



# The Michel Benoist and Robert Mulholland yearly European spine journal review: a survey of the “medical” articles in European spine journal, 2019

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Received: 2 December 2019 / Revised: 2 December 2019 / Accepted: 3 December 2019  
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## Introduction

Many years have gone by since the Editors of ESJ asked Robert Mulholland and me to take a fresh, end-of-the-year look at the articles appearing in the latest volume of the Journal. From the wealth of information provided this year, I have tried to extract the most medically oriented papers. My choice of articles is not a ranking: all the 2019 selected papers contribute to presenting new information, provoking discussion and further research. For example, a basic research study has demonstrated a link between obesity, disk degeneration and low-back pain, as well as the biochemical mechanisms of this link. Infection by *Propionibacterium acnes* as a cause of disk degeneration and herniation remains controversial, calling for future studies with efficient culture techniques and control groups. The ISSLS degenerative spinal phenotype group recommends a revision of the present Modic changes classification. It was also demonstrated that the use of anti-TNF alpha in the treatment of

spondyloarthropathies could not only obtain a good clinical outcome, but also a significant improvement of lumbar lordosis. In a more surgically oriented paper, Le Huec et al. [1] update the spinopelvic parameters and sagittal balance of the spine, allowing for better-planned surgical management of the patients. The above papers and others highlight the fact that overall, spine research is progressing in many domains, improving care of patients with spinal diseases. Clearly, it is still “springtime for low-back pain.”

## Basics

A biochemical link exists between obesity, intervertebral disk degeneration and low-back pain. The *in vitro* study by Segar et al. [2], published in the February issue, is an interesting and important research paper. It explains why obesity is a significant risk factor for musculoskeletal problems, and particularly for disk degeneration and low-back pain. It is now admitted that a degenerated disk can be a source of pain in the low back. It is also admitted that disk degeneration depends not only on biomechanical alterations stimulating the nociceptive nerve terminals, but mostly on the production of pro-inflammatory cytokines which up-regulate degradative processes. The present study was performed using bovine IVDs, similar in cell and matrix properties to human disks. It investigates the effects of leptin, an adipokine produced by fat tissue but also by multiple other tissues, including cartilage, upon the intervertebral disk. Cells were cultured with varying concentrations of leptin alone or together with pro-inflammatory cytokines. Results demonstrate that leptin leads to a greater production of proteases and NO. Addition of leptin to an inflammatory environment creates a synergetic effect with greater production of NO, MMPs and potentiation of other pro-inflammatory cytokines. These results effectively support the link between obesity

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(over-production of adipokines, including leptin) and disk degeneration and pain.

## Lumbar epidural lipomatosis

Lumbar epidural lipomatosis related to an accumulation of fat tissue in the epidural space may compress the dural sac and generate symptoms similar to those observed in lumbar canal stenosis. Obesity is a frequent clinical feature: dietary restriction may improve the symptoms. Similarly, correction of systemic metabolic disorders (greater uric acid, insulin and ferritine levels) may have a therapeutic effect on LEL. If the medical treatment fails, surgical decompression may be necessary. The paper by Bayerl et al. [3], published in the January issue, deals with the results of the surgical treatment of LEL. It is a prospective observational study over 3 years, comparing the outcome of 38 patients with LEL diagnosed on MRI scans and 51 patients with canal stenosis who received microsurgical decompression. All patients suffered from symptoms typical of lumbar spinal stenosis: sciatica and low-back pain. Demographic parameters were similar in both groups. Outcome parameters included NRS leg, NRS back, walking distance, ODI%, RMDQ, SF36 and Odom's criteria. Patients with LEL improved significantly after surgery. No obvious difference could be found between the two groups in all outcome scores. Clinical improvement was disclosed in both groups, with an overall benefit lasting for 3 years.

## Spondyloarthropathies

The paper by Son et al. [4], published in the April issue, deals with the comparative effects between two treatments of ankylosing spondylitis (AS): nonsteroidal anti-inflammatories plus sulfalazine versus anti-TNF alpha on clinical and radiological parameters. It is a prospective study, enrolling 133 consecutive AS patients. All patients were initially treated with NSAIDs for 1 year. At the end of the year, a group of 69 patients (group A) had an excellent result and continued with the same treatment. Sixty-four patients (group B) did not respond to NSAIDs and were treated with anti-TNF alpha for 1 year. Clinical outcome was assessed by the bath AS disease activity index (Basdai), VS and CRP. Twelve radiographic parameters were measured on an upright whole-spine lateral radiograph. Clinical and radiological parameters were assessed at baseline, when changing treatments, and every 6 months during follow-up. At baseline, CRP, Basdai and thoracic kyphosis were significantly higher in group B. When comparing patients of the same group before and after treatment, no significant difference was disclosed in radiological parameters in group

A. In contrast, lumbar lordosis was significantly improved in group B, correlated with a better clinical outcome. Significant relationships between radiological parameters and Basdai were found on correlation analysis. On multiple regression analysis, lumbar lordosis was a significant predictor of Basdai. The merit of this interesting study is to demonstrate the possible relationship between treatment modalities and sagittal balance in AS.

