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Review Article

Is it necessary to revise the metastatic spine surgery scores for lung cancer?

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Abstract

Lung cancer and lung cancer related metastatic spine disease had for many years a poor prognosis. However, after the introduction of molecule targeted agents into the treatment of lung cancer the survival has been prolonged. The prognostic scores, mainly represented by the revised Tokuhashi Score, that have been used in the last decades to predict the survival of the patients and guide the choice of the optimal treatment, classify the patients into short term (<6 months), intermediate (6-12 months) and long term (>12 months) survivors and recommend conservative or surgical treatment accordingly. These scores have not been revised lately and there is a great concern that this improvement in survival of lung cancer patients is not reflected in the calculated scores. This is a review of the literature concerning the accuracy and validity of the current metastatic spine surgery scores in relation to lung cancer derived spinal metastases. Broad consensus exists about the need to revise the current scores and develop new ones specifically for lung cancer.

Keywords: Lung Cancer, Prognostic Scores, Spine Metastases, Surgery Scores, Tokuhashi Score

Introduction

Metastatic spine surgery scores have been guiding the choice of treatment for cancer patients with spinal metastases the last decades. Most of these scores have been introduced at least a decade ago and have not been revised since then despite the development of effective treatments that have a positive impact on survival. The improvement in the survival of cancer patients and specifically lung cancer patients the last decades has been significant and has led to the fact that in many cases these scoring systems fail to predict the survival of cancer patients with spinal metastases accurately. This observation raised the question whether there is a need to validate the accuracy of these scoring systems.

Methods

A literature review was conducted to evaluate the accuracy of the current metastatic spine surgery prognostic scores. Eligible studies were selected through title, abstract and full text consideration. The following expressions were used as keywords: lung cancer spine metastases, metastatic spine surgery prognostic scores, metastatic spine disease, vertebral metastases and prognostic scores, spine metastases and prognostic scores. Only papers in English language were included.

Lung cancer and spinal metastases

Lung cancer is one of the most common types of cancer worldwide and is responsible for the greater amount of cancer related deaths[1]. The lung carcinomas have

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been classified into two main groups based on how they respond to the available treatment and also the likelihood of metastases. Small cell lung carcinoma (SCLC) that is more often metastatic quite early on and responds well to initial chemotherapy and non-small cell lung carcinomas (NSCLC) that are less often metastatic but they are also less responsive to the available initial treatment. There are three histological types of lung cancer that belong to NSCLC. These types are the adenocarcinoma (AD) which is the most common one, the squamous cell carcinoma (SCC) and the large cell carcinoma (LCC). The NSCLC account for more than 80-85% of all lung cancers and 30% to 40% of NSCLC patients develop bone metastases with the vertebral column being the most common site[2].

Metastatic spine tumors derived from lung cancer progress rapidly. For many years they had a poor prognosis since lung cancer was considered more aggressive than other cancers that metastasize to the spine. Breast, prostate, thyroid and kidney tumors are also likely to give metastases to the spine[3]. The primary symptom of spinal metastases is usually local pain but pathological fractures, spinal instability, deformity, and neurological compromise due to spinal cord compression, are also very common. All these leads inevitably to a decrease of the quality of life of the patient. The main goal of the treatment of these patients is to improve the quality of life and to extend the survival of the patient.

Treatment options include chemotherapy, radiotherapy and surgical management that can vary from palliative surgery up to radical excision. Palliative surgery is usually selected for pain management, to decompress the spinal cord or a nerve root, in the case of spinal instability and also if the surgery is expected to improve the survival of the patient. Radical excision is usually preferred in selected cancers when there is a secluded spinal metastasis and mostly in younger patients. Palliative procedures include posterior decompression and instrumentation, posterior decompression without instrumentation, anterior decompression and instrumentation, while excisional procedures include spondylectomies.

