HIP-SPINE SYNDROME: A NON-SYSTEMATIC LITERATURE REVIEW

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Design: non-systematic literature review. The aim of the study was to analyze the current state of the problem of treating patients with hip-spine syndrome. Diagnosis and treatment of a combination of degenerative pathologies in the hip joints and spine are complicated due to the significant coincidence of the symptoms of the diseases. Loosening of hip endoprosthesis components remains the second most common cause of revision surgery after infection. Increasing awareness of the mobility of the spinopelvic complex, as well as taking into account the sagittal alignment of the trunk, are important for improving the quality of surgical treatment of patients with hip-spine syndrome. Currently, there is no established tactical surgical algorithm for treating patients with hip-spine syndrome: there is no consensus on which pathological condition should be treated first, and algorithms for the sequence of surgical treatment of the spinopelvic complex require supplementation and consolidation by prospective studies.

Key words: hip-spine syndrome; coxo-vertebral syndrome; coxarthrosis; degenerative diseases of the spine; spinal stenosis; hip replacement.
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Hip-spine syndrome is a set of symptoms resulting from concurrent impairments of the lumbar spine, lumbosacral spine and hip joints that is confirmed by imaging techniques and has corresponding clinical signs, however, unfortunately, with their different interpretations.

Offierski and MacNab are considered to be the first who described hip-spine syndrome and presented their classification in 1983 [1]. The basic principle of this classification is to identify the main reason of disability in patients with combined radiologically confirmed abnormality of the lumbosacral spine and hip joints. Patients examined by the authors were divided into 3 groups:

1) *simple (or primary) type:* patients with symptoms who can be easily classified as having a hip joint or spine disease because of one source of pain according to the medical history, clinical examination, or using a diagnostic nerve block;

2) *complex type:* patients with symptoms and clinical examination results that give a confusing presentation; therefore, it is difficult to determine the main reason of disability; the source of pain in such patients is combined, and it is hard to find the prevailing one;

3) *secondary type:* patients who were classified as having hip joint or spine diseases according to the medical history, physical examination, or diagnostic nerve block results; the source of pain in such patients is combined; the prevailing source is easily identified, however, it is secondary to changes and deformations of the adjacent part of the lumbo–pelvic–hip complex.

A separate group of patients (Group 4) included patients with an incorrectly diagnosed type of syndrome based already on the treatment performed: patients who underwent primary surgical treatment that did not lead to relief of pain syndrome and required additional intervention on the adjacent part of the lumbo–pelvic–hip complex. This classification stays relevant to the present day [2–5, 6]. However, simple grouping of the syndrome depending on the predominant pathology does not provide a full representation of the changes in the lumbo–pelvic–hip system and does not indicate the entire multiplicity of the relationship between the pelvic ring and the hip joints, which are essentially the base of the spine and take the main axial load of the anatomical structures above the pelvis [7].

The objective was to analyze and to summarize information on the issues of diagnosis and management of patients with hip-spine syndrome from 1983 to 2024.

Material and Methods

Design: a non-systematic literature review.

The search was conducted using five electronic databases: PubMed, Ovid Medline, Cochrane Library, Google Scholar, and resources of eLibrary from 1983 (the first mention of hip-spine syndrome) [1] to 2024 inclusive. There were no limitations on the level of evidence for the studies under consideration. To maximize the sensitivity of the search strategy, the terms *hip-spine, coxo-vertebral syndrome, coxarthrosis, degenerative dystrophic diseases of the spine,* and *hip replacement* were combined into keywords and terms for the search.

Inclusion criteria were the following:

1) open access publications, with no limitations related to the type and language;

2) publications containing information on the epidemiology of concomitant pathology of the hip joints and lumbosacral spine and on complications of surgical treatment for hip-spine syndrome;

3) publications describing algorithms and strategies for diagnosing hip-spine syndrome;

4) publications describing the selection of surgical strategies for hip-spine syndrome.

Exclusion criteria were the following:

1) publications indicating local pathology of the lumbosacral spine or hip joints;

2) non-surgical treatment of hip-spine syndrome;

3) duplicated publications.

Results and Discussion

1,431 publications were obtained as a result of this search. When evaluating according to the inclusion/exclusion criteria, 91 sources were included in this review.

Issues related to the hip-spine syndrome can be described with several aspects.

Relevance of the hip-spine syndrome

• *Significant prevalence of patients with concomitant degenerative pathology of the lumbosacral spine and hip joints.*

Osteoarthrosis is the most common disease of the musculoskeletal system associated with old age, and the second most significant cause of disability in the elderly, after cardiac diseases [8]. It is detected by radiological examination in more than 80% of individuals aged over 55; more than 40 million US citizens have this condition [9]. Radiological signs of knee osteoarthrosis are detected in 40% of individuals aged over 80, while radiological signs of coxarthrosis are registered in 12% of individuals aged over 80 [9–11]. Lumbar spinal stenosis as a type of arthrosis manifestation is also common. It was found that 39 million (0.53%) people worldwide are annually diagnosed with spondylolisthesis, 403 million (5.5%) – with symptomatic disc degeneration, and 103 million (1.41%) – with spinal stenosis [12]. Upon that, spondylolisthesis as a type of stenosis can be observed in 6% of males and 9% of females [13]. Spine CT results revealed the 3.4% frequency of spinal stenosis in individuals aged over 40. Moreover, MRI can demonstrate even higher rates: a study conducted by Borenstein et al. [13] showed 60% prevalence of stenosis among individuals aged over 60. Degenerative pathologies of the spine and hip joint are often concomitant [14–16], while only 3.5% of patients with total hip replacement (THR) had previously undergone spine surgery [17]. In 2017, at least one million hip replacement surgeries were performed worldwide [11, 18]. In the United States, 438,000 THRs were performed in 2010 [19]. The true incidence of combination of lumbar stenosis and hip arthrosis is unknown [9], however, if we consider 1,000,000 THRs, the proportion of patients with spine surgery will be at least 35,000 patients.

• *Significant risk of postoperative complications: loosening of hip prosthesis components.*

Despite significant advancement in technologies, loosening of hip prosthesis components stays the second most common reason for revision hip surgery, following infections [20, 21]. Numerous studies have confirmed an increased rate of dislocations and revisions in patients with spinal deformity [22–25], rigid spine [26, 27], as well as in patients who have previously undergone hip replacement combined with lumbar fusion [28–32]. An increased risk of hip dislocation and revision was demonstrated in patients with concomitant deformity of the trunk profile in sagittal plane with high pelvic tilt (PT >20°) and LL-PI ratio >9° [22–24].

