
About authors:
Nazarova Evgenia Olegovna, postgraduate student of the Department of neurology, neurosurgery and medical genetics; tel.: +79034464729; e-mail: golikova.jenya@yandex.ru
Karpov Sergei Mikhailovich, MD, Professor, Head of the Department of neurology, neurosurgery and medical genetics; tel.: +79054101523; e-mail: karpov25@rambler.ru
Apaguni Arthur Eduardovich, MD, Professor, Head of the Combined Injury Department in Stavropol State Emergency Hospital; Professor of the Traumatology, Orthopedics Department; tel.: +79054161001; e-mail: artuni@yandex.ru
Karpov Alexey Sergeevich, postgraduate student of the Department of neurology, neurosurgery and medical genetics; tel.: +79286354634; e-mail: www.lexa2790@gmail.com
Krokhmal´ Sergey Vyacheslavovich, postgraduate student of the Department of neurology, neurosurgery and medical genetics; tel.: +79188784994; e-mail: sergey267770@gmail.com

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USE OF THE MODIFIED FRANKEL SCALE IN ASSESSING VERTEBROMEDULLARY DISORDERS IN EMERGENCY SERVICE OF A MULTI-SPECIALITY HOSPITAL

Monashenko D. N. 2, Ivanova N. E. 1, Davydov E. A. 1, Smulsky M. V. 2, Oleinik E. A. 1, Ulitin A. Yu. 1

1 Polenov Neurosurgical Institute of Almazov National Medical Research Centre, Saint-Petersburg, Russian Federation
2 City Hospital № 26, Saint-Petersburg, Russian Federation

ПРИМЕНЕНИЕ МОДИФИЦИРОВАННОЙ ШКАЛЫ FRANKEL ПРИ ОЦЕНКЕ ВЕРТЕБРОМЕДУЛЛЯРНЫХ РАССТРОЙСТВ В УСЛОВИЯХ УРГЕНТНОЙ СЛУЖБЫ МНОГОПРОФИЛЬНОГО СТАЦИОНАРА

Д. Н. Монашенко 2, Н. Е. Иванова 1, Е. А. Давыдов 1, М. В. Смульский 2, Е. А. Олейник 1, А. Ю. Улитин 1

1 Российский научно-исследовательский нейрохирургический институт им. проф. А. Л. Поленова – филиал Национального медицинского исследовательского центра им. В. А. Алмазова, Санкт-Петербург, Российская Федерация
2 Городская больница № 26, Санкт-Петербург, Российская Федерация

Spinal canal deformities of various etiologies are one of the most severe types of spine pathology, which often cause disability and social alienation of patients, which requires long-term, expensive, multi-stage treatment. This indicates the high medical and social significance of the problem and requires developing a unified approach to the treatment of this pathology, in particular: choosing optimal tactics of surgical procedures to reduce the frequency of both immediate and long-term complications and return the patient to the previous level of activity. Usage of our modified Frankel scale based on the analysis of 236 cases of spinal canal deformities allows a to assess neurological disorders in patients not only with spinal injuries but also with other vertebromedullary pathologies, such as degenerative-dystrophic, inflammatory and tumoral diseases of the spine and spinal cord.

Keywords: spinal canal deformities, modified Frankel scale, vertebromedullary pathology

Deformations of the vertebral canal of various etiologies are one of the most severe types of spine pathology, which often cause disability and social alienation of patients, which requires long-term, expensive, multi-stage treatment. This indicates the high medical and social significance of the problem and requires developing a unified approach to the treatment of this pathology, in particular: choosing optimal tactics of surgical procedures to reduce the frequency of both immediate and long-term complications and return the patient to the previous level of activity. Usage of our modified Frankel scale based on the analysis of 236 cases of spinal canal deformities allows a to assess neurological disorders in patients not only with spinal injuries but also with other vertebromedullary pathologies, such as degenerative-dystrophic, inflammatory and tumoral diseases of the spine and spinal cord.