Unilateral sacroiliitis is a rare clinical disorder with various causes. The differential diagnosis between the two most frequent etiologies: spondyloarthropathies or infective, may be difficult, especially in the early phase of the disease. The article by Kanna et al. [5], published in the April issue, is a retrospective study investigating the value of MRI findings when compared with the histologic and bacteriologic tissue cultures obtained by biopsy. The authors collected 33 patients who presented with a unilateral gluteal pain and a positive Patrick's test. All patients underwent a biopsy and MRI evaluation, including coronal and axial T1, T2, STIR and contrast-enhanced fat-suppressed T1W images of both sacroiliac joints. Based on the MRI features, patients were divided into two groups: in group A, infective sacroiliitis was diagnosed in 60% of the patients. Severe subchondral bone marrow edema, widening of the joint space, intra-articular abscess and peri-articular muscle abscess were disclosed. Thirteen of the 33 patients (39%) of group B presented with MRI features of inflammation, including moderate subchondral edema on both sides of the joint, erosions, maintained joint space and absence of abscess. Interestingly, tissue biopsy disclosed an infection in 13 out of 20 patients of group A. In contrast, the biopsy was consistently negative in all patients of group B. The authors conclude that MRI has a high sensitivity (71%) and specificity (100%) in the diagnosis of inflammatory sacroiliitis.

## Postoperative complications

The article by Kwan et al. [6], published in the January issue, is an important one. It is a prospective multicenter study, emanating from fifteen investigational sites, reviewing rate and types of all non-neurological complications after complex adult spinal deformity surgeries (ASD) in a cohort of 272 adult patients. Inclusion criteria were Cobb angle of 80°, preoperative myelopathy, OLF or OPLL with deformity and patients who had undergone corrective osteotomy or three-column osteotomy. Adverse events were classified as intra-operative, those occurring within the first 6 weeks after surgery, and late after 6 weeks. The incidence of all non-neurological complications was 67%. The most frequent complication was surgically related (27.6%) of which implant failure and dural tear were the most common. One hundred and twenty-one patients (44%) suffered from more than one

complication. Identification of risk factors for developing a non-neurological complication included in the univariable analysis: age, previous spine surgery, number of documented non-neurological comorbidities and ASA grade as risk factors. On multivariable regression analysis, previous spine surgery was the only independent risk factor. This paper comprises an interesting discussion and review of the literature. It will help preoperative counseling for shared decision making. The same study group has previously reported the postoperative neurological data, showing a new neurological deficit rate of more than 20% after complex ASD surgery.

The paper by Wilson et al. [7], published in the September issue, aims to identify risk factors for postoperative complications as a function of surgeon and anesthesiologist volume and experience, as well as anesthesia care-team composition. A total of 5900 patients who underwent ACDF ( $n=2976$ ) or PLF ( $n=2924$ ) were identified in a high-volume orthopedic institution between 2005 and 2014. The procedures were performed by 18 individual surgeons (median annual case volume—77, and median experience—15 years), and by 40 individual anesthesiologists (median case volume—37, and median experience—11 years). Multivariable logistic regression models were used to evaluate the outcomes of any complication, cardio-pulmonary complications and prolonged length of stay (over 7 days). Interclass correlation coefficients were evaluated to determine how much variation in outcomes could be explained by provider characteristics. Results are interesting and reassuring. Overall, it was found that provider characteristics played a minor role in influencing postoperative complications. No relationship was found between provider variables and outcome in ACDF patients. In the PLF cohort, surgeon annual case volume ( $>25$ ) was associated with decreased odds of prolonged length of stay. For both surgical procedures, surgeon volume and experience explained the greatest variation in complications and anesthesia provider explained the least variation. In general, the authors also observed a decline in the incidence of complications throughout the study period. It is important to note that this study was performed in a high-volume specialized institution; the results may not be the same in a less-specialized institution.

The paper by Harwin et al. [8], published in the September issue, deals with the incidence of myocardial infarction (MI) after lumbar spine surgery. This is an important study, considering that previous studies had shown a postoperative MI mortality rate between 26.5 and 70%. The purpose of the present study was to analyze the relationship between lumbar spine surgery, preoperative risk factors and myocardial infarction. Humana Insurance database was analyzed from 2007 through 2016. A total of 105,505 patients were identified, of whom 644 (0.63%) developed a myocardial infarction within 10 days of the spine surgery. Patients were stratified according to the lumbar surgical approach

(anterior fusion, posterior fusion and non-fusion), sex, age, Charlson comorbidity index and preoperative risk factors. The total incidence of MI was calculated for each surgical approach. Differences of incidence were determined according to demographic factors, and risk ratios were determined for preoperative diagnosis. There was a significantly higher incidence of MI in the fusion group (0.77%) than in the non-fusion group (0.45%). Of the recorded MI, 70% occurred within 1 week of surgery, which is in agreement with the previous studies analyzed by the authors. Male patients, older patients and those with high cholesterol, obesity, congestive heart failure, tachycardia, hypertension, hypotension and a Charlson comorbidity index  $>3$  showed statistically significant increase in the relative risk of MI. The findings of this study can be a guideline for physicians and surgeons when deciding on a procedural technique, considering the patient's age and comorbidities.