These researches involved 1,167 patients and reported a total of 34 (2.9%) dislocations. A.V. Peleganchuk et al. [2] demonstrated an increased risk of dislocations of the femoral component of prosthesis in patients with Roussouly posture types 1, 2, and 4. Excessive compensatory increase in posterior pelvic tilt in order to maintain an upright position leads to anteversion of the acetabular component; it increases the risk of impingement and dislocation of the femoral component, and, as a rule, contributes to loosening of prosthetic components, especially of the acetabular one [22–24].

A number of authors provided similar information on the risks of loosening and revision rate of the hip joint prosthesis in case of rigid spinopelvic complex; it indicates the high significance of assessing the motion of pelvis and lumbar spine in the sitting and standing positions when planning hip joint replacement. One study revealed a relatively low incidence of dislocations (1.55%), however, an increase to 2.73% was observed with short spinal fusions (1–2 levels). Multilevel fusion involving three or more levels is associated with an increased risk of dislocations with rates tripling and reaching 4.62%. [33]. Bedard et al. [34] report 8.3% dislocations of the femoral component in patients who underwent spinal fusion and THR vs 2.9% in those who underwent THR only. In this context, the authors do not specify the level of fusion in the lumbar spine, although it is known that the further it is from the pelvis, the lesser the effect on pelvic tilt. Similar results were reported by Sing et al. [31], with no specified level of fusion, stating only the fact that it was performed: according to their results, the revision rate in patients who underwent THR only was 7.3% after 24 months of follow-up. In patients with short fusion (<2 levels), this value increases to 11.2%, and it reaches 14.2% in patients with long fusion (>2 levels) [32]. Perfetti et al. [33] also reported relatively high risks of dislocation (7.19%) and revision (4.64%) after previous fusion.

Difficulty in diagnosing hip-spine syndrome

• *Difficulty in finding the prevailing source of hip-spine syndrome pain, disability and its reason (hip joint, spine, hip joint – spine).*

Each patient with concomitant pathology of the hip joint and spine requires a personalized approach to diagnosis. The clinical presentation is characterized by a variety of symptomatic manifestations. A number of authors take up the position that pain syndrome in coxarthrosis, arthrosis of the sacroiliac joints, and degenerative changes in the lumbosacral spine have similar manifestations, and this complicates the task of clinical verification of the prevailing pathology or source of pain syndrome [35–39]. Several individuals may have isolated areas of pain in the extremities: thigh, knee, calf muscle, ankle, or heel area [40]. Pain associated with degeneration of the hip joint is localized in the groin (84% of cases), gluteal region (76 %), anterior thigh (59%), posterior thigh (43%), anterior knee (69%), lower leg (47%), and calf (29%) [41, 42]. In patients with lumbar spine diseases, pain is of various origin (discogenic, facet, radicular) and is described by multiple and combined irradiation; all of this also does not help to find the source of pain [43]. If a patient with lumbar spine and hip joint diseases experience pain only on the lateral surface of the lower leg, determining its origin can be extremely difficult [41]. Finding the source of pain may be complicated by the clinical syndrome related with changes in the sacroiliac joints that often conceals radicular lesions. The pain is often unilateral and lateralized in the projection of the sacroiliac joints. The most specific area of sacroiliac joint damage is the area located immediately below the posterior superior iliac spine; it is approximately 3 × 10 cm in size (known as the Fortin area) [44, 45]. Pain radiates to the gluteal region in 94% of cases, to the lower lumbar region in 72%, and spreads to the lower extremities along the posterolateral surface of the thigh in 50%. Pain radiates below the knee in 28% of cases, to the foot in 12%, to the groin area in 14%, to the upper lumbar region in 6%, and to the abdomen in 2 % [45, 46]. In several cases, patients cannot provide accurate description of their pain, and it results in a long diagnostic search. A clear illustration of pain irradiation considering dermatomal innervation in concomitant pathologies that hinders in diagnosing the prevailing source of pain is provided in Fig. 1 [44–50].

A careful history taking and physical examination often allow distinguishing between radicular pain and joint pain; however, the differentiation is sometimes extremely difficult [40]. When it is hard to identify the prevailing source of pain, ENMG, diagnostic injections into the hip joint (blocks), paravertebral blocks, and sacroiliac joint blocks are used, however, their sensitivity varies from 75 to 87% [41].

• *There is no established algorithm for instrumental examination of patients with hip-spine syndrome.*

Changes in the spine and hip joints are visualized using radiological imaging, including radiography, CT, and MRI of these areas. Publications over the last 20 years indicate a growing interest in assessing the biomechanical relationship between the hip joint and the spine in connection with its effect on the incidence of hip joint prosthetic instability (dislocations) [51–55]. The spine, pelvis, and femur move in a coordinated way with each other in everyday life, and the acetabulum being a part of the pelvis changes its 3D orientation together with the pelvis depending on the standing, sitting, and forward bending of the trunk [56–58]. By the principle of incidence, this also applies to the acetabular component of the prosthesis after total hip replacement. Such changes can be observed on radiological images in the standing and sitting positions that involve the L3 vertebra and the proximal femur [59]. Due to the growing interest in assessing the biomechanical relationship of the hip joint and spine, most authors point out the importance of performing anteroposterior radiography of the spine and pelvis in a standing position and lateral radiography of the spine and pelvis in a standing and sitting position for patients with hip-spine syndrome and recurrent dislocations of the hip prosthesis [20, 56, 60] (Fig. 2). Based on the radiological images, motion of the lumbo–pelvic–hip complex is analyzed and the parameters of the trunk sagittal profile are calculated. V.V. Pavlov et al. [16] proposed an alternative method for measuring sagittal balance parameters in patients in standing and sitting positions, while focusing on the change in the rotation axis: from the acetabular one in the standing position to the sciatic one in the sitting position; it can help to determine the causes of hip joint prosthesis dislocations when the acetabular component is in the safe zone (Fig. 3).

To standardize terminology and to simplify the understanding of the lumbopelvic interaction, the Hip and Spine Workgroup was made for the first time at the 2018 annual meeting of the American Academy of Orthopedic Surgeons (AAOS). A list of terms commonly used in the literature was developed, and the parameters required for evaluating the interaction of the hip-spine complex were defined [57, 61, 62]. The basic parameters with their features assessed using lateral radiological images of the spine and pelvis in the standing and sitting positions are provided in Table 1 and Fig. 4.