Keywords: spinal canal deformities, modified Frankel scale, vertebromedullary pathology
Spinal injuries constitute, on average, 17.7 % of the locomotor system injuries [1]. Unstable damage of the lower thoracic spine and lumbar spine are the most common — up to 54.9 %, and the outcome of treatment is affected by a variety of factors [2, 3, 4, 5, 6]. Aiming to perform decompression of neurovascular formations of the spinal canal and stabilize the affected segment of the spine with minimum invasion for the patient within the shortest possible time [7, 8, 9, 10, 11, 12],

In the emergency service of a large multi-specialty hospital, there can be implemented a particular algorithm of patient examination in cases of complicated SCD wherein neurological deficiency was assessed based on the modified Frankel scale. This scale, proposed by N. Frankel in 1969, has come into widespread acceptance among clinicians [13, 14, 15, 16]. In pediatric practice A.Y. Mushkin additionally distinguished the ER type — the absence of motor deficiency in the presence of radicular (pain) syndrome [17, 18, 19]. The scale distinguishes five types of the severity of motor and sensory spinal disorders, which is not enough for an objective analysis of structural damage, isolated sensory disorders, radiculopathy, disorders of pelvic organs with spinal canal deformity. The purpose of work was to assess the effectiveness of our modified Frankel scale for assessing vertebromedullary disorders with spinal canal deformity of various etiologies in emergency service of a multi-specialty hospital.

**Material and Methods.** When the patient was admitted to the hospital, his examination included history taking, general investigation, pain measurement, determination of the amplitude of active and passive movements of the limbs and muscle strength, assessment of sensory and pelvic disorders, as well as palpation of all parts of the spine. Thus, in neurological examination, first of all, the state of motor function of the limbs was assessed: active movements, deep and surface reflexes, range of motion in the joints of the limbs, and muscle strength. Assessment of conductor and segmental disorders allowed to determine the level and nature of the damage of the spinal cord and its roots.

Visual analog scale (VAS) was used to assess the intensity of pain syndrome [1, 5]. The VAS used was a horizontal line 10 cm long, the ends of which correspond to the extreme degrees of pain intensity (from «no pain» to «unbearable pain»). The patient was offered to assess the pain and make a mark corresponding to the severity of the pain syndrome at the moment. The distance between the marks from «no pain» to «unbearable pain» was measured in centimeters and rounded if necessary.

Long-term results of treatment were assessed by calling the patient in for a control examination in a hospital. The study included: complaints inquiry, history taking, physical examination, assessment of pain syndrome according to the VAS, neurological examination according to the modified Frankel scale.

Since an essential criterion for assessing the outcome of the treatment is the «satisfaction» of the patient, in our work, we used the MacNab scale [5], namely its modification [7], to conduct a subjective assessment of the effectiveness of the procedures. Proposed in 1971 by Canadian orthopedist Professor Ian MacNab, the scale is the most frequently mentioned and easy to use in assessing patient’s satisfaction with the conducted treatment. The modified version of the MacNab scale differs in that each of the levels of patient satisfaction corresponds to the criteria according to which the researcher determines the outcome of the procedure for the patient.

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application package and the Basic Statistic program, the
significance of the differences was estimated using the
Pearson’s chi-squared test, the relationship between
factors and types of outcomes was calculated using
the Spearman’s rank correlation coefficient. After the
conducted correlation analysis, we selected only those
features that had a significantly (p<0.05) strong (R ≤ 0.7)
or moderate (0.3 ≤ R ≤ 0.7) correlation.

Results and Discussion. In order to clarify the tactics
of surgical treatment and to assess the effectiveness
of various decompressive-stabilizing procedures for
patients with spinal canal deformities of the thoracic
and lumbar spine, we analyzed the results of surgical
treatment of 236 patients with spinal canal deformities
of various etiologies (spinal injuries, degenerative-
dystrophic disease of the spine, tumor lesion of the spine
and spinal cord, spondylitis) of thoracic and lumbar spine.

All the patients were operated on in St. Petersburg state
budgetary institution of health care city hospital No. 26 in
the period from 1998 to 2018. The scope and sequence
of the surgical procedures were determined according
to the modified scale of Frankel. The degree of the spinal
canal deformity and severity of neurological disorders, and the form and degree of the
spinal canal deformity determined different approaches
to the spine. The average age was 46.1±1.1, including
137 men, 44.2±1.3 years of average age, 99 women,
and 48.8±1.8 years of average age. Preliminary planning
of surgical procedure was based on the assessment of
vertebromedullary pathology in patients, the degree
of surgical procedure was based on the assessment of
vertebromedullary pathology, the degree of the spinal
canal deformity, damage to osseous and
ligamentous structures, the possibility of using methods
of eliminating compression of neurovascular formations
of the spinal canal and fixing the affected spinal motion
segment. The main principles of surgical treatment
of patients were the aiming for early implementation
of surgery and simultaneous decompression of
neurovascular formations of the spinal canal with the
restoration of the support capacity of the affected spinal
motion segment. The distribution of patients according
to the type of neurological disorders depending on
vertebrodural pathology is shown in Table 1.

