


ORIGINAL ARTICLE

Osteopontin, GLUT1 and Ki-67 expression in malignant peritoneal mesothelioma: prognostic implications

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peritoneal mesothelioma, survival, immunohistochemistry, osteopontin, GLUT1, Ki-67.

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Abstract

Background: Malignant peritoneal mesothelioma is the most common primary peritoneal neoplasm. The only universally recognised pathological prognostic factor is histopathological subtype. Prognostic markers based on patient features and clinical stages have been disappointing.

Aims: To assess the prognostic role of several clinicopathological features in a retrospective cohort of 60 patients diagnosed with peritoneal mesothelioma.

Methods: Sixty patients were centrally collected and were immunohistochemically analysed for the expression of osteopontin (OPN), GLUT1 and Ki-67. Labelling was assessed by two pathologists. Complete clinical information and follow-up were obtained from patients' records.

Results: OPN expression was identified in 52 (86.6%) of 60 specimens, and GLUT1 in 39 (65%) of 60 specimens. Univariate Cox regression analysis showed that a lower peritoneal carcinomatosis index (PCI), tumour-directed treatment (chemotherapy or surgery alone or in any combination), lower Ki-67, GLUT1 and lower OPN expression had a statistically significant positive effect on overall survival (OS). PCI (hazard ratio (HR) = 1.032 (95% confidence interval (CI): 1.000–1.067); $P = 0.054$) and tumour-directed treatment (HR = 0.211 (95% CI: 0.104–0.430); $P < 0.001$), Ki-67 (HR = 22.326 (95% CI: 3.523–141.498); $P = 0.003$) and OPN (HR = 7.268 (95% CI: 1.771–29.811); $P = 0.009$) retained independent prognostic significance in the multivariate analysis, all with a positive effect on OS with the exception of GLUT1.

Conclusions: OPN, Ki-67, treatment and PCI were independent indicators for OS, and a higher level of OPN expression correlated significantly with poorer OS.

Introduction

Malignant peritoneal mesothelioma (MPeM) is a very rare malignancy of serosal membranes and is associated with asbestos exposure. The epidemiological data on malignant mesothelioma vary widely worldwide, with an incidence of 4.5 cases per million in East China,¹ that is increasing mainly due to asbestos exposure. Although a multimodal therapeutic approach improves the response to treatment and survival, the prognosis is poor, with a median survival time rarely exceeding 12 months.^{2,3} Prognostic markers based on patient features and clinical stages have been disappointing. In this study, we focussed on histological and immunohistochemical variables of importance in

other tumours but that have been rarely studied before in MPeM.

Ki-67 is a nuclear protein that is detectable in every phase of the cell cycle of proliferating cells but is absent in quiescent cells.⁴ Most studies have indicated that high expression of Ki-67 leads to a poor prognosis. At present, Ki-67 is commonly used as a predictive and prognostic marker in several cancer types such as gastric,⁵ colorectal⁶ and malignant pleural mesothelioma (MPM).⁷

Osteopontin (OPN) is a secreted glycoprotein that has critical roles in several biological processes, such as cell-matrix interactions, immunological regulation, tumour development and cell migration.^{8–11} Mean plasma OPN values were significantly higher in MPM patients than in controls and patients suffering with benign respiratory disease.¹² Cappia *et al.* found that immunohistochemical OPN expression was an independent prognostic predictor for overall survival (OS) in MPM.¹³

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GLUT1 is a member of the glucose transporter isoform family that can usually be detected in erythrocytes, the blood–brain barrier and the placenta but rarely in other organs. Its prognostic role has been shown in several cancers.^{14,15} For mesothelioma, GLUT1 is mainly used to differentiate tumour tissue from reactive mesothelium.¹⁴

The aims of the present study were therefore to evaluate the possible prognostic value of OPN and GLUT1 expression in MPeM patients and to elucidate the correlation between OPN and GLUT1 expression levels and clinical features.