Choice of treatment strategy for hip-spine syndrome

• *What should be operated first (hip joints or spine)? Which area of surgery should be chosen for the first stage?* Is *the patient's condition improvement possible after the first stage? To what extent is the second stage of treatment necessary? Should patients with hip-spine syndrome be treated in two stages?*

These issues indicate the ambiguity of approaches to the management of concomitant pathologies.

The only scenario that leads to absolute agreement and does not generate doubts in the choice of surgical priority between hip surgeons and spine surgeons is when the patient demonstrates signs of myelopathy and root compression with radiculopathy. In these cases, the choice in favor of primary spine surgery is obvious [68–70]. Moreover, the clinical effectiveness of spine surgery can be significantly reduced by delayed treatment, especially if the delay exceeds 12 months after THR [71]. This is associated with the progressing demyelination because of chronic compression that worsens postoperative recovery [72, 73]. Delayed THR, especially in case of significant clinical improvement after spine surgery, only reduces the possibility of further revision arthroplasty [71]. This is quite understandable, especially considering current trends in surgery, with the use of minimally invasive and endoscopic techniques that contribute to early postoperative recovery even in elderly patients [74].

In all other respects, there are many controversies between physicians and their teams. The most debatable situation arises in regard to patients with pain caused by both coxarthrosis and degenerative disease of the lumbar spine, and with no neurological symptoms (patients with complex and secondary types of hip-spine syndrome). Several authors declare for performing primary spinal surgery because of the confirmed clinical benefit [75, 76] and a faster and more effective recovery period [72, 73]. However, recovery can be problematic in this case because of the persistent contractures of the hip joints and, consequently, decreased pelvic motion associated with coxarthrosis or extended spinal fusion; it will result in spinal pain decrease, however, will not improve the function of the hip joint and the clinical symptoms caused by its damage. This is understandable, since such a situation will not lead to a satisfactory result and full recovery of a patient. At the same time, patients who underwent spinal surgery after a previous THR do not experience the desired pain relief aspatients with no previous THR [77, 78].

Spinal surgery as a first stage may be important for patients with deviations in sagittal profile values, with high pelvic tilt (PT more than 20°) and a change in the LL-PI ratio >9°, since it improves the functional orientation of the acetabulum making a corridor of sufficient pelvic version [79]. The outcomes of sagittal profile correction surgeries indicate a significant reduction

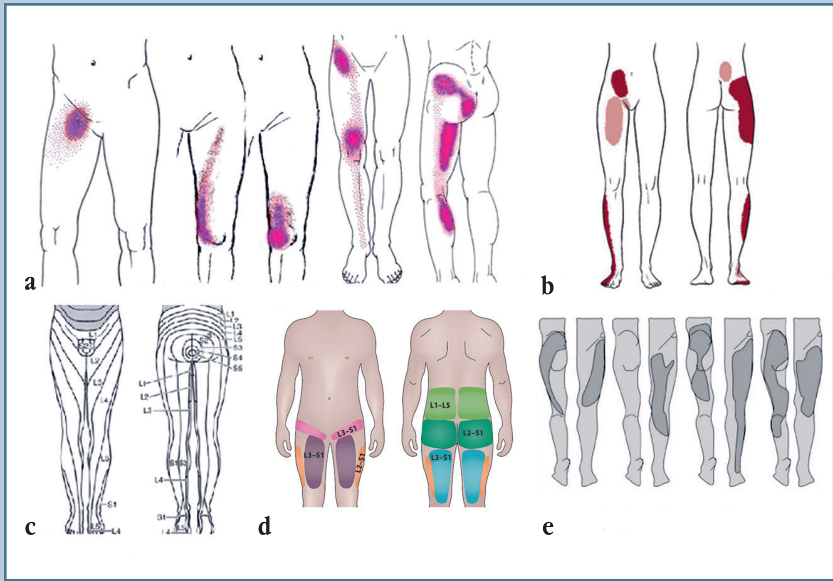

Fig. 1
Distribution of pain depending on its source: **a** – pathology of hip joints; **b** – pathology of sacroiliac joints; **c** – lesion of the nerve roots in the lumbosacral spine; **d** – lesion of facet joints in the lumbosacral spine; **e** – lesion of intervertebral discs in the lumbosacral spine [44–50]

Fig. 2
Radiographs of a male patient with pathology of the spine and hip joints: **a** – sitting position; **b** – lateral radiograph in a standing position; **c** – frontal radiograph

in previous excessive anterior anteversion (AA) (mean reduction range 4.96–11.2°, $p < 0.001$) and acetabular inclination (AI) (mean 7° ± 10°, $p < 0.001$) with correction of spinopelvic parameters; it may further indicate the correct positioning of the hip replacement components [79–83]. However, as mentioned previously, long-term fixation results in limited pelvic version. This is the cause of one of the potential disadvantages of primary fusion performed before THR, i.e. limitation of the pelvic version that increases the risk of postoperative complications, especially impingement, dislocations, and hip joint prosthesis instability [20]. Although it gives cause for reasonable concern, there are techniques that could reduce this risk, for example, the use of dual-mobility components in arthroplasty [84].

Many authors declare for primary hip surgery in patients without neurological signs because of many cases of hip flexion contracture in such patients; its elimination leads to an improvement in quality of life and pain relief, including pain in the spine [6, 22, 51, 68]. It also allows for optimal positioning of the patient on the operating table to perform spinal surgery and contributes to the improvement during subsequent rehabilitation. The authors of several publications provide data demonstrating that lumbar spine surgery before THR is associated with lower decrease in pain, deterioration in quality of life, and lower patient satisfaction one year after THR [17, 85, 86].

Attempts to develop an algorithm for selecting the order of surgical treatment in regard to spine and hip joints are ongoing. The algorithm proposed by Sultan et al. [22] may be considered the most advanced and revised one. The authors performed the literature review and proposed an algorithm to select the order based on the assessment of the presence/absence of hip joint contracture and the presence/absence of the trunk sagittal imbalance in patients with concomitant spinal deformity and grade 3 coxarthrosis (Fig. 5).

The main consideration limiting the use of this algorithm in all patients with hip-spine syndrome is the lack of consideration of the presence/absence of neurological signs, as well as the lack of justification by prospective trials.

• *Spatial orientation requirements for the acetabular component implantation: the issue of the safe zone for placing hip prosthesis acetabular component; the issue of a hip prosthesis selection; the issue of using spinal stabilization devices.*

The criteria for positioning the acetabular component in total hip replacement are the matter of heavy discussions, especially with regard to the optimal angle of acetabular component anteversion [20].