Molecule targeted agents and bone modifying agents in the treatment of lung cancer

Lung cancer patients have been considered to have worse prognosis than patients with other primary cancers that metastasize to the spine and as a result these patients were treated conservatively in many cases. However, the survival of lung cancer patients and lung cancer derived metastatic spine tumors has been significantly improved since molecule targeted agents such as gefitinib, erlotinib, crizotinib, afatinib, osimertinib and bone modifying agents (BMA) such as denosumab and zolendronic acid have been introduced to the treatment. It is observed that many patients pass the one-year survival prediction that was considered to be the best possible outcome for many years[4].

Genomically driven treatments with targeted agents that interfere with the Epidermal Growth Factor Receptor (EGFR) pathway and Anaplastic Lymphoma Kinase (ALK) inhibitors have been widely used lately. Since the observation that most lung cancer cells express EGFR on their surface, many trials investigated the result of EGFR tyrosine kinase inhibitors (TKIs) such as erlotinib and gefitinib in the treatment of NSCLC patients. It was observed that certain mutations in the tyrosine kinase domain resulted in better response to the treatment therefore the EGFR mutation analysis is recommended.

Another target of genomically driven treatment is Anaplastic Lymphoma Kinase (ALK). Inhibitors of ALK such as first generation crizotinib and second and third generation ceritinib and alectinib have been approved in the line of treatment of ALK positive patients.

In addition to the improvement of molecular biology the understanding of the importance of histology has also played a key role to maximize treatment efficacy. The main classification of lung cancer into SCLC and NSCLC was considered for many years enough to guide the treatment but the past decade many studies have proven that further histological subtyping of NSCLC might be of major importance to the treatment outcome. In trials that investigated the efficacy and the safety of drugs used for NSCLC such as bevacizumab the researchers came to the conclusion that not all histological subtypes of NSCLC respond similarly. They reported the presence of severe side effects associated with specific histology and also improvement in survival when specific drug combinations were used in histologically selected populations. The available literature highlights the importance of patient subtyping and patient selection and also suggests that testing for selected molecular alterations might be essential to achieve the best possible results in the treatment of lung cancer[5].

Lin et al. published a study of 137 patients with EGFR-Mutant metastatic lung adenocarcinoma treated with gefitinib or erlotinib between 2002 and 2009 where the 5-year survival rate is 14,6% while prior studies for unselected patients who were treated with chemotherapy and not EGFR TKIs report a 5-year survival rate lower than 5%[8]. Nishino et al. reported a 5-year survival rate of 8,4% in patients with NSCLC that received gefitinib although in this study they did not perform systemic genotyping to select the patients with EGFR mutations[6].

Prognostic Scoring Systems

The predicted survival at the time of diagnosis along with the primary site and staging of the tumor are the main factors that influence the decision for the optimal treatment of spinal metastases. In general, in the majority of studies, expected survival more than 6 months has been used as criterion for surgical treatment. To help estimate the expected survival of patients with such metastases several scoring systems have been developed in the last decades. Some of the most

popular are the Tomita Score, the modified Bauer Score, the Oswestry Spinal Risk Index and the revised Tokuhashi Score.

Tomita Score

The Tomita Score[7], which was introduced in 2001, is based on 3 parameters: (1) the grade of the malignancy, (2) the presence of visceral metastases and (3) the number of bone metastases. A primary tumor with slow growth is assigned 1 point, when there is moderate growth 2 points and when the primary tumor progresses rapidly is assigned 4 points. In this parameter lung cancer is assigned 4 points. The absence of visceral metastases is graded with 0 points and when visceral metastases are present, the metastases that are considered treatable are assigned 2 points and the untreatable metastases 4 points. As far as the bone metastases are considered, when they are solitary or isolated, they are graded with 1 point while the presence of multiple metastases is graded with 2 points. The Tomita Score ranges from 2 to 10. The treatment that is recommended is wide or marginal excision for scores 2-3, marginal or intralesional excision for scores 4-5, palliative surgery for scores 6-7 and supportive care for scores 8-10[7].