Methods

Patients and tumour tissue samples

A total of 60 patients diagnosed with MPeM from October 2012 to October 2018 at Cangzhou Central Hospital was included in this study. Clinical information on patient demographics, asbestos exposure, treatments, follow-up and outcome was retrieved from patient medical records. The histopathological diagnosis criteria for MPeM were established according to the guidelines.¹⁶ The stage of MPeM was evaluated by a novel ‘TNM’ staging system proposed in 2011 by Yan *et al.*,¹⁷ which was based on extent of peritoneal disease burden (T), intra-abdominal nodal metastasis (N) and extra-abdominal metastasis (M). The T stage is determined by calculating the peritoneal carcinomatosis index (PCI). PCI scores of 1–10, 11–20, 21–30 and 31–39 correspond to T stages of 1, 2, 3 and 4, respectively. Stage I disease included T1N0M0, stage II included T2–3N0M0 and stage III included T4N0M0 and any N/M-positive disease. Formalin-fixed paraffin-embedded tumour tissue samples were retrieved from the archives of the Pathology Department and clinical information on patient sex, age at diagnosis, asbestos exposure, follow-up and outcome was retrieved from patient medical records. Patients did not receive any treatment prior to biopsy, since tissue specimens were collected for diagnostic purposes. The study was approved by the Medical Ethics Committee of Cangzhou Central Hospital (approval ref. no. 2012-012-01) and was carried out in accordance with the Declaration of Helsinki. This study was funded by Cangzhou Finance Bureau. No conflict of interest exists in this manuscript.

Table 1 Primary antibodies used for immunohistochemistry

| Target | Description | Manufacturer | Dilution |
|--------|--------------------------------|-----------------|----------|
| OPN | Mouse monoclonal, clone AkmZA1 | ZSGB-Bio, China | 1:100 |
| GLUT-1 | Rabbit polyclonal | ZSGB-Bio, China | 1:200 |
| Ki-67 | Rabbit monoclonal, clone EP5 | ZSGB-Bio, China | 1:200 |

OPN, osteopontin.

Immunohistochemical analyses

Three consecutive 4- μ m-thick tissue sections were cut from each paraffin block, and used for immunohistochemical staining of OPN, GLUT1 and Ki-67. Briefly, a 4- μ m tissue section of each specimen was placed on a poly-L-lysine-coated slide, deparaffinised and rehydrated. Antigen retrieval was performed by heating in a pressure cooker in citrate buffer (pH 6.0). Primary antibodies (Table 1) were allowed to bind to targets, followed by a standard ABC immunohistochemistry protocol using a biotinylated secondary antibody (ZSGB-Bio, China), horseradish peroxidase as marker and diaminobenzidine as a chromogen (ZLI-9019, ZSGB-Bio). Slides were counterstained with haematoxylin. The same protocol was followed for negative controls, with omission of the primary antibody. Positive control tissues were used. Staining was performed as described earlier.

Immunoreactivity evaluation

The immunostained sections were examined by two authors (X. Guo and L. Tian) without knowledge of the patients' characteristics. Cases with discrepancies were jointly re-evaluated until a consensus was reached. At least 200 cells were scored per $\times 40$ field. Sections of OPN and GLUT1 staining were scored semi-quantitatively for immunoreactions as follows: 0, <5% of immunoreactive cells; 1+, 5–25% of immunoreactive cells; 2+, 26–50% of immunoreactive cells; and 3+, >50% of immunoreactive cells. Reactive grade 0 was defined as negative, and reactive grade 1+, or 2+, or 3+ was defined as positive. Ki-67 labelling index (Ki-67LI) was determined as a percentage after counting the total number of positive cells per 1000 tumour cells. Lower Ki-67LI was defined as $\leq 10\%$, and higher Ki-67LI as $> 10\%$.

Statistical analyses

OS was calculated from the time of initial diagnosis to death or last follow-up and expressed in months. Mean OS and the upper and lower limits of the confidence intervals (CI) are given. Mann–Whitney *U*-tests were used to compare two and more than two groups. Correlations between parameters were tested by calculation of the Spearman rank correlation coefficient (Spearman's

Table 2 Osteopontin (OPN) and GLUT1 immunostaining results

| | OPN, intensity | | | | GLUT1, intensity | | | | Asbestos exposure | | Treatment | | |
|--------|----------------|----|----|----|------------------|----|----|----|-------------------|----|-----------|-------|----|
| | 0 | 1+ | 2+ | 3+ | 0 | 1+ | 2+ | 3+ | Yes | No | BSC | HIPEC | SC |
| Number | 8 | 16 | 23 | 13 | 21 | 20 | 15 | 4 | 52 | 8 | 22 | 32 | 6 |