In 1978, Lewinnek et al. [87] proposed a safe zone for cup placement defined by the range of the acetabular inclination (AI) and anteversion (AA). When placing the acetabular component in this range, the risk of impingement of the femoral neck with the acetabular component or edge loading was reduced while maintaining joint motion in the adequate range. The authors recommended 30°–50° inclination with 5°–25° anteversion [20, 87]. Later, it was found that the acetabular component was within the safe zone in most cases of femoral component dislocations [88] indicating limited effect of this zone and other factors. Amuwa and Dorr [89] reported that the measure of the anteversion angle can have an effect on the incidence of dislocations and indicated a target value of 35° for combined anteversion (acetabular component anteversion + femoral component anteversion) with a safe zone 25°–50° for acetabular component inclination. It was also demonstrated that the trunk balance has an impact on the 3D orientation of the acetabulum and the functional shape of the hips [56]. The risk of premature wear, impingement, and edge loading of the acetabular component was found to be higher with acetabular component inclination over 45°, so the boundaries of the safe zone were adjusted to reduce inclination to 30°–45° and anteversion to 5°–25° [25].

Fig. 3
Radiographs of a male patient in the standing and sitting position with calculation of PI, PT and sciatic PT (change in the point of rotation from acetabular one in standing position to sciatic one in sitting position) [16]

Table 1

The main biomechanical parameters of the spine and pelvis with a description of their calculation and an indication of the conditional norm, assessed on direct and lateral radiographs of the spine and pelvis with the patient standing and sitting [20]

Term	Definition	Norm for population [59]		
		standing	sitting	difference between standing and sitting
Sacral slope (SS)	The angle formed between the line of the S1 superior endplate and the horizontal line	40° ± 10°	20° ± 9°	11–29°
Pelvic tilt (PT)	The angle formed between the vertical line and the line drawn from the middle of the S1 endplate to the center of the femoral head	13° ± 6°	–	–
Pelvic tilt / pelvic incidence (PI)	The angle formed between the line drawn from the midpoint of the S1 endplate to the center of the femoral heads and the line perpendicular to the midpoint of the S1 endplate. This is the sum of the pelvic tilt angle and the sacral slope (PI = PT + SS)	53° ± 11°	53° ± 11°	–
Anterior inclination of the acetabulum / cup (Ante-inclination or AI)	The sagittal angle of the acetabulum (or cup in case of total hip replacement), which is a combination of both the anterior (anteversion) and inclination (inclination) positions. It is the angle between the line tangent to the anterior and posterior edges of the acetabulum and a horizontal line [63]. When calculating this angle from a frontal radiograph, the anteversion of the acetabulum is measured separately using the technique by Callaghan et al. [64], and the inclination of the acetabulum is measured separately using modified technique by Ackland et al. [65].	35° ± 10°	52° ± 11°	–
Pelvic-femoral angle (PFA)	Sagittal position of the hip joint and femur is an indicator of hip flexion in the sitting position and extension in the standing position relative to the position of the pelvis. It is measured as the angle between the line from the middle of the S1 endplate to the center of the femoral heads and the second line parallel to the femoral shaft [66, 67]	180° ± 15°	125° ± 15°	51–69°
Combined sagittal index (CSI)	The acetabular angle in sagittal plane, which is the sum of anterior inclination (AI) of the acetabulum / cup and the pelvic femoral angle (PFA)	203–233°	162° ± 198°	–

In 2017, a target zone of up to 40°–50° AI and 15°–30° AA was proposed based on post-arthroplasty pelvic CT, which was based on the position of the acetabular components [25]. Considering the differences in reference planes, the mean recommended safe zone was 41° of inclination and 16° of anteversion for radiological angles, and 39° and 21° for surgical angles, respectively [90].

Recently obtained data indicate that positioning the acetabular component in the safe zone without considering the patient's anatomy and kinematic variations in the spinopelvic complex does not reduce the incidence of femoral component dislocations [25, 51]. With the consideration of the biomechanics of the spine and hip joints, radiological examination of the patient in the standing and sitting positions can help to define the optimal position of the hip acetabular component [12, 20]. Classifications of the kinematics and biomechanics of the spinopelvic complex were developed based on radiological images in the standing and sitting positions (Table 2). These classification systems include the degrees of motion for the spine and pelvis based on the difference in SS between the standing and sitting positions: very flexible (SS difference >30), rigid (SS difference <10), normal (SS difference in the range of 10–30). Parameters for spinopelvic complex alignment were also proposed [59]. All of this provides valuable information when discussing the treatment of patients with concomitant hip and spine diseases. However, further studies are required to develop a unique validated classification system approved by orthopedists and neurosurgeons and prospectively tested on a sufficient number of patients to provide a standard surgical algorithm [56].

The Bordeaux classification of the hip-spine relationship developed by Riviere et al. [60] is currently the most complete and comprehensive one. It describes relations between the pelvis and the spine and allows stratification of the risks of impingement or femoral component dislocation according to the type of hip-spine relations. The classification also requires a lateral radiological image of the entire spine with the patient standing and sitting. The aim is to evaluate PI, SS, PT, and the physiological relationships between them (PI = PT + SS; LL = 0.54 × PI + 27.6) [56]. The classification includes the following:

1) assessment of Roussouly spinal sagittal alignment (flat-back types 1 and 2 with PI <40° and types 3 and 4 with greater curves; Fig. 6);

2) acetabulum type: acetabulum with high anterior anteversion (type 1) and acetabulum with low anterior anteversion (types 2 and 3; Fig. 6);

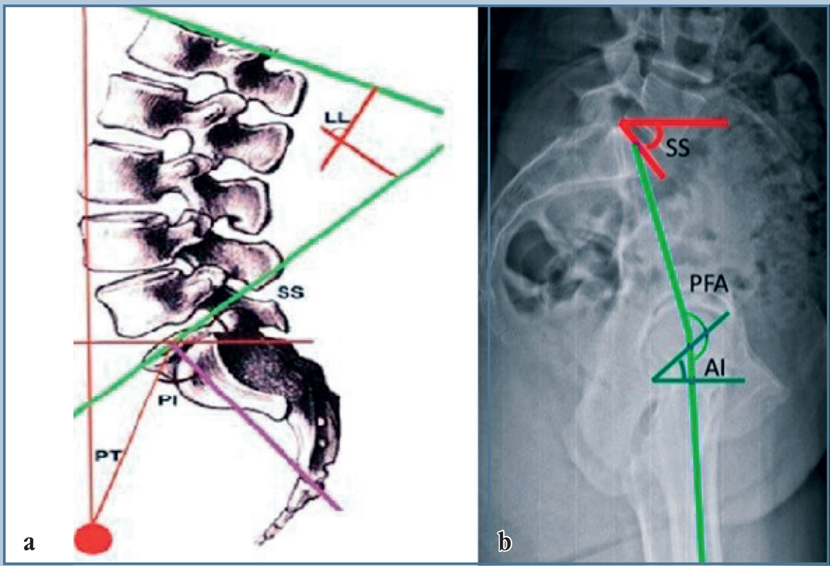

Fig. 4
Measurement of biomechanical parameters of the spine and pelvis: **a** – assessment of the sacral slope SS, pelvic tilt PT, pelvic incidence PI; **b** – assessment of the pelvic-femoral angle PFA, sacral slope, anterior inclination of the acetabular cup AI

