for SLN detection, and incomplete data. The study was approved by the Institutional Review Board of Faculty of Medicine Siriraj Hospital, Mahidol University, Thailand (COA NO. Si443/2014).

Identification and diagnosis of SLNs

Either blue dye or radioisotope technique was used for sentinel mapping. For blue dye technique, 5 mL of 1% isosulfan blue dye was injected subcutaneously adjacent to the primary tumor, periareolar, upper and outer quadrant of breast or adjacent to the previous biopsy cavity around 5 min before surgery according to the discretion of surgeon. All blue nodes were regarded as SLNs and dissected for the frozen section. Tc-99m nanocolloid was used in 2 patients. The dose was calculated by radiologist and injection was performed peritumoural or intradermal in the quadrant of the tumor on the day of surgery.

Histopathological evaluation

Frozen section was performed intraoperatively. SLNs with diameter of less than 5 mm were frozen intact, whereas SLNs with diameter of more than 5 mm were bisected longitudinally and half was frozen. Frozen sections of the SLNs were taken from the optimal cross-sectional surface with a microtome setting of 4 μmm. If no metastasis was detected at this point, the SLN was declared free of metastasis at intraoperative frozen section. Definitive pathological analysis consisted of serial sectioning of the SLNs at four levels of 250 μmm intervals along the longitudinal axis for permanent section. From every section, two parallel slides of 4 μmm were made. All slides were stained with haematoxylin and eosin (H&E) and with anti-cytokeratin immunohistochemistry[10]. Macrometastasis, micrometastasis, and isolated tumor cells were defined as tumor size of > 2 mm, 0.2-2 mm and < 0.2 mm, respectively. SLN was defined as positive when macrometastasis, micrometastasis, or isolated tumor cells were identified by any method of detection. ALND was performed in every patient with positive SLNB diagnosed by intraoperative frozen section or definitive pathological analysis. ER, PR and HER2 status was determined by immunochemistry. ER and PR score of more than ten percent and HER2 score of 3+ were classified as positive. The tumor stage was classified according to American Joint Committee on Cancer (AJCC) staging seventh edition.

Statistical analysis

Clinicopathological data was collected from the database for each variable. The data was analyzed with the SPSS 21. For numeric data, values were expressed as mean ± standard derivation (SD) and median (min-max). Numeric data was analyzed with Student's *t*-test if normally distributed, and equality of variances are given. If not, the Mann–Whitney test was used for comparison of data. Categorical data was analyzed with Chi-square or Fisher's exact test. *P*-value of < 0.05 was considered significant. A multivariable logistic regression analysis was performed to determine the independent predictive effect. The predicted probability of SLN metastasis was calculated for each patient using the MSKCC nomogram available at the website. (http://nomograms.mskcc.org/Breast/BreastSLNodeMetastasisPage.aspx).

To measure the nomogram's discrimination, a receiver-operating characteristic (ROC) curve was constructed. Overall accuracy of the nomogram was expressed by the area under the ROC curve (AUC). The AUC provides a useful parameter for comparing the nomogram's predicted probability with the actual outcome, thus measuring the accuracy. AUC has an inferior accuracy between 0.5 and 0.7, if AUC more than 0.75 that means the test was good accuracy.

Results

Correlations between clinicopathological parameters and SLN status

The study population consisted of 760 patients. Median age at diagnosis was 53 years (19-95 years). Characteristics of the study population were summarized in Table 1 (in comparison with that of the MSKCC). Correlations between clinicopathological parameters and SLN status were summarized in Table 2. The total of 2,211 frozen SLNs were obtained. The mean number of identified frozen SLN per patient was 3.061 nodes and the median was 3 (1-12). The total of 3,354 permanent SLNs were obtained. The mean number of permanent SLN identified per patient was 4.407 nodes and the median was 4 (1-22). Two hundred and four of the 760 patients (26.84%) had at least one positive SLN identified by frozen section and permanent section (serial H&E and IHC). Of these, 37 patients (4.87%) were identified by permanent section and 19 patients (2.5%) had micrometastasis.

Tumor size, tumor location, tumor type, histological grade, lymphovascular invasion, multifocality, and PR status were correlated with the probability of SLN metastasis by univariate analysis (Table 2). By multivariate analysis, tumor size, tumor location, tumor type, lymphovascular invasion, multifocality and PR were significant independent predictors for SLN metastasis (Table 3). There was no difference in frequency of SLN metastases with tumor grading ($P = 0.438$).