Modified Bauer Score

The modified Bauer Score[8] is based on 4 positive prognostic factors (1) the absence of visceral metastases, (2) the absence of lung cancer, (3) the primary site of cancer being breast, kidney, lymphoma or multiple myeloma and (4) solitary skeletal metastasis. Each positive prognostic factor is assigned one (1) point. The treatment goal and the recommended surgical strategy is guided by the total points that each patient is assigned on the modified Bauer Score. For scores 0-1, supportive care without any surgery is the optimal treatment according to the score interpretation. For patients that are assigned 2 points, short term palliative treatment is recommended and more specifically dorsal surgery approach, while patients that are graded with 3-4 points, venterodorsal surgical strategy for middle term local control of the disease is the treatment goal[8].

Oswestry Spinal Risk Index

The Oswestry Spinal Risk Index (OSRI) is a scoring system that predicts survival in patients with metastatic spinal disease and is based on two parameters, (1) the primary tumor pathology (PTP) and (2) the general condition (GC) of the patient. Primary tumors with slow growth such as breast, thyroid, prostate, myeloma, hemangioma, endothelioma, non-Hodgkin's lymphoma are assigned 1 point in the (PTP) calculation. Primary tumors with moderate growth such as kidney, uterus, tonsils, epiphanynx, synovial cell sarcoma, metastatic thymoma are assigned 2 points; tumors of the stomach, colon, liver, melanoma, teratoma, sigmoid colon, pancreas, rectum, and unknown origin tumor that are known to progress rapidly are graded with 4 points, while 5 points are assigned to lung cancer alone because of its very rapid growth. The general condition (GC) grading of the patient takes under consideration the Karnofsky Performance Status (KPS). For KPS 80-100% (good general condition) 0 points are assigned, for KPS 50-70% (moderate general condition) 1 point and for KPS 10-40 % (poor general condition) 2 points. The OSRI is calculated as follows, OSRI: PTP +(2- GC)[9].

Balain et al. compared OSRI to the three most popular scoring systems Tomita, modified Bauer and revised Tokuhashi Score in a prospective cohort study of 199 patients and they suggest that is easier to calculate and outperforms the previous scores[9]. Fleming et al. performed a study of 121 patients with vertebral metastases reporting a strong correlation between the OSRI prediction and the actual survival of the patients of the study suggesting that OSRI can satisfactorily predict the survival[10].

Revised Tokuhashi Score

The Tokuhashi Score[11] first designed in 1990 and then revised in 2000 and 2005 is based on 6 parameters, (1) general condition using the Karnofsky Performance Status (KPS) (2) number of extraspinal bone metastases, (3) number of vertebral metastases, (4) number of visceral metastases, (5) primary site of cancer and (6) palsy. Each parameter is rated from 0 to 2 points except for the primary site of cancer that ranges from 0 to 5 points.

The general condition parameter of the revised Tokuhashi Score is calculated as follows: for poor general condition (KPS 10-40%) 0 points, for moderate general condition (KPS 50-70%) 1 point and for good general condition (KPS 80-100%) 2 points. As for the extraspinal metastases, when the number of extraspinal metastases is ≥3 the patients get 0 points, for 1-2 extraspinal metastatic foci 1 point and when there are none, the patient is assigned 2 points. For metastases found in vertebral body, the patients are assigned 0 points when they are found on ≥3 vertebras, 1 point when they are 2 and 2 points when only one vertebral metastasis is present. For unresectable metastases of the internal organs the patient is assigned 0 points, for resectable metastases of internal organs 1 point and when there are not any metastases found at the internal organs 2 points.

The fifth parameter of the score ranges from 0 to 5 points as mentioned before. When the primary site of cancer is lung, osteosarcoma, stomach, bladder, esophagus or pancreas the patients is assigned 0 points; for tumors of the liver, gallbladder or unidentified 1 point; for other primary cancers 3 points; for kidney and uterus tumors 4 points and for primary malignancy of the thyroid, breast, prostate and carcinoid 5 points. Lastly the state of palsy is evaluated and then graded with 0 points for complete palsy (Frankel A, B), 1 point for incomplete palsy (Frankel C, D) and for no palsy (Frankel E) 2 points[11].