The paper by Hu and Lieberman [9] in the January issue is a retrospective single center review, aiming to evaluate the effect of previous operations on the patient's outcome of revision surgery for adult spinal deformity (ASD). One hundred and thirty-seven consecutive patients underwent revision surgery. Patients were classified in three groups, according to the number of previous spine operations: Group 1 had one previous operation; Group 2 had two previous operations; and Group 3 had three or more previous operations. Revision surgery was tailored to each specific patient. It is generally admitted that it is more technically difficult to achieve deformity correction than in primary procedure. Clinical outcome measurements included VAS for back and leg pain, and ODI. Radiographic measurements consisted of standing sagittal and coronal radiographs. The various spinopelvic parameters were obtained. Results are interesting. Patients who had had three or more previous surgeries had significantly worse ODI scores at baseline, compared to those who had one or two previous operations. Radiographic measurements showed that patients who had two or more previous operations had worse coronal and sagittal imbalance. Analysis of perioperative surgical and medical complications showed that the rates of minor complications did not differ between the groups. However, patients who had had three or more previous operations had higher rates of major and overall complications (although not significantly). At 30-month follow-up, more patients in group 2 had additional surgery, more than the patients in group 1, and more patients in group 3 had more additional surgery than patients in group 2. When dealing with the results of the revision surgeries at 3-month FU, it was shown that all groups had a significant improvement in their back and leg pain and ODI. Improvement in ODI was similar among the groups. This paper provides useful information for physicians and surgeons.

## Lumbar and cervical canal stenosis

The article by Iderberg et al. [10], published in the June issue, aims to determine the impact of socioeconomic factors and length of sick leave after surgery for lumbar canal stenosis. It is a nationwide register-based study. A total of 13,406 patients met the study criteria. Patients over 65 years were omitted for the sick leave analysis. The baseline demographic, socioeconomic characteristics as well as the health status before spine surgery were tabulated. Two patient-reported outcome measures: global assessment of leg pain (GA) and ODI, were analyzed. Overall, the multivariate regression showed that clinical and socioeconomic factors had a serious impact on both GA and ODI, presented in detail in the article. Some predictive variables of good outcome were disclosed: being born in EU, no back pain at baseline, high income and educational level. In contrast, predictors of worse outcome were: previous spine surgery, back pain more than 2 years before surgery, smoking, comorbidities, being unemployed and on social welfare. This remarkable piece of work highlights the importance of carefully analyzing the clinical and socioeconomic factors when discussing surgery for lumbar stenosis. Previous studies had already pointed out the influence of these factors on outcome, but not to this extent, with a high number of patients and based on high-quality registers.

Tandem cervical and lumbar stenosis may have a complex clinical presentation, potentially mixing signs and symptoms in upper and lower extremities. For patients not responding to conservative treatments, surgical management becomes an option. Staged surgery is usually preferred, due to a lower risk, especially in elderly patients. Treating the most symptomatic stenosis first seems logical, but its identification may be difficult. On the other hand, studies have shown that mere decompression of one stenosis can be sufficient to relieve symptoms. In the absence of a current consensus as to which stenosis to treat first, the retrospective study by Luo et al. [11], published in the January issue, is welcome. It intends to evaluate whether decompression of the cervical or lumbar stenosis alone can relieve symptoms and to analyze the progression of symptoms in the non-operated stenosis. Forty-seven TSS patients were selected in a 5-year period and divided into two groups. Group A ( $N$ : 11) where the lumbar stenosis was operated first, as symptoms and signs predominated in the lower limbs; and Group B ( $N$ : 36), operated first when signs and symptoms predominated in the upper extremities. In addition to the clinical and neurological evaluation, the assessments used were JOA score, and Nurik's grading. At a mean follow-up of 35 months, 69% of the patients in Group B, where the cervical stenosis was treated first,

had a complete resolution of their symptoms and did not need a second-staged surgery for lumbar stenosis. Among the patients of Group A, where lumbar stenosis was treated first, the need for a second-staged surgery for the non-operated stenosis was significantly higher. Moreover, and for a non-elucidated reason, a significant number (73%) of these patients suffered from a dramatic aggravation of the cervical-related symptoms. Worsening of JOA score and Nurik's grade occurred soon after the lumbar operation, sometimes necessitating an urgent second-staged surgery. This study contains a few serious limitations, discussed by the authors, who conclude, however, that treatment of cervical stenosis first seems more appropriate.