Validation of MSKCC nomogram in Thai breast cancer patients

The performance of the MSKCC nomogram was assessed in our data set and, the patients with a predictive value of < 11% had a frequency of SLN metastasis of 0%, those with values larger than 80% had a frequency of SLN metastasis of 78.3% (Table 4). So, these two values should be the cut-off point for unnecessary for SLNB. When analyzing deeply in detail of the lower cut off point value, if the predicted probability < 12% the

Table 1 Characteristics of descriptive of the two group for SLN nomogram of MSKCC, New York and Siriraj Hospital, Thailand

Variable	Siriraj Hospital group (n=760)		MSKCC, New York group (n=1,545)	
	N	%	N	%
Age (years)				
Median (range)	53 (19-95)		56 (25-90)	
40	106	13.9	191	11.7
41-69	567	74.6	1,066	69.0
70	87	11.4	298	19.3
Pathological size (mm)				
Median (range)	18 (1-65)		13 (1-95)	
1	10	1.3	51	3.3
1.1-5	28	3.7	199	12.9
6-10	104	13.6	362	23.4
11-20	276	36.2	642	40.4
21-30	244	32.2	215	13.9
31-50	87	11.4	80	5.2
51	11	1.4	14	0.9
Tumor location				
UOQ	357	46.9	879	56.9
LOQ	129	16.9	211	13.7
UIQ	117	15.4	264	17.1
LIQ	64	8.5	135	8.7
Central	93	12.2	NA	NA
Tumor type				
Invasive ductal	683	90.3	1,339	86.7
Invasive lobular	36	4.7	166	10.7
Special type	37	5.0	40	2.6
Histological grade				
I	164	21.5	89	5.8
II	423	55.5	661	42.8
III	173	22.9	522	33.8
Unknown	0	0	107	6.9
Lymphovascular invasion				
No	623	82.0	1,205	78.0
Yes	137	18.0	340	22.0
Multifocality				
No	664	87.3	1,155	74.8
Yes	96	12.6	390	25.2
Estrogen receptor				
Negative	163	21.5	273	17.7
Positive	597	78.4	1,186	76.8
Unknown	0	0	86	5.6
Progesterone				
Negative	278	36.6	600	38.8
Positive	482	63.3	858	55.5
Unknown	0	0	87	5.6
SLN				
Negative	556	73.1	966	62.5
Positive	204	26.9	579	37.5

Table 2 Univariate analysis of Clinicopathological characteristics of patients with SLN metastasis

Variable	SLNs (-)		SLN (+)		*P*-value
	N	%	N	%	
No. of patient	556	73.09	204	26.90	
Age, years (mean)	53.61		53.26		0.509
Tumor size (mean; mm)	19.79		24.98		0.000
Location					0.005
Upper outer quadrant	248	44.5	109	53.2	
Lower outer quadrant	94	16.9	35	17.1	
Upper inner quadrant	102	18.3	15	7.3	
Lower inner quadrant	47	8.5	17	8.8	
Central quadrant	65	11.7	28	13.7	
Tumor type					0.010
Invasive ductal	486	89.5	192	93.7	
Invasive lobular	25	4.5	11	5.4	
Special type	35	6.3	1	1.0	
Histological grade					0.017
I	134	24.1	30	14.6	
II	301	54.0	122	59.5	
III	121	21.9	52	25.9	
Lymphovascular invasion					0.000
No	501	89.9	122	60.0	
Yes	55	10.1	82	40.0	
Perineural invasion					0.001
No	498	92.7	157	84.4	
Yes	48	7.4	20	18.3	
Multifocality					0.014
No	496	89.0	169	82.4	
Yes	60	10.8	35	17.6	
ER					0.165
Negative	127	22.8	36	18.0	
Positive	429	77.2	168	82.0	
PR					0.042
Negative	216	38.8	62	30.7	
Positive	340	61.2	142	69.3	
HER2-IHC					0.931
1+	161	41.5	68	43.0	
2+	96	24.7	37	23.4	
3+	130	33.8	52	33.5	

Table 3 Multivariate logistic regression analysis of the likelihood of SLN metastasis

