Interobserver agreement for the spine instability neoplastic score varies according to the experience of the evaluator

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OBJECTIVES: To evaluate the interobserver agreement for the Neoplastic Spine Instability Score (SINS) among spine surgeons with or without experience in vertebral metastasis treatment and physicians in other specialties.

METHODS: Case descriptions were produced based on the medical records of 40 patients with vertebral metastases. The descriptions were then published online. Physicians were invited to evaluate the descriptions by answering questions according to the Neoplastic Spine Instability Score (SINS). The agreement among physicians was calculated using the kappa coefficient.

RESULTS: Seventeen physicians agreed to participate: three highly experienced spine surgeons, seven less-experienced spine surgeons, three surgeons of other specialties, and four general practitioners (n = 17). The agreement for the final SINS score among all participants was fair, and it varied according to the SINS component. The agreement was substantial for the spine location only. The agreement was higher among experienced surgeons. The agreement was nearly perfect for spinal location among the spine surgeons who were highly experienced in vertebral metastases.

CONCLUSIONS: This study demonstrates that the experience of the evaluator has an impact on SINS scale classification. The interobserver agreement was only fair among physicians who were not spine surgeons and among spine surgeons who were not experienced in the treatment of vertebral metastases, which may limit the use of the SINS scale for the screening of unstable lesions by less-experienced evaluators.

KEYWORDS: Spine; Health Services Research; Models, Statistical; Observer Variation.

INTRODUCTION

The spine is the most frequent site of bone metastases. In up to 20% of patients, the symptoms related to vertebral metastases are the initial manifestation of cancer (1). Vertebral metastases can cause severe complications, including compression of the spinal cord, which is found in 5-14% of patients with cancer over the course of the disease (2,3). The spinal cord compression may result from the growth of the tumor mass in the epidural space or may be associated with pathological fracture of the vertebra, which leads to compression by bone fragments or mechanical instability secondary to fracture (4,5).

Many studies have examined the options for operative treatment of spinal cord compression caused by solid tumors (2,6,7) and found that surgery contributes to a better quality of life and improves the ability to walk for patients with vertebral metastases (8).

The indication for surgical intervention is based on the health of the patient, survival prognosis, histology of the primary tumor, expectation of improvement with the use of other methods of treatment, and presence of spinal instability (9). The criteria for defining instability of the spine are well accepted for spinal injuries. However, there is
controversy regarding the criteria for definition of instability arising from metastatic involvement (10).

Spinal instability is a key element in decision-making regarding the need for surgical treatment. However, the lack of objective criteria for vertebral instability is one of the reasons why many patients are unnecessarily referred to specialists for spinal evaluation, which results in increased healthcare costs, increased length of stay in hospitals and a delay in the start of cancer treatment. Additionally, many patients are treated insufficiently to correct the instability and they suffer worsening of the fracture, deformity, pain, and neurological deficits because the severity of the instability was not recognized.

Spinal instability, according to the Spine Oncology Study Group (SOSG), is defined as a loss of spinal integrity resulting from a neoplastic process that is associated with movement-related pain, symptomatic or progressive deformity, and/or neural compromise under a physiologic load (11). Despite the established definition of this concept of stability, its application in clinical practice is difficult. Therefore, the SOSG published the Neoplastic Spine Instability Score (SINS) based on the association of the best literature available with a consensus of expert opinions (11).

The SOSG classification uses parameters such as the location of the lesion and clinical characteristics of pain, quality of the matrix of the bone lesion, radiographic alignment of the spine, collapse of the vertebral body, and involvement of posterior spine structures. The minimum score is 0, and the maximum score is 18 points. A score between 0 and 6 indicates stability, a score between 7 and 12 indicates indefinite stability, and a score between 13 and 18 indicates instability. An expert evaluation is recommended for patients with a score of 7 points or higher (11) (Table 1).

One possible application of the SINS score is the screening for spinal instability in the emergency room for quick decision-making. There is a consensus on the need for expert opinion in cases of spinal cord compression.