BSC, best supportive care; HIPEC, heated intraperitoneal chemotherapy; SC, systemic chemotherapy.

rho). Comparative analysis of OPN and GLUT1 expression with the patients' clinicopathological characteristics was analysed using the Mann–Whitney *U*-test. The *P*-value for the statistical significance was set at 0.05. All above statistical tests were conducted using *spss* software (v23; *spss*, IBM). We used R statistical software (version 3.5.2) to perform the survival analysis, specifically the 'survival' package. The least absolute shrinkage and selection operator (LASSO) method was used to select the optimal predictive features in risk factors from the patients. Features with non-zero coefficients in the LASSO regression model were selected. Then, univariate Cox regression analysis was used to assess the prognostic significance of selected clinicopathological characteristics ($P < 0.1$). The hazard ratios (HR) were calculated in a multivariable Cox model including parameters significantly associated with OS in the univariate analysis. The *P*-value for the statistical significance of these tests was set at 0.05.

Results

Patients

In total, 60 patients were evaluated in this study, 22 of which were male and 38 were female. The median patient age at diagnosis was 62 years (range, 42–84 years). Asbestos exposure was documented for 52 (86.7%) patients; 35 (59%) patients had been exposed professionally and 17 (27.7%) patients environmentally. Thirty cases were epithelioid (50%), and 30 cases were non-epithelioid (50%). The mean PCI was 27.55 (range 3–39). According to the novel 'TNM' staging system, five (8.3%) patients were stage I, 47 (78.3%) patients were stage II and eight (13.3%) patients were stage III. Most patients (63.3%) received tumour-directed treatment, that is chemotherapy or surgery alone or in any combination, whereas the remaining patients received best supportive care or were not treated, mainly due to comorbidities, advanced disease stage or poor performance status. Median OS was 6 months (range, 1–48 months). Five patients were still alive at the time of the final analysis. Clinical information is detailed in Table 2.

Correlations and differences between OPN, GLUT1 and Ki-67 expression and clinicopathological parameters

OPN and GLUT1 expression results are detailed in Table 2, and representative specimens are shown in Figure 1. Staining of OPN and Ki-67 was nuclear, while that of GLUT1 was cytomembranous. OPN was expressed in 52 (86.6%) of 60 specimens, and GLUT1 in 39 (65%) of 60 specimens. Ki-67 was expressed in all specimens (range 0.01–0.8, mean 0.192, standard deviation 0.1654, median 0.15). Spearman's rho analysis revealed GLUT1 expression was related to both histological type and Ki-67LI ($r = -0.259$, $P < 0.05$; $r = 0.324$, $P < 0.05$; Table 3), and OPN expression was related to PCI ($r = 0.267$, $P < 0.05$; Table 3). Mann–Whitney *U*-test also confirmed that GLUT1 expression varied among histological type and Ki-67LI groups ($P = 0.047$ and $P = 0.003$, respectively; Table 3), and OPN expression differed in the Ki-67LI groups ($P = 0.04$; Table 3).

Survival analysis

Among the texture features, 11 features were reduced to nine potential predictors based on 60 patients in the primary cohort and were identified as features with non-zero coefficients in the LASSO logistic regression model (Table 4). The univariate Cox regression analysis showed that female sex, a lower PCI, tumour-directed treatment, lower Ki-67, GLUT1 and lower OPN had a statistically significantly positive effect on OS (Fig. 2). However, PCI (HR = 1.032 (95% CI: 1.000–1.067); $P = 0.054$) and tumour-directed treatment (HR = 0.211 (95% CI: 0.104–0.430); $P < 0.001$), Ki-67 (HR = 22.326 (95% CI: 3.523–141.498); $P = 0.003$), and OPN (HR = 7.268 (95% CI: 1.771–29.811); $P = 0.009$) retained independent prognostic significance in the multivariate analysis, all with a positive effect on OS (Table 5). The model that incorporated the above independent predictors was developed and presented as the nomogram (Fig. 3).