Variable	B	SE	Wals	OR	95% CI	*P*-value
Palpable breast mass	-0.107	0.266	0.161	0.899	0.533 - 1.515	0.688
Histological grade	0.253	0.325	0.602	1.287	0.680 - 2.436	0.438
PR	0.623	0.200	9.765	1.865	1.262 - 2.758	0.002
Multifocality	0.587	0.265	4.916	1.799	1.071 - 3.024	0.027
Lymphovascular invasion	1.712	0.220	60.568	5.539	3.599 - 8.524	0.000
Tumor size	0.755	0.193	15.266	2.128	1.457 - 3.108	0.000
Tumor location	1.308	0.338	14.955	3.697	1.906 - 7.172	0.000
Tumor type	3.100	1.130	7.529	22.198	2.425 - 203.228	0.006

Table 4 Predicted probability of the Memorial Sloan–Kettering Cancer Center (MSKCC) nomogram applied to the study population

Predicted probability (%)	n	(%)	SLNs (+)
0–10	31	4.1	0% (0)
11-20	118	15.6	10.2% (12)
21-30	148	19.5	16.2% (24)
31-40	142	18.7	23.9% (34)
41-50	111	14.6	27.9% (31)
51-60	85	11.2	41.2% (35)
61-70	53	7	41.5% (22)
71-80	42	5.5	52.4% (22)
81-90	23	3	78.3% (18)
91-100	5	0.7	100.0% (5)

Table 5 MSKCC nomogram applied to the study population at an 2-20% predicted probability

Predicted probability (%)	N	SLNs (+)
2	1	0% (0)
4	2	0% (0)
5	3	0% (0)
6	5	0% (0)
7	3	0% (0)
8	6	0% (0)
9	6	0% (0)
10	5	0% (0)
11	9	0% (0)
12	7	14.3% (1)
13	13	15.4% (2)
14	14	14.3% (2)
15	16	6.3% (1)
16	14	7.1% (1)
17	11	9.1% (1)
18	12	8.3% (1)
19	6	0% (0)
20	16	18.8% (3)

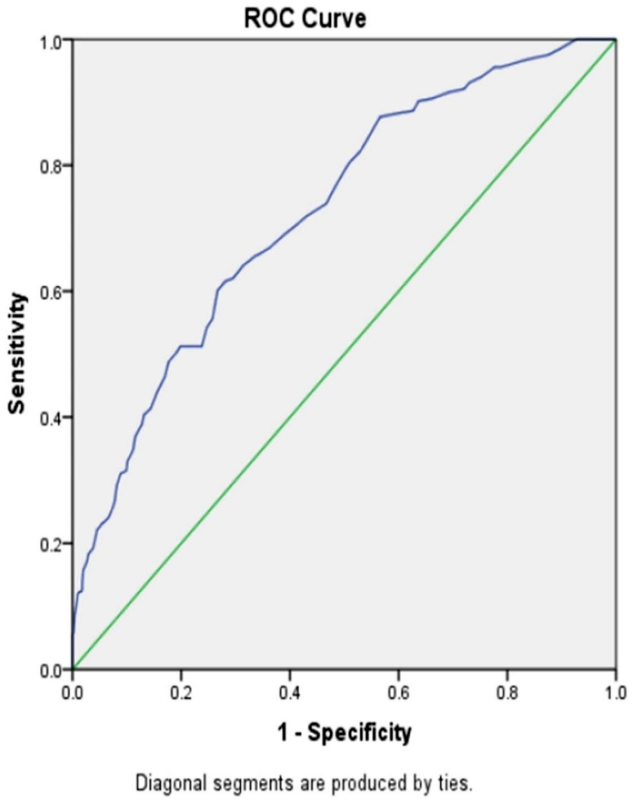


Figure 1 Receiver operating characteristics (ROC) curve calculation for the discrimination of the Memorial Sloan–Kettering Cancer Center nomogram (MSKCC) in predicting each individual patient's probability of having positive SLN applied to our center data (n = 720)

frequency of SLN metastasis was 0% (Table 5).

To estimate the accuracy of the MSKCC nomogram in our data, the ROC curve calculation for the discrimination of the MSKCC nomogram was applied to our data. The AUC for our population was 0.73 (Figure 1). ROC curve calculation for the actually predicted probability predicting each patient's probability of having positive SLN from our patient's data showed the AUC of 0.77 (Figure 2).