<table>
<thead>
<tr>
<th>Type of neurological disorders according to the modified Frankel scale</th>
<th>Type of pathology</th>
<th>Type of pathology</th>
</tr>
</thead>
<tbody>
<tr>
<td>DDS</td>
<td>SI</td>
<td>Spondylitis</td>
</tr>
<tr>
<td>A</td>
<td>Number of cases</td>
<td>0</td>
</tr>
<tr>
<td>% of all cases</td>
<td>0.0 %</td>
<td>3.0 %</td>
</tr>
<tr>
<td>B</td>
<td>Number of cases</td>
<td>0</td>
</tr>
<tr>
<td>% of all cases</td>
<td>0.0 %</td>
<td>1.7 %</td>
</tr>
<tr>
<td>C</td>
<td>Number of cases</td>
<td>1</td>
</tr>
<tr>
<td>% of all cases</td>
<td>0.4 %</td>
<td>15.7 %</td>
</tr>
<tr>
<td>D</td>
<td>Number of cases</td>
<td>0</td>
</tr>
<tr>
<td>% of all cases</td>
<td>0.0 %</td>
<td>9.3 %</td>
</tr>
<tr>
<td>R</td>
<td>Number of cases</td>
<td>31</td>
</tr>
<tr>
<td>% of all cases</td>
<td>13.1 %</td>
<td>29.2 %</td>
</tr>
<tr>
<td>RD</td>
<td>Number of cases</td>
<td>21</td>
</tr>
<tr>
<td>% of all cases</td>
<td>8.9 %</td>
<td>9.7 %</td>
</tr>
<tr>
<td>S</td>
<td>Number of cases</td>
<td>0</td>
</tr>
<tr>
<td>% of all cases</td>
<td>0.0 %</td>
<td>0.4 %</td>
</tr>
<tr>
<td>E</td>
<td>Number of cases</td>
<td>0</td>
</tr>
<tr>
<td>% of all cases</td>
<td>0.0 %</td>
<td>0.4 %</td>
</tr>
<tr>
<td>Total</td>
<td>Number of cases</td>
<td>53</td>
</tr>
<tr>
<td>Total %</td>
<td>22.5 %</td>
<td>69.5 %</td>
</tr>
</tbody>
</table>

Upon comparing the results of examination of
patients with traumatic and non-traumatic etiology of the
formation of complicated forms of the spinal canal de-
formity, it was noted that the regression of neurological
disorders in the presence of spinal injury depends not
on the degree of the spinal canal deformity and hypot-
dic deformation, but on the initial traumatic changes in
neural structures obtained at the time of the spinal in-
jury.

The distribution of patients according to neurological
disorders depending on the pathology after surgery is
shown in Table 2.

<table>
<thead>
<tr>
<th>Type of neurological disorders according to the modified Frankel scale</th>
<th>Type of pathology</th>
<th>Type of pathology</th>
</tr>
</thead>
<tbody>
<tr>
<td>DDS</td>
<td>SI</td>
<td>Spondylitis</td>
</tr>
<tr>
<td>A</td>
<td>Number of cases</td>
<td>0</td>
</tr>
<tr>
<td>% of all cases</td>
<td>0.0 %</td>
<td>2.1 %</td>
</tr>
<tr>
<td>B</td>
<td>Number of cases</td>
<td>0</td>
</tr>
<tr>
<td>% of all cases</td>
<td>0.0 %</td>
<td>1.3 %</td>
</tr>
<tr>
<td>C</td>
<td>Number of cases</td>
<td>0</td>
</tr>
<tr>
<td>% of all cases</td>
<td>0.0 %</td>
<td>4.2 %</td>
</tr>
<tr>
<td>D</td>
<td>Number of cases</td>
<td>11</td>
</tr>
<tr>
<td>% of all cases</td>
<td>4.7 %</td>
<td>15.3 %</td>
</tr>
<tr>
<td>R</td>
<td>Number of cases</td>
<td>0</td>
</tr>
<tr>
<td>% of all cases</td>
<td>0.0 %</td>
<td>1.3 %</td>
</tr>
<tr>
<td>RD</td>
<td>Number of cases</td>
<td>0</td>
</tr>
<tr>
<td>% of all cases</td>
<td>0.0 %</td>
<td>0.0 %</td>
</tr>
<tr>
<td>S</td>
<td>Number of cases</td>
<td>16</td>
</tr>
<tr>
<td>% of all cases</td>
<td>6.8 %</td>
<td>11.4 %</td>
</tr>
<tr>
<td>E</td>
<td>Number of cases</td>
<td>26</td>
</tr>
<tr>
<td>% of all cases</td>
<td>11.0 %</td>
<td>33.9 %</td>
</tr>
<tr>
<td>Total</td>
<td>Number of cases</td>
<td>53</td>
</tr>
<tr>
<td>Total %</td>
<td>22.5 %</td>
<td>69.5 %</td>
</tr>
</tbody>
</table>