The Tokuhashi Score classifies patients into three prognostic categories. In patients with a score between 0 and 8 (Group 1) the predicted survival is 6 months or less,

for a score 9 to 11 (Group 2) predicted survival is 6 to 12 months and for a score 12 to 15 (Group 3) the predicted survival exceeds 12 months[11].

This scoring system has guided the choice of treatment of patients with spinal metastases for several years. In patients with a total score less than 8, more conservative or palliative procedures were suggested. In patients with a score 12 to 15, therefore a better prognosis, excisional procedures were considered to be the best option whereas patients with a total score 9 to 11 were more of a gray area and the decision was based on the judgment of the treating surgeon on an individual basis.

Since its introduction the Tokuhashi Score has been the most popular score that is used to guide the choice of the optimal treatment strategy for metastatic spine tumors. The lung cancer as a primary site is assigned 0 points. As a result, in the case of lung cancer patients, the maximum total score that a patient can be assigned to, using the present criteria, is 10 and therefore is not possible to predict patient outcomes at 1 year of survival or more.

Tokuhashi Score accuracy

Since the efficacy of oncologic therapies constantly improves, the survival of cancer patients is in general prolonged and taking under consideration the fact that in many studies the actual survival time of the cancer patients is often greater than the one obtained using the revised Tokuhasi score, the accuracy and the validity of the revised Tokuhashi Score is in question. The same observation applies to the other above mentioned scoring systems as well.

When Tokuhashi et al. published the revised Tokuhashi score in 2005, they presented a concordance between the expected and the actual survival rate of 82,5%[11]. With this result agree many authors in multiple published studies.

Yamasita et al. investigated, in a prospective study, 51 patients with spinal metastases and reported that the actual survival was in agreement with the one predicted based on the revised Tokuhashi score in 79% of the cases[12].

Ulmar et al. studied retrospectively 217 patients with spinal metastases between 1984 and 2005, that were surgically treated and calculated the original and the revised Tokuhashi score suggesting that these scores show a significant predictive value although in the case of the revised Tokuhashi score the reliability was lower, especially in the Group 1 of the patients. The authors then performed a modified grouping of the revised Tokuhashi Score and proceed to divide the patients into two prognostic groups with the criteria of the one year predicted survival (group 1 TS ≤8, and group 2 TS ≥9) and then provided the patients with the desirable instrumentation and that modification achieved the highest reliability according to the authors[13].

On the other hand many authors including Gruenberg, Pointillar, Quraishi and Gakhar reported lower concordance of Tokuhashi score. More specifically these authors report that the concordance was noticeably lower in Group 2 (TS 9-11) while in Group 1 (TS 0-8) and Group 3 (TS 12-15) higher.

Gruenberg et al. analyzed, in a retrospective study, 105 patients with vertebral metastases that were treated surgically from 2004 to 2014. The patients were divided in 3 groups according to the revised Tokuhashi score. The concordance was 80% in the first group, 33.3% in the second group and 100% in the third group. The general concordance of Tokuhashi Score in this study was 67,6%, significantly lower than the one presented by the creators of the score. The authors conclude that in their study the Tokuhashi score proved accurate in predicting the survival of patients with either short life expectancy (Group 1) or long-life expectancy (Group 3) but fails to rightfully evaluate the expected survival of patients in Group 2. They propose a more case-by-case approach for patients that fall in Group 2 to avoid undervaluation of the survival rate of these patients[14].