We developed a model using our significant factor for prediction of SLN metastasis. The AUC of the new model was 0.76 (Figure 3) that closed to AUC actual probability and more accurate than the MSKCC nomo-

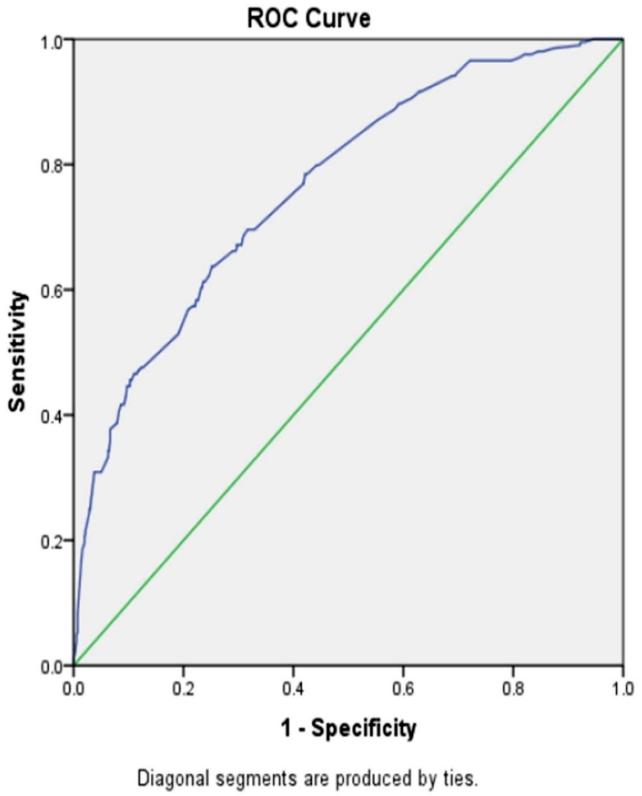


Figure 2 Receiver operating characteristics (ROC) curve calculation for the discrimination of the actual predicted probability in predicting each individual patient's probability of having positive SLN applied to our center data (n = 720)

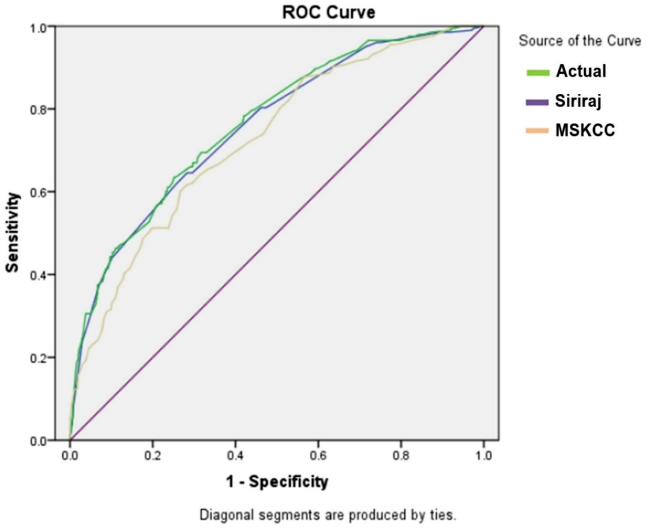


Figure 3 Receiver operating characteristics (ROC) curve calculation for the discrimination of the Memorial Sloan–Kettering Cancer Center nomogram (MSKCC), the actual predicted probability and Siriraj probability in predicting each individual patient's probability of having positive SLN applied to our center data (n = 720)

gram when applied to our patient. However, all three ROC curves had the same trend line and had no obvious deviation.

Discussion

SLNB has been the standard procedure for staging of axilla to decrease the surgical morbidity of ALND. However, the side effects of SLNB without consecutive ALND should not be neglected. In the NSABP B-32 trial, a comparison of 3-year post-surgical morbidity levels between patients with negative SLNB and those with a negative SLNB and negative ALND showed that the percentage of patients in the SLNB group had relative shoulder abduction deficits < 10%, peaked at 41% at 1 week; arm volume differences < 10% at 36 months; numbness (15%) and tingling (10%), peaked at 6 months[24]. Furthermore, SLNB would bring more waste of medical resources, especially in cases of patients with a very low or high probability of positive SLN. More attention was paid to avoid axillary surgery in negative SLN patients and improve their quality of life without losing benefit of treatment.