Discussion

MPeM is a rare disease with poor clinical outcome. The natural history of mesothelioma results in a median

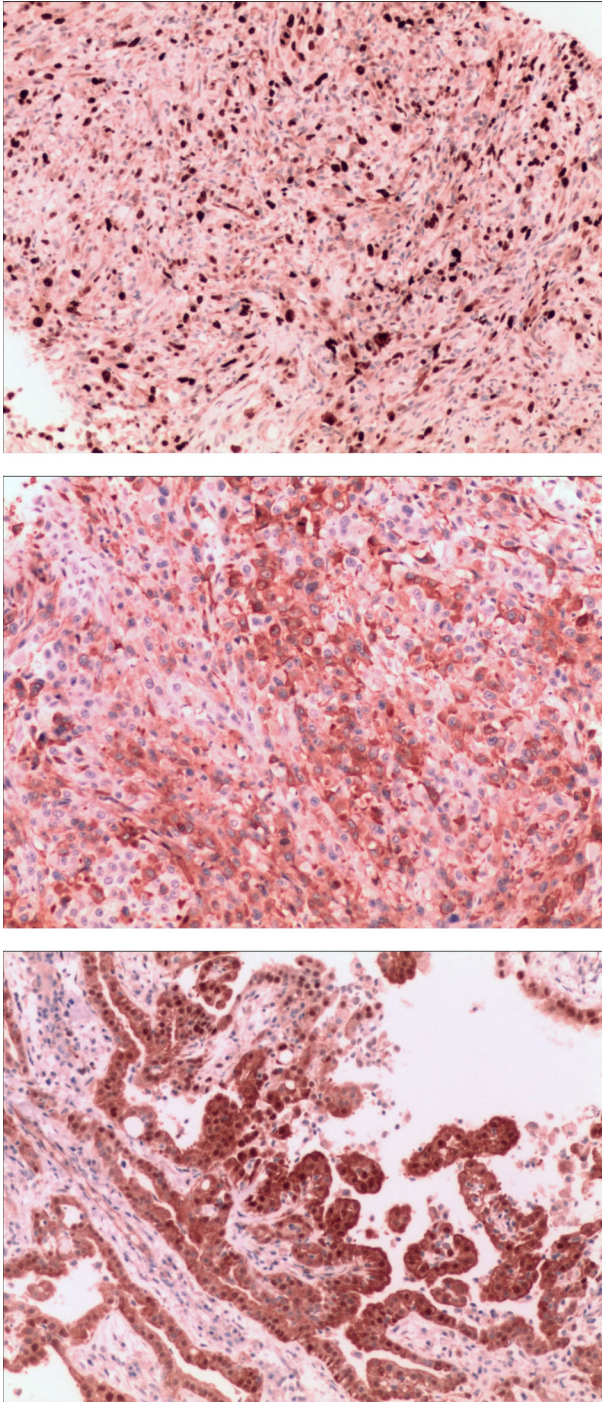


Figure 1 Representative pictures of the immunohistochemistry: expression of Ki-67, GLUT1 and osteopontin in malignant peritoneal mesothelioma.

survival of 7–9 months.¹⁸ Highly selected patients with early stage epithelioid disease, treated with cyto-reduction, either alone or in combination with chemotherapy and/or radiation therapy, have a median

survival of up to 2 years.¹⁹ There is a need to define more accurately the prognosis of this disease at diagnosis to better determine the therapeutic strategy for each patient. Furthermore, this can help clinicians to determine patients who might need closer monitoring, or start systemic treatment earlier.

In the past, several prognostic factors have been evaluated for MPeM such as sex, histology, PCI, age at diagnosis, mitotic rate, platelet count and pre-operative CA-125. Among these markers, sarcomatoid histology, high PCI and age older than 60 years²⁰ at diagnosis have been correlated to poor survival. Vigneswaran *et al.* found that the percentage of epithelioid differentiation is an independent predictor of survival in MPM and should be taken into careful consideration when recommending surgical treatment for patients with biphasic MPM.²¹ While in this study we found that age, sex, histological type or TNM stage did not affect OS in the univariate analysis. The explanation for this finding may be that the incidence of MPeM was higher in females than in males in this region. There is a predominance of the female patient population compared with previous studies, and this is accounted for by the fact that women were involved in large handspun asbestos processes in this area. The exposure time and intensities were higher in females than in males. In our study, 22 (36%) patients were male and 38 (63.3%) patients were female.