Quraishi et al. studied, in a semi-prospective study over 8 years, 201 patients that were surgically treated for spinal metastases calculating their revised Tokuhashi scores. The predictive value of the revised Tokuhashi score in this study is 66% (Group 1: 64%, Group 2: 64% and Group 3: 69%). The authors report a longer survival after surgery than the one predicted by the revised Tokuhashi Score and they express their concern that many patients that could benefit from surgical intervention may be deprived of this opportunity due to their classification by the revised Tokuhashi Score. The authors conclude that despite being a useful tool in guiding the treatment in those patients, the Tokuhashi score should not be the only factor taken under consideration when deciding whether to proceed with an operative treatment or not[15].

Gakhar et al. performed a prospective study of 90 patients that underwent surgery for their spinal metastases and calculated their expected survival based on the revised Tokuhashi Score. In Group 1, 36,1% actually survived less than 6 months; in Group 2, 9,1% matched the predicted survival and in Group 3, 80,9% survived more than 12 months. Overall, only 33,4% agreed with the predicted survival period. To conclude the authors, question the accuracy of the Tokuhashi Score, especially for patients in groups 1 and 2[16].

Eap et al. studied 260 patients reporting a 95% agreement between the actual survival and the one predicted by the revised Tokuhashi Score. They support the validity of the Score and in addition they propose the addition of two factors that according to them are lacking from the Tokuhashi scoring system and that should be taken under consideration when deciding the optimal treatment and especially the need for excisional surgery. These are the age of the patient and the time to metastasis diagnosis. According to this study age >70 years has shorter expected survival and as for the time between the diagnosis of the primary cancer and the diagnosis of the spinal metastases they suggest that it is of great importance, with early metastases having a poor

prognosis while delayed metastases a better one. The time from primary diagnosis to the diagnosis of spinal metastatic disease is clearly associated with the aggressiveness of the primary tumor and its respond to the systemic therapy and they suggest that patients with delayed metastatic disease should be considered for excisional procedures[17].

Tokuhashi Score and lung cancer

Kobayashi et al. observed retrospectively 31 patients with spinal metastases derived from different types of cancer that underwent surgery, aiming to compare their prognoses after the operation. They divided the patients into Lung cancer (LK Group); prostate, breast or thyroid (PB Group); and other (OT Group). The revised Tokuhashi Score of the LK group was lower than the PB or OT group. As for the actual survival, the PB Group survived longer than the LK Group but there was no difference in survival between LK and OT Groups. The authors conclude that the revised Tokuhashi Score may underestimate the survival of lung cancer patients especially since the progress in the treatment of lung cancer has managed to increase survival time for patients with lung cancer. They also suggest that surgical treatment may be beneficial as much for lung cancer patients as for other types of cancer, even if revised Tokuhashi Score is <8. The fact that in the revised Tokuhashi Score, lung cancer is assigned 0 points lowering the total score, is according to the authors no longer acceptable and they propose a further revision of the Tokuhashi Score and suggest that a grading of 2 for lung cancer may be more appropriate[18].

In a study of 207 patients, Uei et al. examined and compared treatment outcomes of lung cancer patients with spine metastases that were treated before and after the introduction of molecularly targeted drugs and bone modifying agents. The patients that were included in the study were treated either conservatively or surgically depending on their revised Tokuhashi Score and the treating doctors' opinions. The concordance rate between the Tokuhashi Score and actual survival was higher (85,2%) in the group of patients treated before the introduction of these new drugs and was lower (62,1%) in the group of patients treated after 2006 when BMAs and molecular targeted drugs were used which clearly reflects the extended survival period seen after 2006[19].

Uei et al. retrospectively examined 207 lung cancer patients with metastatic spine tumors in an attempt to analyze the factors that are relevant to the survival of the patient after the treatment, may that be surgical or conservative. The selection of the treatment was based on the pathology of the lung cancer, the patients' general condition and the expected survival. The factors that were analyzed included age, sex, the affected region of the spine, the histology of the lung cancer, the revised Tokuhashi Score parameters, laboratory data such as ALP and CEA and the use of molecule targeting agents and BMA. The conclusion of the study was that the histology of the lung cancer, the patients' general condition and neurological status and the use of molecule targeting treatment significantly influenced the survival of the patient[20].