As a result of ventral repositioning-stabilizing proce-
dures in all cases, we achieved the reconstruction of
the spinal canal deformity and decompression of neurovas-
cular formations of the spinal canal to varying degrees.

To adapt this scale to the assessment of neurological
disorders in the presence of spinal canal deformities
of different etiologies, we have proposed and implemented
in practice two more types of disorders – R – radiculo-
pathy and S – isolated sensory disorders.

Thus, the scale has the following outlook: A – absence
of motor and sensory function; B – complete absence
of movements, but with the presence of sensitivity; C – sig-
nificant impairment of motor function with the presence
of sensitivity; D – slight impairment of movements with
normal sensitivity; R – radiculopathy; RD – slight impair-
ment of movements with radiculopathy; S – no motor
movements, only sensory disorders; E – no neurological
complications.

Table 2

Distribution of patients according to neurological
disorders depending on pathology after surgery
The correlation between the severity of neurological disorders and the spinal lumen deficit before and after surgery

<table>
<thead>
<tr>
<th>Type of neurological disorders according to the modified Frankel scale</th>
<th>Spinal lumen deficit before the surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0–25 %</td>
</tr>
<tr>
<td>A</td>
<td>1</td>
</tr>
<tr>
<td>% of total number</td>
<td>0.4 %</td>
</tr>
<tr>
<td>B</td>
<td>3</td>
</tr>
<tr>
<td>% of total number</td>
<td>1.3 %</td>
</tr>
<tr>
<td>C</td>
<td>8</td>
</tr>
<tr>
<td>% of total number</td>
<td>3.4 %</td>
</tr>
<tr>
<td>D</td>
<td>9</td>
</tr>
<tr>
<td>% of total number</td>
<td>3.8 %</td>
</tr>
<tr>
<td>% of total number</td>
<td>7.2 %</td>
</tr>
<tr>
<td>R</td>
<td>56</td>
</tr>
<tr>
<td>% of total number</td>
<td>23.7 %</td>
</tr>
<tr>
<td>S</td>
<td>0</td>
</tr>
<tr>
<td>% of total number</td>
<td>0.0 %</td>
</tr>
<tr>
<td>E</td>
<td>1</td>
</tr>
<tr>
<td>% of total number</td>
<td>0.4 %</td>
</tr>
<tr>
<td>Total</td>
<td>95</td>
</tr>
<tr>
<td>Total %</td>
<td>40.3 %</td>
</tr>
</tbody>
</table>

Neurological disorders according to the modified Frankel scale before and after surgery

<table>
<thead>
<tr>
<th>Type of disorder</th>
<th>Before surgery</th>
<th>After surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>%</td>
</tr>
<tr>
<td>A</td>
<td>7</td>
<td>3.0%</td>
</tr>
<tr>
<td>B</td>
<td>4</td>
<td>1.7%</td>
</tr>
<tr>
<td>C</td>
<td>40</td>
<td>16.9%</td>
</tr>
<tr>
<td>D</td>
<td>24</td>
<td>10.2%</td>
</tr>
<tr>
<td>R</td>
<td>113</td>
<td>47.9%</td>
</tr>
<tr>
<td>RD</td>
<td>46</td>
<td>19.5%</td>
</tr>
<tr>
<td>S</td>
<td>1</td>
<td>0.4%</td>
</tr>
<tr>
<td>E</td>
<td>1</td>
<td>0.4%</td>
</tr>
<tr>
<td>Total</td>
<td>236</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Muscle strength, tactile, and pain sensitivity were evaluated according to this scale.

The study of muscle strength was performed according to a five-point scale [1] as follows:

- 0 – atonic paralysis, no signs of active muscle contraction;
- 1 – weak active contractions of some muscles, but without movement in the corresponding limb joint;
- 2 – distinct (visual) active muscle contraction with movement in the joint while excluding the weight of the limb;
- 3 – movements in joints, coping with only the weight of the limb of various amplitudes;
- 4 – full scope of movement in the joint with overcoming resistance, which can be measured by a dynamometer;
- 5 – a full range of movement with overcoming the weight of the limb with overcoming the resistance equivalent to the healthy symmetrical muscle.