For most tumours, depth of tumour invasion, tumour differentiation, number of lymph nodes in the metastatic field and tumour location were of prognostic significance. MPeM shows local aggressiveness and rare distant metastases.^{22–24} The PCI was an assessment of the distribution and extent of MPM in 13 abdominopelvic regions, and represents tumour burden. Numerous studies have supported PCI as a prognostic factor.^{25,26} In comparison to most previous reports, PCI was recorded by computed tomography (CT) because most patients are not treated with surgery. Ahmed *et al.* found that CT and laparoscopy seems to be effective tools for assessment of peritoneal carcinomatosis using the PCI score, has no statistically significant differences regarding total PCI score compared to surgery.²⁷ In addition, the PCI is based on observer estimation either surgical or radiological. If interpreted carefully by a trained radiologist they will still be useful for comparative purposes. In this study, univariate Cox regression analysis showed that lower PCI had statistically significant positive effects on OS, and a further multivariate Cox regression analysis confirmed these correlations. This is similar to previous studies.

Table 3 Correlation and differences of osteopontin (OPN) and GLUT1 expression with clinicopathological parameters and Ki-67LI in patients with malignant peritoneal mesothelioma

| | No. | OPN | | | | | GLUT1 | | | | | | |
|-------------------|-----|----------------|----|----|----|-------------------------|----------|----------------|----|----|----|---------------------------|----------|
| | | Reactive grade | | | | P-value† | P-value‡ | Reactive grade | | | | P-value† | P-value‡ |
| | | 0 | 1+ | 2+ | 3+ | | | 0 | 1+ | 2+ | 3+ | | |
| Age (years) | | | | | | | | | | | | | |
| ≤60 | 25 | 5 | 5 | 10 | 5 | 0.808; <i>r</i> = 0.032 | 0.666 | 11 | 7 | 7 | 0 | 0.055; <i>r</i> = 0.249 | 0.219 |
| >60 | 35 | 3 | 11 | 13 | 8 | | | 10 | 13 | 8 | 4 | | |
| Sex | | | | | | | | | | | | | |
| Male | 22 | 4 | 7 | 7 | 4 | 0.268; <i>r</i> = 0.145 | 0.264 | 7 | 7 | 6 | 2 | 0.550; <i>r</i> = -0.079 | 0.545 |
| Female | 38 | 4 | 9 | 16 | 9 | | | 14 | 13 | 9 | 2 | | |
| Histological type | | | | | | | | | | | | | |
| Epithelioid | 30 | 4 | 5 | 14 | 7 | 0.3; <i>r</i> = -0.136 | 0.296 | 6 | 13 | 8 | 3 | 0.046*; <i>r</i> = -0.259 | 0.047* |
| Non-epithelioid | 30 | 4 | 11 | 9 | 6 | | | 15 | 7 | 7 | 1 | | |
| Ki-67LI | | | | | | | | | | | | | |
| Lower | 30 | 3 | 11 | 11 | 5 | 0.322; <i>r</i> = 0.13 | 0.403 | 16 | 9 | 3 | 2 | 0.012*; <i>r</i> = 0.324 | 0.003* |
| Higher | 30 | 5 | 5 | 12 | 8 | | | 5 | 11 | 12 | 2 | | |
| PCI | | | | | | | | | | | | | |
| PCI ≤ 27.5 | 25 | 6 | 7 | 8 | 4 | 0.04*; <i>r</i> = 0.267 | 0.069 | 9 | 10 | 5 | 1 | 0.51; <i>r</i> = 0.087 | 0.478 |
| PCI > 27.5 | 35 | 2 | 9 | 15 | 9 | | | 12 | 10 | 10 | 3 | | |

**P* < 0.05.

†Spearman rank correlation coefficient.

‡Mann-Whitney *U*-test.

PCI, peritoneal carcinomatosis index.

Thus far, there are few effective treatments for peritoneal mesothelioma. Treatment is not standardised and includes best supportive care, systemic chemotherapy, heated intraperitoneal chemotherapy (HIPEC) and cytoreductive surgery (CRS). Our study showed that tumour-directed treatment, especially systemic chemotherapy with pemetrexed alone or in combination with cisplatin, and HIPEC with cisplatin had a statistically significant positive effect on OS by univariate and multivariate Cox regression. Sugarbaker *et al.* found that long-term regional chemotherapy was associated with improved survival in patients with MPeM.²⁸ As reported earlier,^{29,30} CRS and HIPEC for patients with MPeM should improve disease control and increase survival. In our study there were only two patients with CRS; this is a limitation of our study.