3) assessment of the spinal sagittal profile and the corresponding acetabulum type allows distinguishing between type 1 and type 2 spinopelvic complexes. Type 1 complex is a combination of type 1 or 2 spine and type 1 acetabulum; patients with type 1 spinopelvic complex usually use the hip joints for motion in their daily activities (the so-called "hip users"); type 2 complex is a combination of type 3 or 4 spine and type 2 or 3 acetabulum; patients with type 2 spinopelvic complex, as a rule, use the spine for motion in their daily activities (the so-called "spine users"); and

4) modifiers A, B, C, D, and F (Table 3).

This classification has the following limitations: complexity, lack of link to specific for each category surgical strategies (recommendations only), and the current low level of evidence (level 5, specialist opinion) [56].

Current publications describe no established surgical algorithm for the treatment of patients with hip-spine syndrome. Russian scientists A.L. Kardashev et al. [70] proposed a comprehensive algorithm for the surgical treatment of patients with hip-spine syndrome, indicating the sequence of surgical intervention (the main criterion is the presence/absence of progressive neurological deficit) and the strategy for surgical intervention (Fig. 7). This algorithm includes the motion and relationships of the spinopelvic complex in the sagittal and frontal planes, with a detailed description of the types of static deformation of the spinopelvic complex in the frontal plane [91], as well as options for their correction (replacement with lengthening of the lower extremity/hip replacement with increasing the center of rotation/hip replacement with femoral shortening osteotomy). Placement of the acetabular component is described without details: implant the acetabular cup in the true center of rotation of the hip joint considering its anatomical anteversion and inclination.

Ongoing work on the analysis of the syndrome led to the development of a more advanced and revised algorithm described by Batra et al. [20]. This algorithm considers the motion of the lumbo–pelvic–hip complex and the types of relations between the spine and pelvis. The authors included several additional types of spinopelvic relations in the algorithm: 1) kyphotic type with normal motion (normal kyphotic) and rigid spinopelvic complex (stuck kyphotic); the kyphotic type that is defined as the absolute value of the sacral slope (SS) in the sitting position of less than 5° in regard of the spinopelvic parameter, regardless of motion; 2) fixed anterior type/stuck standing position is defined when the sacral slope in the sitting position is >30°; this can be interpreted as maintaining the pelvic position typical for the standing position while sitting; this condition develops after lumbar spine fusion when lordosis is restored; 3) fixed posterior/stuck sitting position is defined when the sacral slope in the standing position is <30°; this can be interpreted as maintaining the pelvic position typical for the sitting position while standing; this situation usually develops after flat spinal fusion or in patients with ankylosing spondylitis; it predisposes to posterior impingement and subsequent anterior dislocation in the standing position (Fig. 8).

The main limitation of the algorithm provided is the need for its justification by prospective studies, and its application requires thorough preoperative planning with mandatory analysis of sagittal balance parameters. The practical application of the obtained target values can be performed only with the navigation technologies, and the value of preoperative planning is reduced in their absence; their use is justified only when establishing the causes of recurrent dislocation and supporting the choice of dual-mobility prostheses. Moreover, this algorithm does not include a surgical treatment if there is a deformity in the frontal plane, in contrast with the study performed by A.L. Kudyashev et al. [70].