There are two types of predictive nomogram developed by the MSKCC. Van Zee et al. developed a nomogram in 2003 to estimate the risk of non-SLN metastasis in the case of positive SLNs[25]. Several groups have validated the nomogram and found fair to good reliability, but at the same time, they had questioned its clinical usefulness[26-28]. Recently, it was reported that this nomogram was of no value with the result of Z0011 included in the 2012 National Comprehensive Cancer Network Clinical Practice Guidelines. It was suggested that SLNB without ALND could offer excellent regional control and might be reasonable management for selected early-stage breast cancer patients with two or more positive SLNs treated with breast conserving therapy and adjuvant systemic therapy[26]. The MSKCC SLNs nomogram developed by Bevilacqua et al. in 2007 can only be validated in German Freiburg[29]. As a new statistical approach that allows the calculation of SLN metastatic risk by combining different clinicopathological prognostic factors, the MSKCC nomogram was developed to provide both clinicians and patients with information that helps to decide on the worthiness of SLNB. To our knowledge, this is the first validation study of the MSKCC nomogram focused on the likelihood of SLN metastasis in Thai breast cancer population, and the results of our study support a predictive accuracy in

Thailand with statistically significant AUC. This means that if we randomly select two patients, of whom one has at least one positive SLN and the other has negative SLNs, there is a 72.6% chance that the nomogram will predict a higher probability for the positive one. It is noteworthy that the ratios of lymphovascular invasion and multifocality in our center were much higher than those in the MSKCC centers. Although the histological grading was independent risk factors for SLN metastasis, it did not take a significant proportion in the MSKCC nomogram. This kind of difference did not affect the application of the MSKCC nomogram in the Thai populations.

Age, tumor size, tumor type, lymphovascular invasion, tumor location, multifocality, ER and PR were associated with SLN metastasis in multivariate analysis in MSKCC[15]. Klar's collective found that tumor size, tumor type, lymphovascular invasion, multifocality, HER2 and histological grade correlated with the probability of SLN metastasis[20]. Moreover, as many studies have also reported, age, tumor size, lymphovascular invasion and histological grade were the independent factors for SLN metastasis[30]. In our study, tumor size, tumor type, tumor location, lymphovascular invasion, perineural invasion, multifocality and PR were significant independent predictors. This result had also supported the variable in the MSKCC nomogram indirectly.

The MSKCC nomogram is a useful tool that could accurately predict the probability of SLN metastasis in early breast cancer patients. The patients with a predictive value of very high or very low probability of SLN metastasis are unlikely to benefit from SLNB but result in higher costs and postoperative morbidity. Several studies showed that axillary surgery could be avoided when the MSKCC predictive value is 10%, but the clinical utility of this standard is limited because the ratio of beneficial patients is lower among the SLNB crowds (average 5%). In this study, patients with a predictive value < 12% had no SLN metastasis. When the predictive value equal to 12%, the positive rate of SLNs was nearly 14.3%, compared with the false-negative rate of SLNs of 8.4% (0–29%) that reported by ASCO[31], which we could consider to avoid ALND either. Patients with predictive values larger than 80% had a frequency of SLN metastasis of 78.3%, and they could carry out ALND directly. We considered that the probability of SLN involvement of < 12% or > 80% was an acceptable cut-off value to select candidates who may avoid SLNB with the MSKCC nomogram, and 8.97% (68/758) of patients could benefit from the new standard. However, the AUC of MSKCC nomogram when applying to Thai patients was 0.73 which meant that the test was fair accuracy. Siriraj nomogram was developed from our significant risk factors. Its AUC was 0.76 which higher than MSKCC nomogram (0.73). Whereas the cut point of AUC of any reliable test was 0.75.

The best statistic tool is when the AUC is near 1, so the MSKCC nomogram (AUC = 0.730–0.780) should be improved. Reyal et al. found that the interaction covariate between ER and HER2 status was a stronger predictor ($p = 0.0031$) of positive SLNB than the ER status itself ($p = 0.016$). They developed a multivariate model to determine the probability of SLN positivity defined with the following variables: tumor size, lymphovascular invasion, molecular subtypes and age at diagnosis. This model showed similar results in terms of discrimination (AUC = 0.72, 0.73, 0.72) in the training and validation sets[23]. The AUCs for our study population were 0.73, 0.77, 0.76 respectively (the MSKCC predictive value, actual predictive value and Siriraj predictive value of SLN metastasis).

Conclusions

In Thai population, the MSKCC nomogram is a useful tool that could accurately predict the probability of SLN metastasis but should be calibrated to be valid and definitive. Predictive model using our data should be suitable for Thai breast cancer patients, but our results have been obtained from the retrospective analysis, a prospective validation should be performed to assess its ability for preoperative discrimination.