Ki-67 is a nuclear protein that is utilised as a proliferation marker in tumour specimens. Ki-67 staining of cytological preparations from pleural effusions has been studied as a potential diagnostic marker to discriminate between reactive mesothelial cells and mesothelioma.³¹ In this study, lower Ki-67 was associated with better OS, and multivariate Cox regression analysis confirmed this correlation. However, Ghanim *et al.* reported that Ki-67 index is an independent prognostic factor in epithelioid

but not in non-epithelioid MPM in a multicentre study.⁷ Thus a larger sample size is required in further studies.

GLUT1 is a member of the glucose transporter isoform family and facilitates the entry of glucose into cells.³² Hommel-Fontaine *et al.* revealed that GLUT1 expression is an indicator of poor prognosis in diffuse MPeM.³³ To date, there have been reports of GLUT1 expression mainly in pleural mesothelioma and its differential diagnosis, but few in peritoneal mesothelioma. Our study found that GLUT1 was expressed in 39 (65%) of 60 peritoneal mesothelioma specimens. We found that GLUT1 expression varied among histological type and Ki-67LI groups. GLUT1 may have a role in the differential diagnosis of MPeM. Also, there was a significant correlation between GLUT1 expression and OS (*P* > 0.05) in univariate Cox regression analyses, but there was no correlation in multivariate Cox regression analyses. Therefore, GLUT1 might not be an independent potential prognostic factor but a potential differential diagnosis factor for a certain MPeM.

OPN is a glycoprotein that is over-expressed in several human neoplasms such as lung, breast and colon cancer.³⁴ It can be detected in serum, plasma, urine and other bodily fluids as well as in tumour tissue. For OPN, tumour expression and blood levels are associated with poor outcome or an aggressive phenotype in