## Modic changes, low grade infection, disk degeneration and low-back pain

The paper by Fields et al. [12], published in the October issue, is a non-specific systematic review dealing with the positive association between Modic changes (MC) and chronic low-back pain. The study, emanating from the ISSLS degenerative spinal phenotypes group discusses the key methodological factors that impact the present MC classification, and their negative consequences in clinical practice and in further research in this domain. For example, in the literature, six studies report the diagnostic performance of the present classification for detecting a painful disk, concordant with a positive discogram. The specificity was over 75% for MC 1, probably less for MC 2 and MC 3. However, the same studies disclosed a low sensibility of MC classification (under 50%) to detect a painful disk. There were also variations between studies. Consequently, the absence of Modic change is not sufficient to rule out pain at a given spine level, underlining the «high cost of the misclassification». The authors attribute the differences between studies' findings to differences in imaging procedures, often related to the variable use of older or newer technologies. These variations may result in inconsistencies in the apparent relationship between MC and LBP, especially in longitudinal studies. In this case, imaging acquired at baseline with older MRI units may be compared at follow-up with improved newer MRI units. According to the authors, recent major advances in imaging techniques are now capable of improving the reliability of MC classification, as well as of intra and inter-rater agreements and better evaluation on treatment. Suggested guidelines for presentation of Modic change data are presented in a separate box. These guidelines concern MRI units, sequences parameters, image evaluation and rater agreement.

The link between infection by *P. acnes*, disk degeneration and low-back pain is still controversial. The excellent paper by Fritzell et al. [13], published in the December issue,

compared bacterial findings in degenerative, painful disks in adults operated for a discal herniation, with findings in adolescent patients, operated for scoliosis with non-degenerated, non-painful disks. Forty adults, aged 33–49, and 20 adolescents (aged 15–20) underwent surgery at seven Swedish hospitals. Samples were cultured from skin, subcutaneous tissue and from over the vertebral laminae. Biopsies were performed from the vertebrae and the disk. DNA samples, collected from disks and vertebrae, were analyzed, using 16S rRNA-based PCR sequencing. MRI findings were assessed, using the Nordic Modic consensus disk classification. Modic endplates changes were analyzed at the operated level as well as at adjacent disk levels in the LDH group. Results are interesting. Nine patients had no growth of *P. acnes* at any site: 6/40 (15%) in the LDH patients and 3/20 (15%) in the scoliosis patients. The positive samples were mostly isolated from skin, subcutis, or deeper in the wound. Overall, 26 out of 40 (65% of the LDH patients) and 15 out of 20 (75%) control patients showed no growth of *P. acnes* in the disk–vertebrae. Of the four disks and vertebral samples from each of the 60 patients, 235/240 (98%) were DNA-negative by PCR. *P. acnes* was found exclusively in the disk–vertebrae samples from one patient in each group. In conclusion, in this study bacterial findings are rarely found in both groups and almost always associated with abundance of the same agent in the skin and the wound. The authors conclude that *P. acnes* found in the disks may be caused by contamination and that in the absence of clinical signs of discitis/spondylitis, an antibiotic treatment should be seriously questioned.

The article by Capoor et al. [14], published in the December issue, is a literature review of microscopy-based studies, aiming to provide definitive evidence of *P. acnes* colonization from a number of human diseases, comprising: *acnes vulgaris*, degenerated disk, prostate disease and atherosclerosis. After evaluating 21 studies, presenting microscopy-based evidence with *P. acnes*-specific FISH probes or antibodies, and after applying their strict inclusion and exclusion criteria, ten studies remained, of which two studies concern degenerative disk disease. Numerous relevant articles have previously discussed the role of *P. acnes* in intervertebral disk tissue which may contribute to its deterioration. However, a substantial proportion of studies remained *P. acnes*-negative. Authors of the present study note that the majority of these negative studies applied cultivation and/or PCR techniques which are susceptible of potential false positive or false negative results. The two studies selected by the authors used a different microscopy methodology, including *P. acnes*-specific FISH probes or antibodies. The authors also suggest that homogenization of the disk samples before culture would increase the culture efficacy. In these two studies, the present authors' methodology disclosed bacterial biofilms, including clearly visualized *P. acnes* which according to the authors supports the theory that a chronic bacterial

infection may be closely associated with the development of some cases of disk degeneration. In conclusion, «this study clearly supports that a subset of herniated intervertebral disks are populated with *P. acnes* prior to any surgical procedure or intervention and not, therefore, the result of contamination».

The paper by Jiao et al. [15] in the December issue is a well-performed systematic review and meta-analysis aiming to find and review studies dealing with the role of *P. acnes* and other bacteria in disk degeneration and herniation. After removal of ineligible reports, sixteen studies were included. All studies of high or moderate quality reported the existence of *P. acnes*. All used a bacteria culture but with different culture methods and different culture times. From the sixteen studies (2084 cases), the pooled proportion of bacteria in the disks was 25.3%. Among the bacteria, 56.4% were *P. acnes*. The pooled infection of *P. acnes* in these studies was 15.5%. The odds ratio of Modic change in culture-positive samples is 1.27, indicating that the presence of bacteria contributes to the development of Modic changes, but the result is not significant. At the present time, an increasing number of studies support the evidence of bacteria, mostly *P. acnes*, in the intervertebral disk, but the proportion of bacteria varies between studies. Considering the heterogeneity in sample sizes, culture methods and positive rates fluctuating between studies, the authors recommend future studies done with efficient culture techniques, control groups and specified patients' types.