Based on the above algorithms of surgical treatment that specify the

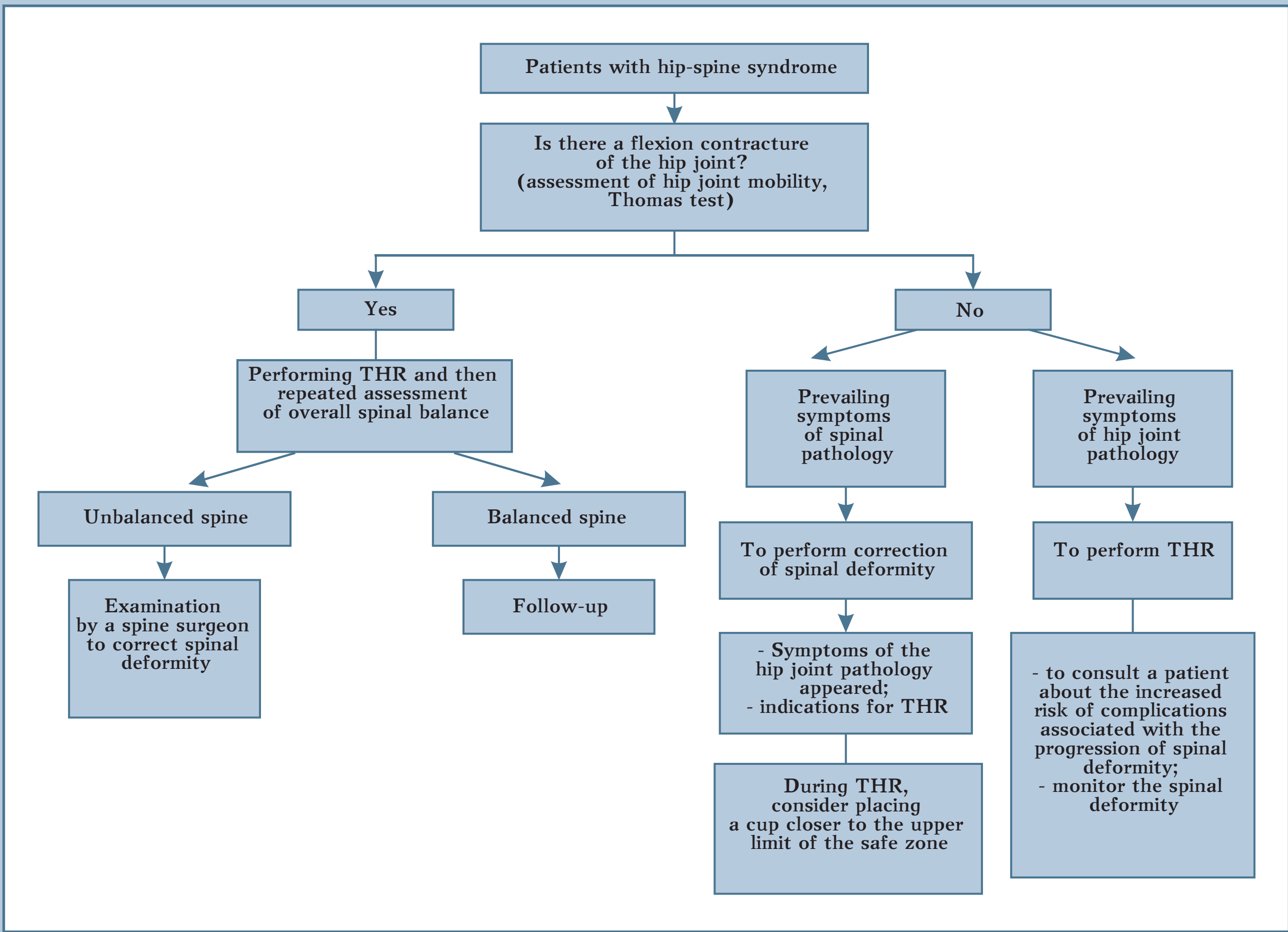

Fig. 5
A Russian-translated version of the algorithm for the sequence of surgical interventions in patients with hip-spine syndrome, taking into account the presence/absence of flexion contracture of hip joints and the presence/absence of sagittal imbalance of the trunk, proposed by Sultan et al. [22]: THR – total hip replacement

sequence and strategy, we offer for discussion a revised comprehensive algorithm for surgical treatment of patients with severe concomitant degenerative changes of the spine and hip joints (grade 3 coxarthrosis + degenerative changes in the spine) provided in Fig. 9. The algorithm describes the criteria for answering the questions: *What kind of surgery should be performed first? and How the surgery should be performed?*

The initial determining factor is neurological deficit or compressive radiculopathy that often requires minimally invasive surgery to eliminate. Another control point is hip contracture that requires surgical replacement of the joint for the above reasons. Further decision-making depends entirely on the sagittal and frontal profile of the patient. The presence of sub- or decompensated sagittal imbalance is critical for performing spinal surgical intervention; in any other case, the primary and most significant is surgical treatment of the hip joint condition according to the accepted algorithms.

Individual clinical presentation should undoubtedly become the determining factor in the treatment of each patient; therefore, the algorithm provided cannot be seen as an ultimate one and requires further discussion and analysis including prospective studies.

Conclusion

- The high prevalence of patients with concomitant pathology of the hip joints and spine is beyond question. Diagnosis and treatment of patients with a combination of hip and spinal degenerative conditions are complicated by significantly overlapping symptoms and impossibility to perform one effective intervention with the clinical significance of both pathologies.
- There is no consensus on the issue of which condition should be treated

Table 2

Classifications of spinopelvic complex kinematics used for surgical treatment planning in patients with hip-spine syndrome [20]

Authors	Classification types	Main parameters	Disadvantages
Stefl	Fixed anterior tilt Fixed posterior tilt Kyphotic Hypermobile	Mobility (SS difference)	Spinal alignment was not considered
Plan	Rigid and balanced Flexible and balanced Rigid and unbalanced Flexible and unbalanced	Balanced (PT <25° and PI–LL <10°)	Types with stuck sitting and stuck standing are not considered
Luthringer	Normal mobility and alignment Normal alignment and stiffness Hypolordosis with normal mobility Hypolordosis and stiffness	Mobility (SS difference) Alignment (PI–LL <9°)	Kyphotic and hypermobile types are not considered

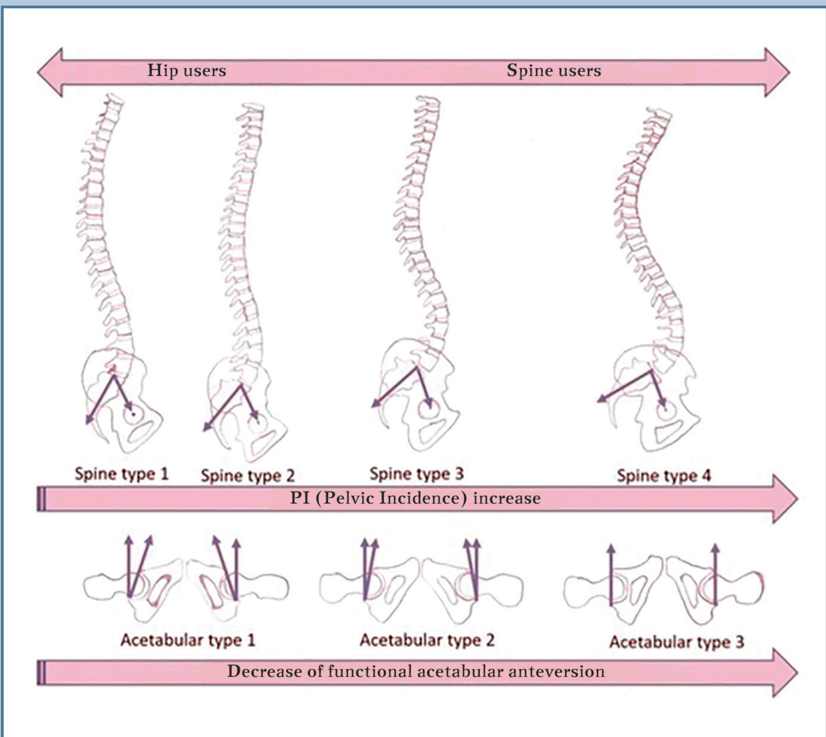

Fig. 6
A Russian-translated version of Bordeaux classification of hip-spine relations: types of relations [60]

first. Algorithms for the sequence of surgical treatment on the spinopelvic complex require revision and justification by prospective studies. Publications describe no established surgical strategy for treating patients with hip-spine syndrome.

- Extending the diagnostic algorithm with new imaging techniques, increasing awareness on spinal motion, and better understanding of sagittal alignment can improve the treatment outcomes for patients with hip-spine syndrome.
- If a patient with hip-spine syndrome has a spinal pathology that requires surgical treatment, and it will result in the lower lumbar vertebrae fixation with the sacrum, this may lead to limited compensatory mechanisms of the pelvic version.