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บทคัดย่อ **ปัจจัยที่ใช้พยากรณ์การแพร่กระจายของโรคไปยังต่อมน้ำเหลืองเซนติเนล และการตรวจสอบเพื่อยืนยันกราฟโนโมแกรม MSKCC ในผู้ป่วยโรคมะเร็งเต้านมชาวไทย**

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วัตถุประสงค์: เพื่อคำนวณปัจจัยเสี่ยงในการแพร่กระจายของโรคไปยังต่อมน้ำเหลืองเซนติเนลและตรวจสอบค่าที่คำนวณได้จากโนโมแกรม MSKCC เพื่อการพยากรณ์การแพร่กระจายของโรคไปยังต่อมน้ำเหลืองเซนติเนลในผู้ป่วยมะเร็งเต้านมในไทย

วัสดุและวิธีการ: มีการวิเคราะห์ฐานข้อมูลการผ่าตัดเลาะต่อมน้ำเหลืองเซนติเนลจากผู้ป่วย 760 ราย โดยค่าพยากรณ์ที่ได้จากโนโมแกรม MSKCC ถูกนำมาคำนวณเพื่อหาแนวโน้มและพื้นที่กราฟใต้ความสัมพันธ์ระหว่างผลบวกจริง (Sensitivity) กับ ผลบวกลวง (Specificity) (ROC curve) ในขณะเดียวกันตัวพยากรณ์การแพร่กระจายของโรคไปยังต่อมน้ำเหลืองเซนติเนลก็ถูกนำมาประเมินเช่นกัน

ผลการศึกษา: ขนาดของเนื้องอก ชนิดของเนื้องอก บริเวณที่เกิดเนื้องอก ความสัมพันธ์กับการลุกลามของเซลล์มะเร็งเข้า สู่ต่อมน้ำเหลือง การลุกลามไปยังรอบๆ เส้นประสาท การเกิดเซลล์มะเร็งหลายๆ ตำแหน่ง หรือสถานะของตัวรับฮอร์โมนโปรเจสเตอโรน ล้วนเป็นปัจจัยพยากรณ์อิสระของการแพร่กระจายของโรคไปยังต่อมน้ำเหลืองเซนติเนล ($p < 0.05$) กราฟโนโมแกรม MSKCC ยังแสดงให้เห็นว่า พื้นที่กราฟใต้ความสัมพันธ์ระหว่าง ผลบวกจริง (Sensitivity) กับ ผลบวกลวง (Specificity) (ROC curve) มีค่าเท่ากับ 0.73 ผู้ป่วยที่ค่าคำนวณน้อยกว่าร้อยละ 12 มีค่าความถี่ในการกระจายของโรคไปยังต่อมน้ำเหลืองเซนติเนลเป็นร้อยละ 0 ในขณะที่ผู้ป่วยที่ค่าคำนวณมากกว่าร้อยละ 80 มีค่าความถี่ในการกระจายของโรคไปยังต่อมน้ำเหลืองเซนติเนลเป็นร้อยละ 78.3

สรุปผลการศึกษา: ปัจจัยเสี่ยงในการแพร่กระจายของโรคไปยังต่อมน้ำเหลืองเซนติเนลในการศึกษาวิจัยครั้งนี้ มีความคล้ายการศึกษาที่ทำในกราฟโนโมแกรม MSKCC บางส่วน โดยกราฟโนโมแกรม MSKCC นับเป็นเครื่องมือที่ใช้ในการพยากรณ์การแพร่กระจายของโรคไปยังต่อมน้ำเหลืองเซนติเนลที่มีแม่นยำและมีประโยชน์ในผู้ป่วยมะเร็งเต้านม การผ่าตัดเลาะต่อมน้ำเหลืองที่รักแร้สามารถหลีกเลี่ยงได้หากค่าคำนวณของผู้ป่วยจากกราฟมีค่าน้อยกว่าร้อยละ 12 และอาจมีการผ่าตัดเลาะต่อมน้ำเหลืองที่รักแร้หากค่าคำนวณมากกว่าร้อยละ 80 ในขณะที่การผ่าตัดเลาะต่อมน้ำเหลืองเซนติเนลอาจต้องทำในผู้ป่วยรายอื่นๆ