### Table 1 - Spine Instability Neoplastic Score (SINS) (11).

| Spine location | Score |
|----------------|-------|
| Junctional (occiput-C2, C7–T2, T11–L1, L5–S1) | 3 |
| Mobile spine (C3–C6, L2–L4) | 2 |
| Semi-rigid (T3–T10) | 1 |
| Rigid (S2–S5) | 0 |
| Mechanical or postural pain | |
| Yes | 3 |
| No (occasional pain but not mechanical) | 1 |
| Pain-free lesion | 0 |
| Bone lesion quality | |
| Lytic | 2 |
| Mixed lytic/blastic | 1 |
| Blastic | 0 |
| Radiographic spinal alignment | |
| Subluxation/translation present | 4 |
| De novo deformity (kyphosis/scoliosis) | 2 |
| Normal alignment | 0 |
| Vertebral body involvement | |
| >50% collapse | 3 |
| <50% collapse | 2 |
| No collapse with >50% of the body involved | 1 |
| None of the above | 0 |
| Posterior involvement | |
| Bilateral | 3 |
| Unilateral | 1 |
| None of the above | 0 |

However, in some patients, the main complaint is axial pain caused by metastatic disease where there is a risk for tumor-related spinal instability. A recent study by Fourney et al. (12) verified good interobserver reliability in determining stability using SINS. However, the study participants only comprised experienced spinal surgeons, and agreement among less-experienced attending physicians was not evaluated.

The objective of this study was to evaluate the interobserver agreement in the Neoplastic Spine Instability Score (SINS) among spine surgeons with or without experience in vertebral metastasis treatment and physicians in other specialties.

### METHODS

This study was based on the medical records of 40 patients with spinal metastatic lesions that were treated at a public referral cancer center (Instituto do Câncer do Estado de São Paulo). The symptoms and history of the disease were described (Figure 1), and the case descriptions and imaging (computed tomography [CT] and magnetic resonance [MRI]) were published in an online system created for this study. The online system allowed the study participants to evaluate the case descriptions by answering questions according to the Neoplastic Spine Instability Score (SINS). In total, 40 cases that represented all SINS categories were included in the system.

Thirty physicians from all of the departments in one of the largest public university hospitals in Latin America (Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo) were invited to participate in this study to evaluate the 40 cases online. In the invitation, the physicians were asked to declare how many cases of metastatic lesions they had surgically treated in the prior year (2011) and to fill in the SINS online questionnaire for ten cases every week. They were not asked to examine patients clinically. Rather, they had to evaluate the case descriptions online (which were based on medical records) and respond to the questionnaire.

The identity of the patients was not revealed to the study participants. Only sex, age, and clinical history and imaging were made available to the participants. This study did not require informed consent, but it was approved by the local ethics committee before the participants were invited.

The interobserver agreement for the final SINS score among the participants was calculated according to the kappa coefficient and the percentage of agreement. The kappa coefficient was also calculated for each component of the SINS: spine location, pain, spinal alignment, vertebral involvement, and bone lesion quality.

The null hypothesis (kappa equals zero, i.e., that there is a lack of agreement or that any observed agreement is purely by chance) was tested by using statistical methods. The reliability was evaluated as proposed by Landis and Koch (13): 0 to 0.2 indicated poor agreement; 0.21 to 0.4 indicated fair agreement; 0.41 to 0.6 indicated moderate agreement; 0.61 to 0.8 indicated substantial agreement; and 0.81 to 1.0 indicated very good agreement. An online collection of statistical programs was used for statistical analysis, and the tools that we used are available at http://www.stattools.net/CohenKappa_Pgm.php.

### RESULTS

Of the physicians invited, 17 agreed to participate in this study and responded to ten questionnaires per week. Seven
of the physicians were not spine surgeons, and they had graduated 3 to 39 years ago. These seven participants were orthopedic surgeons (two), a neurosurgeon (one), and general practitioners (four). The ten other participants were spine surgeons that had graduated 4 to 23 years ago, and three of them were highly experienced, as they had operated on 20 or more cases of spinal metastasis in the year prior to the study. Seven were less experienced: three had operated on three to six cases, and four surgeons had no spinal metastasis cases in 2011.