## Preoperative screening of osteoporosis in spinal surgery

Preoperative detection of osteoporosis before spinal surgery is important to avoid complications such as pseudarthrosis, fixation failure or adjacent level failure. DXA, recommended by the World Health Organization, is widely used. However, several studies have shown that lumbar degenerative changes and space narrowing could significantly increase lumbar spine BMD, as measured by DXA. The paper by Zou et al. [16] in the August issue aims at discussing the interest of using CT Hounsfield units (HU) with an appropriate equipment to identify undiagnosed spinal osteoporosis in patients with lumbar degenerative diseases. A positive correlation between CTHU value and DXA BMD has already been shown in several studies. The advantage of CTHU measurements is to avoid regions of severe degeneration and choose the trabecular bone in the axial CT image of the mid-vertebral body. In the present study, 334 patients were retrospectively reviewed, including postmenopausal women, and men over 50 years who had both lumbar CT scans and DXA scan 1 month before the operation. According to radiological criteria, well defined in the paper, patients were divided into

two groups: those with severe degenerative changes ( $n$ : 182) were placed in the degenerative group, and the others in the control group. CTHU value of the vertebral body  $T$  score and BMD at L1–L4 were measured. CTHU thresholds were calculated to correspond to a  $T$  score of 2.5, using linear equations obtained in the control group. It was found that approximately one-third of the non-osteoporotic patients, according to DXA, were actually osteoporotic, according to the CTHU values. It was also found that the ability of CTHU values to identify osteoporosis was superior to that of hip DXA. In conclusion, the authors recommend using DXA as first choice to evaluate BMD in patients without severe degenerative changes, and to complement by CTHU in the severe degenerative group.

### Cervical spondylotic amyotrophy

The paper by Luo et al. [17], published in the October issue, is a systematic review aiming to update the various aspects of a rare form of cervical spondylosis: cervical spondylotic amyotrophy (CSA). This syndrome is characterized by upper limb muscle weakness and atrophy without sensory deficits. Out of a total of 206 relevant publications, 68 articles were finally retained. The different opinions regarding etiology and pathophysiology are discussed. The principal cause results from multiple lesions of the anterior horn of the spinal cord and of the nerve root. The clinical presentation is generally classified into three groups: proximal, distal and diffuse types, involving features of both proximal and distal types. Diagnosis of CSA is based on a careful analysis of the clinical, neurological, radiological and neuro-physiological assessments. The main differential diagnosis is amyotrophic lateral stenosis. CSA follows a self-limited course, with the symptoms stabilizing after an initial progressive course. There is a consensus that conservative treatment including collar, cervical traction and physical therapy must be the first-line therapy during three or 4 months, carefully observing an eventual progression of symptoms which would be more likely related to the progressive evolution of amyotrophic lateral stenosis. The article contains a review of the surgical treatment, including anterior decompression and fusion or laminoplasty with or without foraminotomy. Results of surgery found in the literature are reported in detail. Factors associated with a poor outcome include distal-type CSA (triceps, muscles of forearm and hand), long symptom duration, older age and greater preoperative muscle weakness.

The paper by Yamada et al. [18], published in the October issue, is a multicenter retrospective study, reporting clinical outcomes in surgically treated distal-type cervical spondylotic amyotrophy. The authors analyze clinical symptoms and radiographic findings, including MRI compressive

lesions, of 43 CSA patients, surgically treated. All patients had weakness and atrophy of forearms and hands without sensory deficits, gait impairment and symptoms of the lower limbs. Previous consultations with neurologists had eliminated the diagnosis of amyotrophic lateral sclerosis. Overall, the radiological findings disclosed a combination of compressive lesions of the anterior horn of the cord and/or of the ventral nerve root at one or multiple levels. The surgical procedures were divided into two groups: the anterior approach included anterior cervical corpectomy and/or anterior cervical discectomy and fusion. The posterior approach included laminoplasty, selective foraminotomy and fusion. Perioperative manual muscle test (MMT) results (6 grades) were used to evaluate the effect of the surgical treatment: good outcomes included recovery of at least one grade; poor outcomes included no improvement. Nineteen of the 29 patients who underwent an anterior approach (66.5%) had a good outcome. Only seven of fourteen patients who underwent a posterior approach had a good outcome (50%). The mean MMT grade in the anterior group improved significantly, from 2.6 to 3.4. However, this group also had the highest rate of complications. The univariate analyses of outcomes disclosed that duration of symptoms was strongly associated with a poor outcome, as shown by the MMT grade, significantly improving in the group operated before 6 months. Despite the limitations of this retrospective study, lacking a powerful statistical analysis, the data obtained are important, considering the rarity of the disease as well as the low number of case series found in the literature.