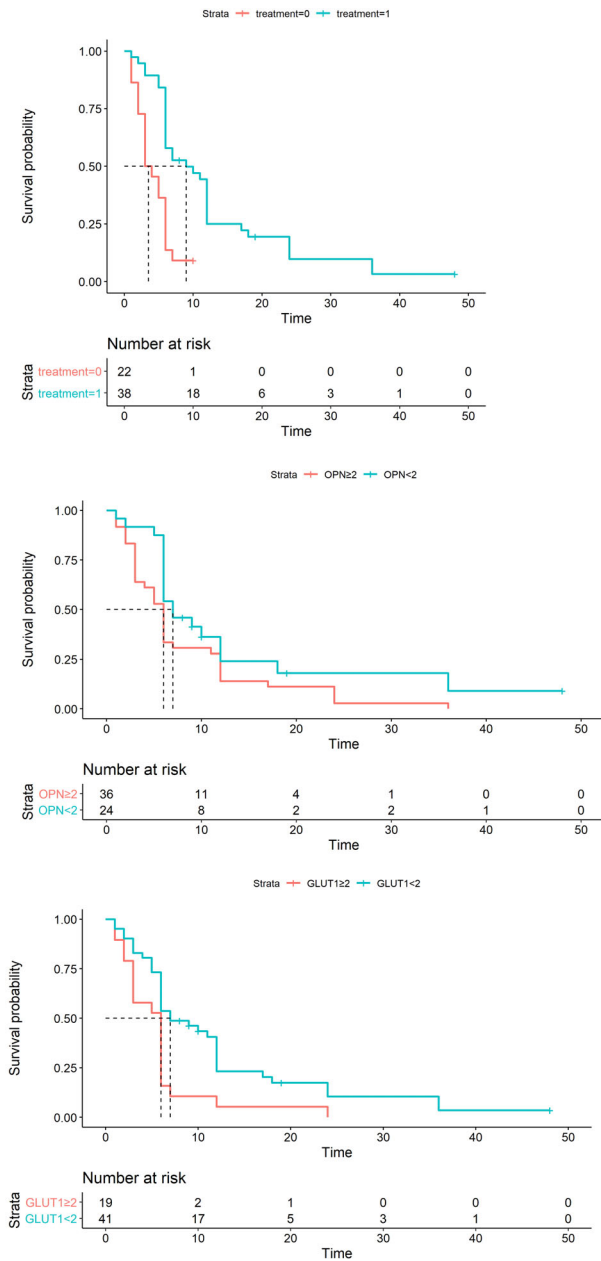


Figure 2 The univariate cox regression analysis showed that female sex, a lower peritoneal carcinomatosis index, tumour-directed treatment, lower Ki-67, GLUT1 and lower osteopontin (OPN) had a statistically significantly positive effect on OS. (A) (—+), Treatment = 0; (—+), treatment = 1. (B) (—+), OPN ≥ 2; (—+), OPN < 2. (C) (—+), GLUT1 ≥ 2; (—+), GLUT1 < 2.

a variety of malignancies, including mesothelioma.^{13,35} Hollevoet *et al.* reported that baseline blood OPN levels were an independent negative predictor of survival in pleural mesothelioma.³⁶ Also, OPN could discriminate

Table 4 The least absolute shrinkage and selection operator selected nine variables: gender, age, peritoneal carcinomatosis index (PCI), treatment, treatment protocols, asbestos, Ki-67, osteopontin (OPN) and GLUT1

| Variable | Coefficient |
|---------------------|--------------|
| Histopathology | 0 |
| Gender | 0.237711585 |
| Age | 0.003406116 |
| PCI | 0.037926980 |
| TNM stage | 0 |
| Treatment | -0.371435667 |
| Treatment protocols | -0.592325376 |
| Asbestos | 0.071049965 |
| Ki-67 | 1.521044111 |
| OPN | 0.134265441 |
| GLUT1 | 0.045488932 |

between asymptomatic asbestos-exposed individuals and early stage MPM patients.³⁷ In our study, we found that OPN expression correlated with PCI or tumour burden, which may be the reason that OPN can be used to distinguish early stage MPM patients from asbestos-exposed individuals and predict prognosis of MPeM. Furthermore, it may help to distinguish tumour stage.

To our knowledge, this is the first study to investigate the relationship between OPN expression and clinicopathological variables and MPeM patient prognosis. We found that OPN expression was not associated with age, sex or histological type, but higher OPN expression correlated with PCI or tumour burden. Moreover, higher expression of OPN was significantly associated with a poorer OS in MPeM cases. In agreement with the literature, the multivariate Cox regression analysis further identified OPN expression, PCI, Ki-67 and treatment (best standard of care vs tumour-directed treatment) as independent prognostic factors in MPeM patients. Thus, we identified OPN as a diagnostic and prognostic biomarker for MPeM.

In addition, OPN expression and blood levels are positively correlated with tumour stage, progression, invasion and metastasis.³⁸ Given the results of this study, OPN was an independent negative predictor of OS, suggesting a potential predictive role for distinguishing tumour stage. However, this needs to be tested in a prospective study. Due to the relatively lower number of cases, most of the treatment data have been based on retrospective reports of single-institution experiences, further large sample investigations are necessary in order to improve statistical power and validate the precise histological subtypes statistical difference.

Table 5 Univariate and multivariate cox regression analyses of prognostic parameters in patients with malignant peritoneal mesothelioma

| Clinical features | Univariate analysis | | Multivariate analysis | |
|---------------------------------|-----------------------|---------|------------------------|---------|
| | HR and 95% CI | P-value | HR and 95% CI | P-value |
| Age | 1.009 (0.981–1.038) | 0.525 | | |
| Gender (male vs female) | 1.518 (0.854–2.698) | 0.155 | | |
| Peritoneal carcinomatosis index | 1.047 (1.019–1.077) | 0.001 | 1.032 (1.000–1.067) | 0.054 |
| Treatment | | | | |
| 1 | 0.300 (0.159–0.568) | <0.001 | 0.211 (0.104–0.430) | <0.001 |
| 0 | 1 | | | |
| Treatment protocols | | | | |
| 2 | 0.198 (0.066–0.587) | 0.001 | | |
| 1 | 0.322 (0.168–0.615) | | | |
| 0 | 1 | | | |
| Asbestos exposure (yes vs no) | 0.957 (0.429–2.135) | 0.915 | | |
| Ki-67 | 18.474 (3.650–93.508) | <0.001 | 22.326 (3.523–141.498) | 0.003 |
| OPN | | | | |
| 3 | 5.790 (1.595–21.026) | 0.053 | 7.268 (1.771–29.811) | 0.009 |
| 2 | 5.034 (1.486–17.045) | | 4.138 (1.082–15.919) | 0.038 |
| 1 | 5.431 (1.518–19.431) | | 6.048 (1.545–23.666) | 0.006 |
| 0 | 1 | | 1 | |
| GLUT1 | | | | |
| 3 | 1.264 (0.428–3.773) | 0.060 | | |
| 2 | 2.418 (1.194–4.896) | | | |
| 1 | 0.997 (0.516–1.927) | | | |
| 0 | 1 | | | |