The study had no sponsors. The authors declare that they have no conflict of interest.
The study was approved by the local ethics committees of the institutions. All authors contributed significantly to the research and preparation of the article, read and approved the final version before publication.

Table 3

Additional modifiers of the hip-spine relations to Bordeaux classification [56]

Indicators	Modifiers				
	A	B	C	D	F
Assessed parameters	SS difference standing — sitting >10°	SS difference standing — sitting ≤0°	SS difference standing — sitting >10°, compensated spinal profile	SS difference standing — sitting >10°, unbalanced spinal profile	Fixed spine
Interpretation of outcomes	Physiological mobility	Stiffness	Modifications associated with aging of the spine	Modifications associated with aging of the spine	Spinal surgery
Risk assessment	Very low	Moderate	Moderate	Very high	Very high

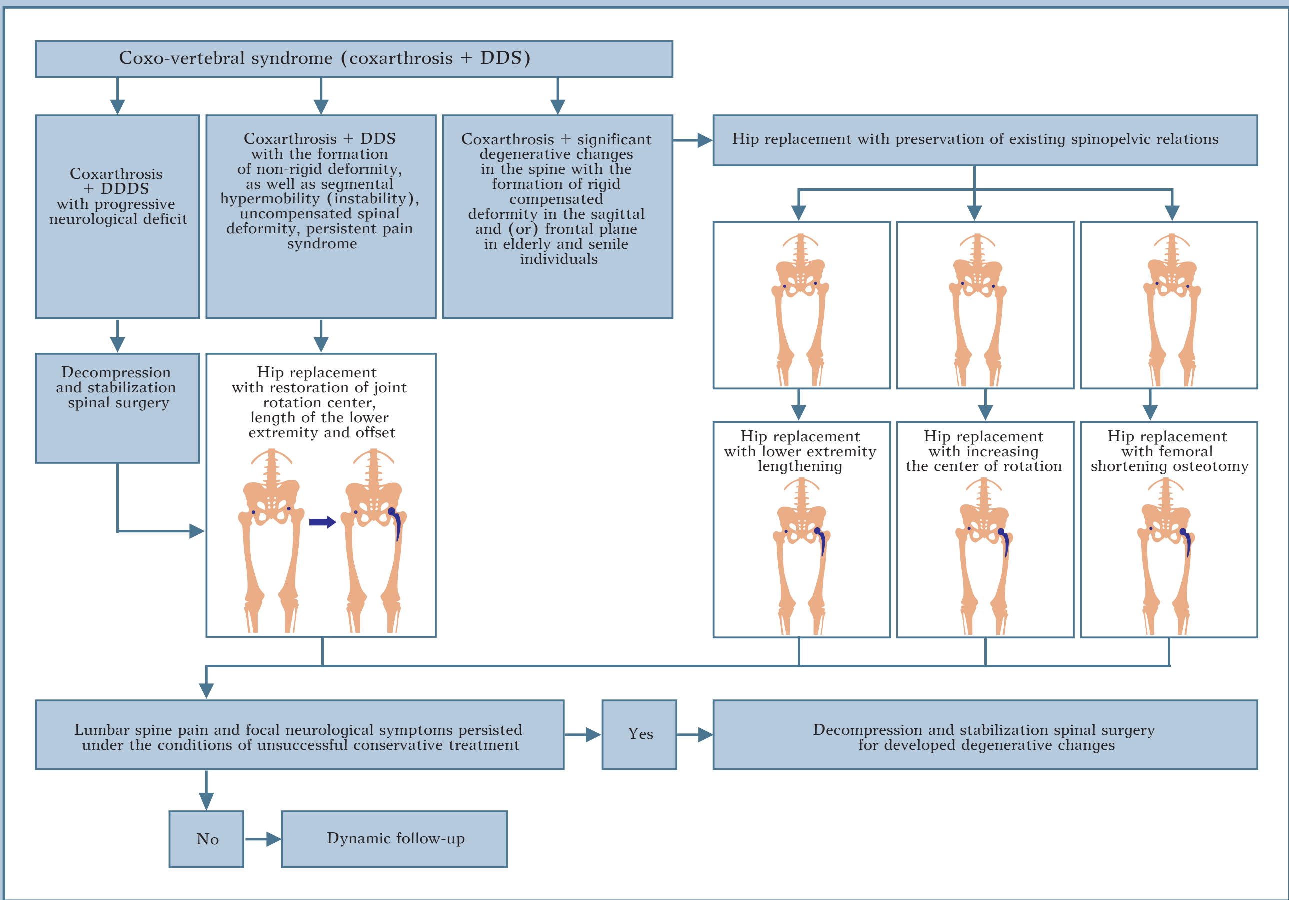

Fig. 7
Algorithm for choosing a reasonable strategy for surgical treatment of patients with combined degenerative pathology of a hip joint and spine [70]: DDS – degenerative diseases of the spine