### Diagnosis of adolescent idiopathic scoliosis: spinal pain in young people

The paper by Tabard-Fougère et al. [19], published in the March issue, deals with the evaluation of the intra-rater reliability and validity of the inclinometer (INCL) and rasterstereography (RAST) in comparison with two-dimensional radiographs for measurements of sagittal angles of AIS patients. Fifty-one AIS patients, aged 10–18 years, with a Cobb angle  $> 10^\circ$ , as measured by the biplanar radiography EOS system, participated in the study. Three repeated measurements of thoracic kyphosis (TK) and lumbar lordosis (LL) were assessed by the inclinometer and rasterstereography system the same day as the EOS examination in order to evaluate the intra-rater reliability, and to assess spinal sagittal angles. The intra-rater reliability of the two procedures was excellent. In contrast, the Pearson coefficients between the two radio-free systems and the EOS radiography system as a gold standard disclosed a high to moderate validity for measuring TK and a low to moderate validity to measure LL. Importantly, the authors indicate that the clinical accuracy of the LL angle and also of the TK angle are strongly

influenced by the patient's position and by the difficulty to find and to replace the anatomical landmarks of the back shape for future calculations. Thus, realization of the records by these two systems calls for an experimented operator. The authors conclude that in clinical practice, these radio-free systems should only be used for assessing the thoracic angle.

The article by Bassani et al. [20], published in the March issue, aims to evaluate the accuracy of rasterstereography (RST) in the diagnosis of adolescent idiopathic scoliosis and its progression over time as compared to a low-dose EOS imaging (RAD). A total of 192 subjects with a majority of females underwent RST and RAD in the same session. In addition, 30 subjects of this group, selected for corrective bracing, underwent the same evaluation at 6-month follow-up. The Cobb angles obtained by the 3D spine reconstruction from RAD were compared to those obtained by RST. TK and LL were also compared. Results were as follows: measurements of the Cobb angles by RST provided lower TK with an average difference of 18°. Measurements of TK were similar in the two procedures, but those of LL by RST underestimated those provided by RAD (34° vs. 43° mean values). The within-subjects correlation to measure the accuracy of RST to monitor scoliosis progression was 0.3. Accuracy of RST to evaluate increased or decreased Cobb angles was 67%. The authors of this important paper conclude that RST cannot be an alternative to the radiographic evaluation and should only be considered for an early screening in a large population of adolescents. The radio-free systems have been developed to avoid frequent radiological assessments in the follow-up of AIS, considering the risks associated with repeated X-ray exposures during puberty. This reviewer would like to remind the reader of the paper by Morel et al. [21], mentioned in my 2018 ESJ review, concerning EOS micro-dose protocol for monitoring the course of AIS patients. Radiation exposure is even more dramatically reduced as compared to the low-dose EOS protocol.

The paper by Hebert et al. [22], published in the July issue, deals with the association of pubertal development and growth and spinal pain in children. It is a prospective longitudinal study, involving 1021 children from ten public primary schools in Denmark. Linear growth (height) was measured seven times, and pubertal development according to Tanner stages was assessed four times over the 42-month duration of the study. Spinal pain was reported via text messaging. Variables for pain duration (total weeks with pain) and frequency (number of episodes) were constructed. Statistical analysis examined the potential association of these variables with pubertal development (Tanner stages 1–5) and linear growth, represented by the change of height, occurring between each of the time points (baseline, 6, 12, 18, 30 and 42 months). Results disclosed that pubertal development was associated with increased spinal pain duration and with frequency of the episodes. Similarly, each 1 cm change in

height in 6 months was also associated with pain duration and frequency. Interestingly, the relationship between pubertal development and spinal pain, as well as growth and spinal pain, was largely independent. This well-performed longitudinal, prospective study confirms that the linear growth observed during puberty is a potential cause of spinal pain, owing to the rapid mechanical loading changes of the spine. The paper contains an interesting discussion, comparing the results of previous studies addressing the same subject. The authors very wisely recommend remaining vigilant in order to detect pediatric patients with spinal pain, presenting with “red flags” and serious pathologies, as well as spondylolysis or psychosocial factors.

### Magnetic resonance spectroscopy (MRS)

The purpose of the very sophisticated study by Gornet et al. [23], published in the April issue, was to determine whether magnetic resonance spectroscopy-derived biomarkers can accurately identify painful disks, quantify the degree of degeneration and thus predict the results of surgery for discogenic low-back pain. The MRS data were used to quantify spectral features related to disk structure (collagen and proteoglycan) and acidity (lactate, alanine and propionate). The MRI magnetic resonance protocol is described in detail in the paper, as well as MRS scores. Ratios of acidity to structure were used to calculate pain potential. A total of 623 disks in 139 patients were scanned, using MRS and 275 disks also received provocative discography (PD). The MRS scores were compared to provocative discography and Pfirrmann grade. Seventy-five of the 275 patients with MRS scanning and PD underwent lumbar surgery. Results demonstrated the high sensibility ( $n$ : 82%) and specificity ( $n$ : 88%) of MRS for identifying disks with positive or negative PD testing. Moreover, surgical success based on ODI and VAS was 97% in MRS positive disks versus 57% in MRS levels at 6-month and 1-year follow-up. Overall, the authors conclude that MRS data can accurately distinguish PD+ from PD– and may improve surgical outcomes for surgery of chronic low-back pain. There is no doubt that if these results are confirmed in future studies, and if this protocol becomes available in clinical practice at a reasonable cost, MRS-derived chemistry will be the first-line noninvasive imaging method.