Statistical significance ($P < 0.05$). P-value in univariate Cox regression was set to 0.1. Treatment: 0 = best supportive care; 1 = chemotherapy treatment. Treatment protocols: 0 = best supportive care; 1 = HIPEC; 2 = systemic chemotherapy. OPN and GLUT1: 0 = negative; 1 = 1+; 2 = 2+; 3 = 3+. CI, confidence interval; HR, hazard rate; OPN, osteopontin.

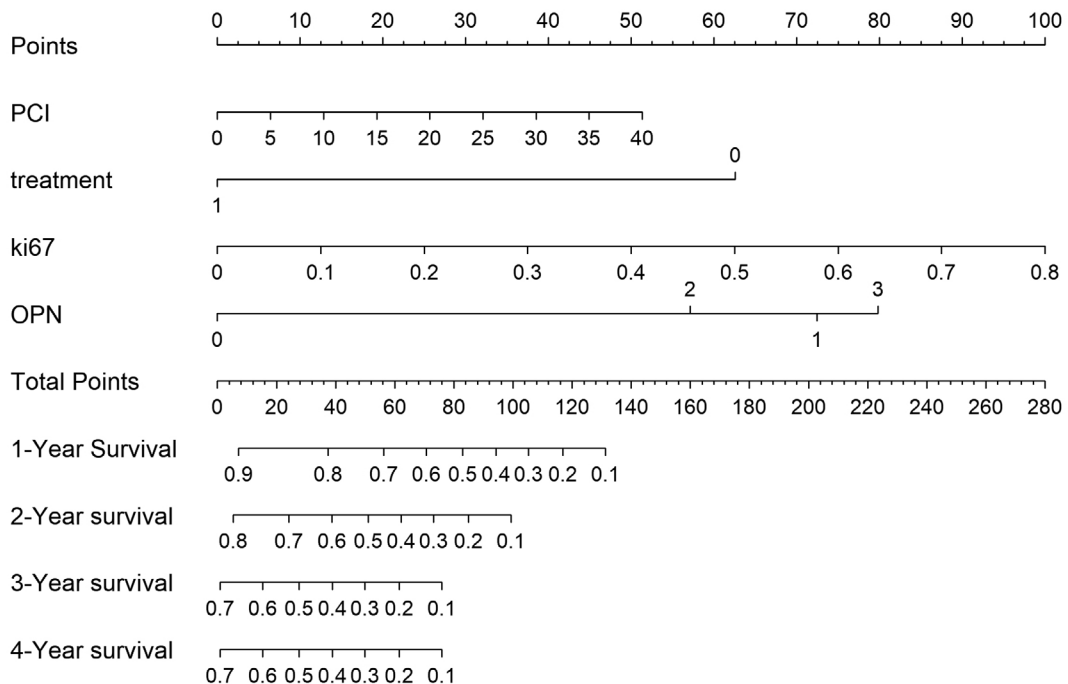


Figure 3 Developed radiomics nomogram. The radiomics nomogram was developed in the primary cohort, with peritoneal carcinomatosis index, treatment, Ki-67, osteopontin incorporated.

Conclusions

We found a high level of GLUT1 expression in MPeM patients. Although GLUT1 expression was not an independent indicator for survival, it may be a possible differential diagnosis factor for a certain subtype MPeM. OPN,

Ki-67, treatment and PCI were independent indicators for OS, and a higher level of OPN expression correlated significantly with poorer OS. This result warrants further prospective studies on OPN as a predictive and distinguish tumour stage marker in MPeM.

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