The agreement for the final SINS score among all participants was fair. For the spinal location only, the agreement was substantial. The agreement for each of the score components is shown in Table 2.

The agreement among the seven physicians who were not spine surgeons was fair for the final SINS and substantial only for the spine location component. The kappa coefficient for these participants is shown in Table 3. None of these seven physicians had previous knowledge of the SINS scoring methodology.

The spine surgeons were divided into those with low and high surgical experience in vertebral metastasis treatment. All of the spine surgeons reported that they knew the SINS scoring methodology, but they did not use it in their daily routine. The less-experienced spine surgeons demonstrated fair agreement for the final SINS score and substantial agreement for the spine location and spinal alignment components, as shown in detail in Table 4. The agreement was higher among experienced surgeons and was substantial for the final SINS score. The agreement was also substantial for spinal alignment and nearly perfect for spinal location (Table 5).

## DISCUSSION

The benefits of surgery in the treatment of spinal compression caused by metastasis of solid tumors are well known (2,14). However, when there is no spinal cord compression and the main complaint is axial mechanical pain it is difficult to recognize the patient population that would benefit from surgical treatment and spinal fixation. The presence of instability is an independent indication for surgery (15) or percutaneous cement reinforcement (6,16,17).

The instability of the spine associated with metastasis is still judged by the attending physician and is based on clinical experience. Criteria that have been developed for traumatic injuries of the spine are often used in these cases. However, the pathophysiology of traumatic fracture of the spine is different from that of metastatic involvement with

### Table 2 - Agreement for the final results and components of the Spine Instability Neoplastic Score (SINS) among all evaluators.

|                           | % of overall agreement | Fixed-marginal kappa | 95% CI          | Agreement   |
|---------------------------|------------------------|----------------------|-----------------|-------------|
| SINS score                | 62.44%                 | 0.375379             | 0.3563-0.3944   | Fair        |
| Spinal location           | 79.76%                 | 0.718683             | 0.7040-0.7332   | Substantial |
| Mechanical or postural pain | 72.54%                | 0.419348             | 0.3952-0.4434   | Moderate    |
| Bone lesion quality       | 56.32%                 | 0.219671             | 0.1989-0.2403   | Fair        |
| Spinal alignment          | 77.22%                 | 0.552618             | 0.5316-0.5735   | Moderate    |
| Vertebral body involvement| 58.79%                 | 0.42924              | 0.4138-0.4426   | Moderate    |
| Posterior involvement    | 61.78%                 | 0.42375              | 0.4059-0.4415   | Moderate    |

**Figure 1** - Example of a clinical case used in the evaluations. “Forty one-years-old patient with a diagnosis of metastatic colon adenocarcinoma. He has a complaint of progressive dorsal pain which is worse at night and with movement. The patient has a limited ability to move on the bed due to dorsal pain.” A. Anteroposterior and profile radiographs. B. Axial cut in computed tomography showing the lesion site.
Table 3 - Agreement for the final result and components of the Spine Instability Neoplastic Score (SINS) among physicians who were not spine surgeons.

| Component                  | % of overall agreement | Fixed-marginal kappa | 95% CI           | Agreement |
|----------------------------|------------------------|----------------------|------------------|-----------|
| SINS score                 | 61.07%                 | 0.346549             | 0.2975-0.3955    | Fair      |
| Spinal location            | 71.79%                 | 0.610494             | 0.5739-0.6470    | Substantial |
| Mechanical or postural pain| 70.36%                 | 0.387745             | 0.3268-0.4486    | Fair      |
| Bone lesion quality        | 45.24%                 | 0.092664             | 0.0424-0.1428    | Fair      |
| Spinal alignment           | 68.57%                 | 0.419333             | 0.3791-0.8695    | Moderate  |
| Vertebral body involvement | 59.40%                 | 0.426548             | 0.3888-0.4642    | Moderate  |
| Posterior involvement      | 57.50%                 | 0.35992              | 0.3146-0.4051    | Fair      |