### Efficacy and safety of injections by intrathecal route

The paper by Kanai et al. [24], published in the February issue, investigates safety and efficacy of intrathecal injection of low-dose bupivacaine as an alternative to epidural

injections of steroids and/or anesthetic in patients with low-back and extremity pain, related to disk herniation, lumbar canal stenosis and spondylolisthesis. Seventy consecutive outpatients were treated. Technique of the procedure is described in detail. The injection was performed without X-ray or CT scan control. In order to determine the optimal dose, an initial dose of bupivacaine of 0.5 mg, followed by 1 mg and 1.5 mg, was injected. The optimal dose was selected according to the analgesic effect and adverse physical effects. Then, the optimal dose was injected once a week, for 2 weeks. The primary outcome was safety. Efficacy was assessed using NRS, JOA score, RMDQ after each injection and after 1, 3, 6 and 12 months. Sensory anesthesia was obtained rapidly, without impeding motor function, walking balance and time of discharge, and persisted 1 year after the injection. No post-dural puncture was encountered in this series, owing to the type of needle used and the fact that patients were placed in the supine position for 30 min observation. The main limitation of this study is the absence of group control. In addition, the injections were performed in patients with different pathologies. Further research is needed to clarify which specific condition responds to this therapy. It is interesting to note that an equivalent positive effect has been observed when using lidocaine injected in the epidural space as a control. This effect also persisted a few weeks, outlasting the normal duration of local anesthetic. These unexpected findings are difficult to explain. This reviewer is concerned by the repetition of lumbar punctures within a short time, when using the intrathecal route.

The paper by Schlatter et al. [25], published in the January issue, deals with the safety of the intrathecal route, causing a potential toxicity related to the administered drugs and/or excipients. The study emanating from the University Hospitals of Paris (APHP) focuses on the intrathecal side effects of methylprednisolone acetate (MPA)—Depo-Medrol, mainly used in rheumatology to treat arthritis and off-label neuropathic diseases and lymphoblastic leukemia. A few publications have reported complications following intrathecal injections of MPA, including arachnoiditis, bladder dysfunction and aseptic meningitis. Clinical cases and results of animal studies are summarized in the paper. Consequently, the FDA has stated: “Depo-Medrol sterile aqueous suspension is contraindicated for intrathecal administration.” Interestingly, the available commercial formulation of MPA contains two excipients with potential toxicity: polyethylene glycol (PGE) and miripirium chloride. Clinical and animal studies have demonstrated their potentially cytotoxic effects in humans and animals. They are summarized on appropriate tables. Overall, this article is a reminder that toxicity when using the intrathecal route may be related not only to the drug administered, but also to the excipients added for various reasons. Consequently, the authors recommend using non-particulate forms of therapy without excipients when the

intrathecal route seems appropriate. These recommendations can be applied to the intrathecal use of corticoids in patients with acute sciatica, still performed in some centers.

### **Abdominal and paravertebral muscles in adult degenerative scoliosis and degenerative spondylolisthesis**

The etiology of spondylolisthesis is probably multi-factorial, using facet tropism, sagittal spinopelvic alignment, race and lumbo-sacral abnormalities. The paper by Fraser et al. [26], published in the June issue, discusses the link between abdominal musculature and DS, which has been reported to be four times greater in females than in males. This is a prospective cross-sectional cohort study of 205 subjects, aged 50 years or over, who presented with low-back pain and/or sciatica. Information was collected by standard history-taking and a questionnaire including age, height, weight, occupation, number of pregnancies and number of abdominal operations. The width and length of the linea alba gap, if any, were measured as well as the presence of a ventral hernia. An MRI or a CT scan was examined for DS. Results of the sub-group analysis confirmed the strong association with females and DS, with a significant difference between sexes for multi-level slips (30% vs. 7%). In the female cohort, patients with DS were statistically more likely to have been pregnant. Thirty percent of patients with DS had had multiple surgical abdominal procedures performed previously; in females with DS, it rose to 41%. Overall, the presence of scars from previous surgery was significant in females, compared to males. Males with vertebral hernia were more likely to develop DS. The data disclosed in this study confirm and extend our knowledge on this subject. As the abdominal muscles have been demonstrated to be a stabilizer of the spine, especially in torsion, the paper highlights the role of weakened abdominal muscles in the development of DS. These results also reinforce the importance of an appropriate reeducation of those muscles after pregnancy and abdominal surgery.

The cross-sectional study by Ohyama et al. [27], published in the September issue, compares the spinopelvic parameters between patients with or without sarcopenia, defined as an age-related loss of muscle mass and function. In the present study, sarcopenia was diagnosed using the diagnostic algorithm of the Asian working group for sarcopenia (AWGS), described in the article. The paper also investigates the prevalence of spinopelvic mismatch, secondary to a decrease in lumbar lordosis: pelvic incidence minus lumbar lordosis  $> 10^\circ$ . Each condition of spinopelvic match and mismatch was compared between the sarcopenia and no-sarcopenia group. The study population included patients aged 50 years or more, having undergone decompression

surgery for lumbar canal stenosis. One hundred and twenty-six patients were retrospectively analyzed, of whom 27 (21.4%) had sarcopenia. Measurements included BMI, JOA, muscle mass using BIA, physical performance using handgrip strength and usual gait speed. The usual spinopelvic radiological parameters were measured. SVA was used as an index of spinal sagittal imbalance. Overall, the spinopelvic parameters, except TK, were not significantly different between the sarcopenia and no-sarcopenia group. Prevalence of patients without spinopelvic mismatch was also not different between the sarcopenia and the no-sarcopenia group. However, among patients with spinopelvic mismatch, SVA and TK were significantly larger in the sarcopenia group than in the no-sarcopenia group. After adjusting the age difference between the two groups, sarcopenia was independently related to an increase in SVA and larger TK. In that case, patients in the sarcopenia group could not compensate their sagittal imbalance by flattening of their thoracic kyphosis. This is well illustrated in excellent figures.