After a two-sided estimate of muscle strength, the scores obtained in each segment were summarized, and the results were put down into the patient’s medical record. The maximum number of points for ten segments of each side was 50. In cases wherein muscle strength for some reason was not checked, the NT (not tested) mark was put down.

The following scale was used to study the sensitivity:

- 0 – no sensitivity;
- 1 – impaired sensitivity;
- 2 – normal sensitivity.

Neurological status was assessed before and after surgery, as well as in the following postoperative days. The control terms of assessment of the patient’s condition were the date of admission of the patient to the hospital, the 10th day after the surgery, and the day of discharge from the hospital.

After the conducted treatment, the following variations of the dynamics of motor disorders were distinguished: full recovery, significant improvement, stabilization with minor improvement, and aggravation. Full recovery corresponded to the limb strength of 5 points. Significant enhancements included 2–3 points increase in strength in two or more myotomes, which corresponded to the rise in the amplitude of movements of the patient.

A slight improvement in motor function included the increase in strength in 1–2 myotomes by 1 point with the appearance of movements in them or a slight increase in the scope of movements in the presence of deep pareses.

In assessing the sensorium, the following variations of disorders were distinguished:

- Full recovery: Characterized by normalization of all types of sensitivity from the damage level;
- Significant improvement: Decrease of the hypoesthesia level by 3–4 and more segments, as well as the transition of anesthesia to hypoesthesia for three or more segments and restoration of deep sensitivity in the limbs;
- Insignificant recovery of sensory impairment: Decrease of the hypoesthesia level by 1–2 segment from the initial state;
- Aggravation: Increase of the sensitivity disorders level from the initial state by two or more segments.

In the study of pelvic organ function, the duration of urine continence, sensation of bladder filling, and urine passing through the urethra were evaluated. The complete recovery included normalization of the bladder function. The significant improvement included an increase in the duration of urine continence for 2 hours or more, restoration of control over urination, and the sensation of bladder filling. Insignificant recovery included an increase in the urine continence time up to 2 hours. Aggravation included development of neurogenic bladder with urinary incontinence.

Thus, patients, according to the modified Frankel scale, were redistributed into groups, which subsequently allowed to evaluate neurological dynamics in general.

A general estimate of patients’ initial state included a mandatory examination by a neurosurgeon and, if necessary, by other specialists, which allowed to plan the scope of the study, taking into account concomitant somatic conditions typical of patients with vertebromedullary pathology. In detecting somatic pathology, purposeful additional examination and treatment of patients were carried out, the degree of readiness of each patient for the upcoming surgery was assessed.
The conducted study showed the possibility of using our modified Frankel scale in the conditions of the 24-hour urgent service of a multi-specialty hospital for treating patients with spinal canal deformities of various etiologies. Thus, one of the crucial aspects of the use of this scale is its simplicity and convenience, especially in the conditions of urgent service, where the use of detailed, complex, and cumbersome scales complicates the processes of urgent diagnostic and therapeutic measures.

The proposed scale of evaluation of neurological disorders makes it possible to see a follow-up pattern of the condition at admission during treatment and observation of patients with complicated spinal canal deformities of various etiologies. The scale is convenient for practical use by doctors of urgent specialized medical services.

Conclusions. The proposed modified scale of evaluation of neurological disorders in patients with vertebromedullary pathology, despite its simplicity, has shown its effectiveness, allowing to quickly obtain data necessary for making decisions on scheduling emergency medical procedures.

Disclosures: The authors declare no conflict of interest.

References

About authors:
Monashenko Dmitry Nikolayevich, CMSc, MD, Head of the Neurosurgery Department № 1; tel.: +79219987215; e-mail: d.monashenko@yandex.ru
Ivanova Natalia Evgenievna, MD, PhD, Professor, Head of the Scientific Department; tel.: +79112187149; e-mail: ivamel@yandex.ru
Davydov Evgeny Alekseevich, MD, PhD, Professor, Neurosurgeon; tel.: +79219646361
Smulsykh Mikhail Valerievich, MD, Neurosurgeon; e-mail: d.monashenko@yandex.ru
Oleynik Ekaterina Anatolyevna, Neurologist; tel.: +79119319677; e-mail: ek_oleynik@mail.ru
Ulitin Alexey Yuriievich, MD, PhD, Director; tel.: +78126704428; e-mail: ulitinaleks@mail.ru