Wenzi Yu et al. studied retrospectively 151 lung cancer patients with vertebral metastases from January 2008 to December 2013, in an attempt to test the accuracy of the Tokuhashi Score in predicting the survival of such patients after they noticed that the survival of those patients were often greater than initially predicted by the Tokuhashi Score. The patients were treated with chemotherapy, molecule targeting drugs, radiotherapy and when indicated with surgical treatment (predicted survival >6 months, unmanageable pain, affected neurological status, patient's choice). Patients were divided into two Groups according to the Tokuhashi Score, Group 1(TS 0-8) with 146 patients and Group 2 (TS 9-11) with 5 patients. A lung cancer patient cannot be scored higher than 10 with the existing revised Tokuhashi Score criteria, therefore a third group was not formed. Taking these under consideration, no patient with lung cancer is expected to survive more than 1 year and no excisional surgery is recommended. According to the results of this study, 91.7% of the Group 1 (134 of the 146 patients) had a greater survival than predicted by the Tokuhashi Score and 4 out of 5 patients of the Group 2 survived longer than 12 months. That shows that only 8.6% had the survival predicted by the Tokuhashi Score. The question that the authors raise is whether the Tokuhashi Score is reliable when determining the optimal treatment for lung cancer patients with spinal metastases since they have shown in their study that if the score had been applied, many of those patients would not have been treated surgically resulting to decreased quality of life and further worsening of their prognosis. Although the authors conclude that the advances in lung cancer treatment have made the Tokuhashi Score less accurate in predicting the survival of lung cancer patients, it has to be noted that they report that for patients with visceral metastases and disease progression to first-time systemic therapy simultaneously, the Tokuhashi Score could predict the survival accurately. As a conclusion the authors propose that the status of visceral metastases and response to first-time systemic therapy should be added into the revised Tokuhashi Score for better accuracy[21].

Hao Tan et al. completed a retrospective study of 180 patients with lung cancer and spine metastatic disease that were treated between 2001 and 2012, where they compared the survival predicted by the most popular prognostic scores with the actual survival of the patient. The revised Tokuhashi Score, Tomita Score, modified Bauer and Oswestry Scores were used in this study. In addition, parameters that could potentially influence the survival were investigated and the results showed that histology (better prognosis for NSCLC), sex (better prognosis for female), general condition, neurological status and the presence of visceral metastases proved to be important prognostic factors. The better survival of patients with NSCLC could also be attributed

to the fact that the advances in the systemic treatment of NSCLC were significant lately. In this study the patients that survived longer had indeed higher scores in all four scores that were calculated but at the same time the actual survival of the patients was significantly underestimated by all of the four scores. The authors conclude that patients should be treated after individual evaluation since the current prognostic scoring systems fail in many cases to be accurate and they also recommend that the doctors that decide about the optimal treatment should always consider the histology of the cancer, the general and neurological condition, and the response to systemic treatments and specifically molecule targeted therapy[22].

Igarashi et al. published a study where they retrospectively evaluated the clinical benefit of operative treatment in patients with vertebral metastases and paralysis from lung cancer. Four patients with NSCLC that had posterior fixation and laminectomy were included in the study. All patients received chemotherapy postoperatively as well. The mean preoperative Tokuhashi Score was 8,3 and the mean Tomita Score was 7. The median survival was 42,5 months after the surgery. According to the calculated prognostic scores it was indicated for these patients to be treated with either palliative surgery or supportive care. In these cases, however, the patients underwent fixation and laminectomy, The improvement of their neurological status and general condition that followed the operation has allowed the patients to receive further therapy (chemotherapy, radiation, new molecular targeted agents) and as a result to prolong their survival. The authors conclude that even patients with paralysis could be considered as candidates for surgical treatment and are also skeptical about how much the primary site of the cancer, in this case lung, affects the result in the revised Tokuhashi Score. They suggest that a prognostic score that would be specifically designed for NSCLC patients, may be more suitable to accurately predict the survival of these patients[23].