Table 4 - Agreement for the final result and components of the Spine Instability Neoplastic Score (SINS) among spine surgeons with low experience for vertebral metastasis treatment.

| Component                  | % of overall agreement | Fixed-Marginal Kappa | 95% CI           | Agreement |
|----------------------------|------------------------|----------------------|------------------|-----------|
| SINS score                 | 60.12%                 | 0.32285              | 0.2738-0.3718    | Fair      |
| Spinal location            | 83.57%                 | 0.768719             | 0.7306-0.8067    | Substantial |
| Mechanical or postural pain| 72.38%                 | 0.391383             | 0.3299-0.4528    | Fair      |
| Bone lesion quality        | 62.86%                 | 0.311485             | 0.2585-0.3644    | Fair      |
| Spinal alignment           | 82.14%                 | 0.629295             | 0.5731-0.6854    | Substantial |
| Vertebral body involvement | 57.98%                 | 0.424512             | 0.3888-0.4601    | Moderate  |
| Posterior involvement      | 61.67%                 | 0.42154              | 0.3761-0.4669    | Moderate  |
Table 5 - Agreement for the final result and components of the Spine Instability Neoplastic Score (SINS) among experienced spine surgeons.

|                      | % of overall agreement | Fixed-Marginal Kappa | 95% CI | Agreement       |
|----------------------|------------------------|----------------------|--------|----------------|
| SINS score           | 76.67%                 | 0.631256             | 0.5069-0.7555 | Substantial    |
| Spinal location      | 93.33%                 | 0.908047             | 0.8114-1.004 | Near perfect   |
| Mechanical or postural pain | 78.33%             | 0.554796             | 0.3913-0.7181 | Moderate       |
| Bone lesion quality  | 69.17%                 | 0.333134             | 0.1727-0.4935 | Fair           |
| Spinal alignment     | 86.67%                 | 0.724376             | 0.5791-0.8695 | Substantial    |
| Vertebral body involvement | 70.00%            | 0.578209             | 0.4799-0.6764 | Moderate       |
| Posterior involvement| 71.67%                 | 0.570617             | 0.4501-0.6911 | Moderate       |

possible improvement would be to divide the lesion quality into two categories: predominantly lytic or predominantly blastic lesions.

One limitation of this study is the low number of participants. Many physicians refused to participate because of a lack of time. It was also difficult to find balanced numbers of specialists from all fields. Ten spine surgeons and seven other specialists participated in this study. Among the ten spine surgeons, only three had previous significant experience with the surgical treatment of metastatic lesions. Despite this imbalance, the number of specialists and non-specialists in this study allowed us to calculate interobserver agreement. Most of the participants in this study were not specialized in metastasis treatment, and the agreement among these physicians was low, which suggests that that either the SINS is not a good screening tool for the emergency room or it requires training prior to use. Additional studies are needed to answer this question.

This study demonstrated that the experience of the evaluator has an impact on the SINS scale classification. The interobserver agreement was only fair among physicians who were not spine surgeons and among spine surgeons who were not experienced in the treatment of vertebral metastases, which may limit the use of the SINS scale for the screening of unstable lesions by less-experienced evaluators.

■ AUTHOR CONTRIBUTIONS

Teixeira WG was involved in the study design, data interpretation, manuscript writing and revision of the final version to be published. Coutinho PR was involved in data collection and analysis, manuscript writing and revision of the final version to be published. Marchese LD and Narazaki DK were involved in data collection and analysis, manuscript critical review and revision of the final version to be published. Cristante AF was involved in the study design, data interpretation, manuscript writing and revision of the final version to be published. Teixeira MJ, Barros Filho TE and Camargo OP were involved in data interpretation, manuscript writing and revision of the final version to be published.

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