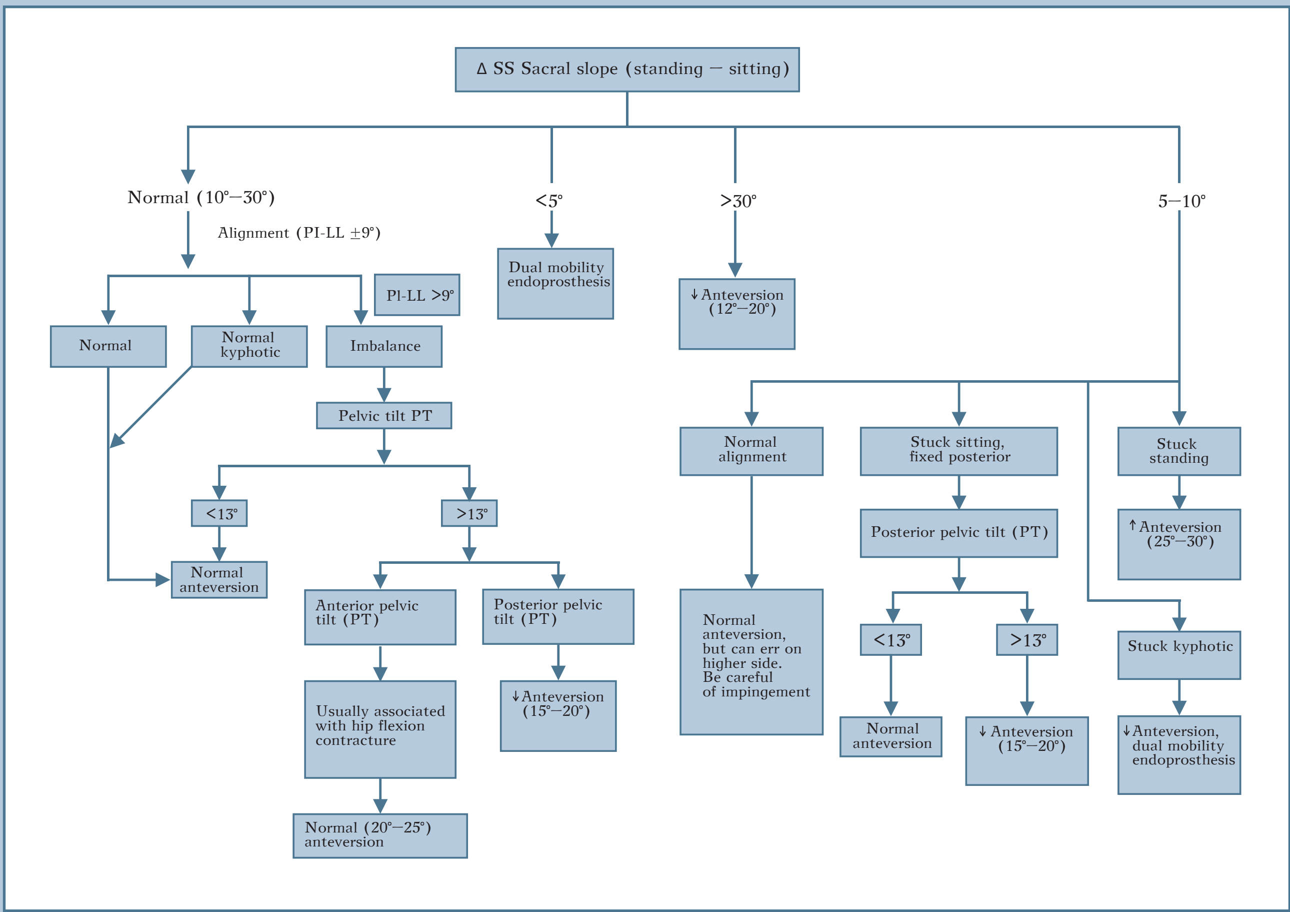

Fig. 8
A Russian-translated version of the strategy algorithm for hip replacement, considering the types of biomechanical relations and mobility of the spine and pelvis [20]

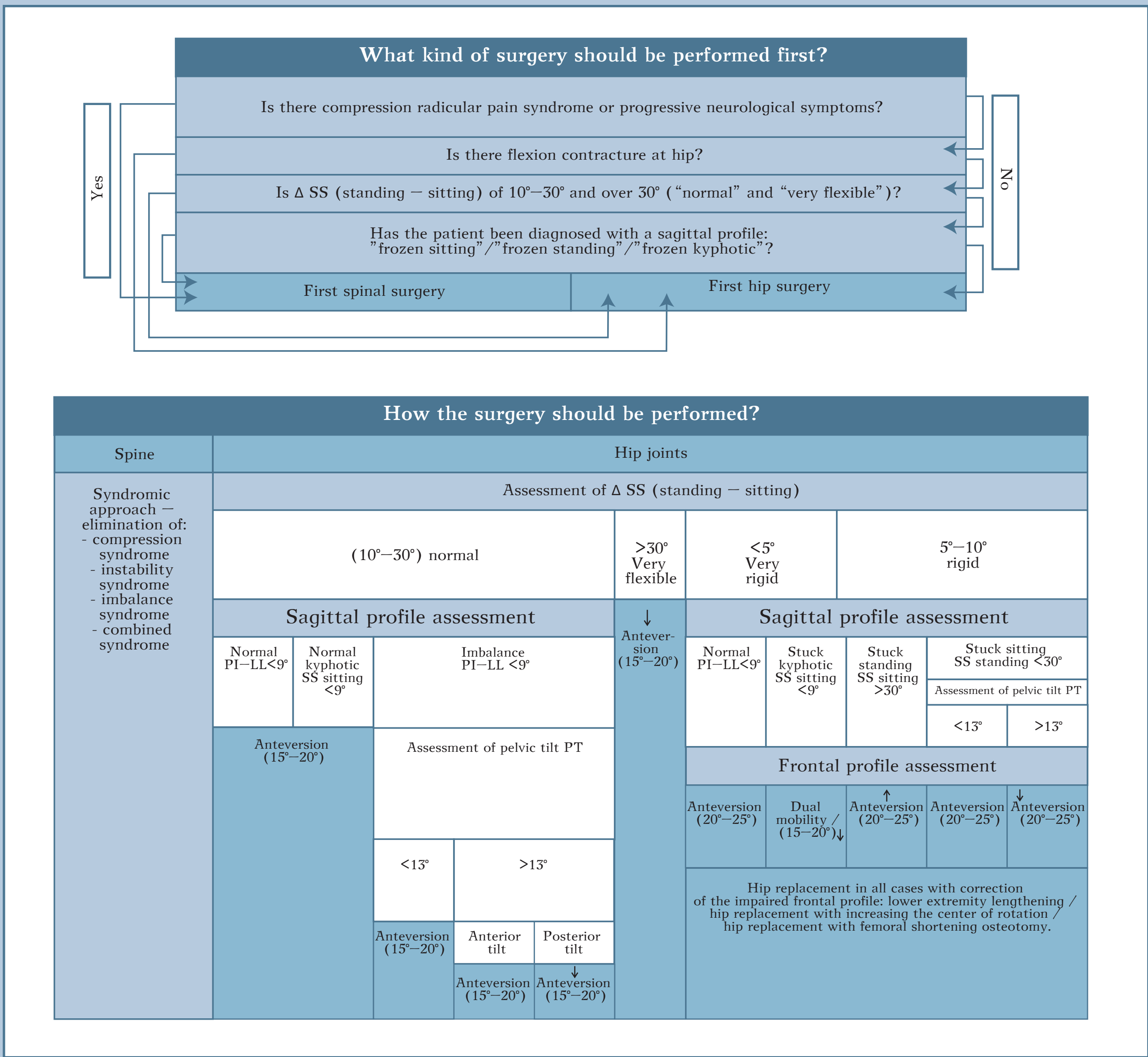

Fig. 9
Algorithm for surgical treatment of patients with severe combined degenerative changes in the spine and hip joints (coxarthrosis grade 3 + degenerative changes in the spine)

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