Morgen et al. performed a retrospective cohort study of 2321 cancer patients with symptomatic metastatic spinal cord compression in an attempt to detect if there is a difference in 1 year survival in such patients from 2005 to 2010, taking under consideration the original site of cancer. They calculated the revised Tokuhashi Score for all the patients and the patients with a score of 5 or higher received surgical evaluation but they were not all operated. As far as lung cancer is concerned, they present that there is an increase in survival over the years. More specifically the one-year survival for lung cancer patients was 4% in 2005 and 19% in 2010. The percentage of lung cancer patients that were treated operatively did not change throughout the years but for these patients the survival went from 9% to 30%. The authors report that the overall one-year survival for all types of cancer included in this study did not change significantly but the survival for specific subgroups such as lung cancer and renal cancer improved dramatically. This could be related with the new treatments available for lung cancer, the use of molecular targeted agents and the increased access to surgical treatments. They question whether this improvement in treatments and therefore in survival of the patients could affect the usability of the current scoring systems. They highlight the importance of the primary site of cancer as a prognostic factor and conclude that the expected survival of these patients may be underestimated. The authors suggest that a revision of the existing scoring systems in relation to primary cancer could improve the accuracy of these scores[24].

Hessler et al. in a retrospective analysis studied 76 patients with spinal metastases from lung cancer that were treated surgically between 1999 and 2004 analyzing the tumor histology, the patients' age, the location of the metastases, the neurological status and their Tokuhashi score. Comparing the predicted and the actual survival in Group 1 (TS 0-8) the concordance was 72,6%, in Group 2 (TS 9-11) 42,9% and since none of the patients could achieve a score higher than 10 due to the fact that lung cancer has 0 points in the score, no patients were included in the third Group. In the study though 7 of the 76 patients actually survived more than 12 months. The actual and predicted survival agreed in 67,1%. The authors highlight the fact that using the Tokuhashi score no lung cancer patient is expected to pass the one-year survival prediction but as proven yet again from this study, in many cases they do. They also point out that patients with life expectancy more than a year may benefit from more aggressive surgery and they suggest that lung cancer patients should not be deprived of the opportunity to receive such treatments. They propose that lung cancer should not be automatically scored as 0 and that a subdivision of the lung cancer diagnosis in the scoring system category may be required[25].

Conclusion

The prognostic scores available for patients with spinal metastatic disease such as the more popular ones Tokuhashi Score and Tomita Score are generic spinal metastases scores and they are not designed specifically for lung cancer patients. All these scores consider lung cancer patients as having a poor prognosis, so given their short-predicted survival, surgery is rarely indicated. Multiple studies though suggest that many lung cancer patients may actually have a longer overall survival mostly due to the recent use of molecular targeted drugs and that these patients should maybe be considered for surgical treatment since they have a better prognosis than initially believed.

In many studies the revised Tokuhashi Score is proven to be effective in predicting the survival in patients with poor prognosis (Group 1) and for patients with long life expectancy (Group 3) while it is less accurate for patients that belong in Group 2. So even though these scores may be helpful in classifying the patients into short term, intermediate or long-term survivors, in many cases they

fail to predict more precisely the survival.

Therefore, according to the literature and the multiple studies on the matter, the decision for choosing either the conservative or operative treatment should not be based exclusively on the existing prognostic scores but preferably it should follow a more multidisciplinary approach taking under consideration the factors that affect the survival of these patients and the improved response of the patients to the new available treatments.

To conclude, many authors suggest that a revision of the prognostic scores may be necessary in order to reflect the improvement in the overall survival after the introduction of genomically driven treatments and at the same time a development of a prognostic score specifically for lung cancer patients may be beneficial since the generalization of the existing prognostic score may result in some patients being undertreated.

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