The paper by Xie et al. [28], published in the July issue, explains the association between paravertebral muscle (PVM) change in adult degenerative scoliosis and its association with bony structural parameters. This prospective cross-sectional study includes 78 patients with ADS, aged > 50 years, with a Cobb angle > 10°. No radiculopathy, no previous physical therapy. The control group consisted of 65 healthy individuals with similar demographic characteristics. The lumbar multifidus muscle was chosen for evaluation. All subjects underwent a radiograph to measure the bony structures: lumbar scoliosis Cobb angle, lumbar lordotic angle, lateral vertebral translation and apical vertebral rotation. Percentage of fat infiltration area (% FIA) was recorded by MRI, using image J software. In the control group, the percentage of FIA was similar in bilateral sides and at all levels. In contrast, the percentage of FIA in the ADS group was significantly higher in the concave side than in the convex side, and at all levels. The asymmetric degree of multifidus change was positively correlated with Cobb angle, lateral vertebral translation and apical vertebral rotation, but not with the lordotic angle. In this study, the percentage of fat infiltration appears to be the major indicator of paravertebral muscle change in adult degenerative scoliosis, its asymmetric degree increasing with the lumbar scoliosis Cobb angle.

The research study by Eguchi et al. [29], published in the July issue, investigates the involvement of sarcopenia in middle-aged and elderly women with degenerative scoliosis. A total of 971 women, mean age 70.4, were included in the study. Degenerative lumbar stenosis (DLS) was disclosed in 87 cases; 884 served as a group control. Criteria for lumbar degenerative scoliosis were > 10° and a sagittal vertebral axis (SVA) > 50 mm<sup>2</sup>. Exclusion criteria were idiopathic scoliosis, compression fracture, previous spinal surgery,

Parkinson and other neuro-muscular disorders. Muscle mass, including the appendicular skeletal muscle mass, was measured using a bioelectrical impedance analyzer (BIA). Bone mineral density (BMD) was measured in both groups, using DXA. Radiographic measurements in frontal and lateral views were obtained to measure scoliosis and the parameters evaluating spinal alignment. Results revealed a high prevalence of sarcopenia in the degenerative scoliosis group: 59.8% versus 48.8% in the control group. The regression analysis showed that decrease in trunk muscle mass was a significant risk factor for DLS, independent of age, suggesting that trunk muscle mass reduction is involved in lumbar scoliosis. Whether sarcopenia is a determinant factor of degenerative scoliosis or visa-versa remains speculative. Further longitudinal studies are clearly needed. Based on their results, the authors recommend a program of exercise therapy to maintain and enhance skeletal muscles. They also recommend correcting vitamin D deficiency and treatment of osteoporosis, which have been shown to be strongly associated with sarcopenia.

The paper by Toyoda et al. [30], published in the February issue, investigates the association of back muscle strength and sarcopenia-related parameters in patients with spinal disorders. It is a cross-sectional observational study, including 213 patients aged 66–92 years, presenting various spinal disorders listed in the paper. Participants were classified as having sarcopenia based on muscle mass, muscle strength and physical performance. Muscle mass was evaluated using the BIA method. Physical performance was measured according to the handgrip strength and gait speed. Back muscle strength was measured using a digital back muscle strength meter in standing position. Subjects were classified into three stages: sarcopenia, dynapenia or normal according to the guidelines recommended by the European Working Group for Sarcopenia and according to the cutoff values recommended by the Asian Work Group for Sarcopenia. The statistical analysis indicates a high prevalence of sarcopenia and dynapenia in patients with spinal disorders. Back muscle strength was significantly correlated with trunk muscle mass and physical performance. Very wisely, the authors conclude that although multiple interrelated factors contribute to the development of sarcopenia, spinal disorders might be a risk factor for disease-related sarcopenia.

## Symptomatic Tarlov cysts

The paper by Hulens et al. [31], published in the October issue, deals with a very controversial subject: whether Tarlov cysts can be a source of pain and produce symptoms. The second aim of the study was to challenge the persisting idea that TCs are irrelevant findings. According to the authors, at the present time there are no available data from

well-designed, scientific research studies to support this assumption. In the authors' narrative review, 224 publications were identified, the majority of which concern sacral meningeal cysts. A long and interesting chapter discusses the pathogenesis of TCs which arise from increased hydrostatic and pulsatile pressure, forcing CSF into the nerve root sheaths leaving the dural sac. Numerous and valuable arguments are discussed. They include, for example, the fact that lowering hydrostatic pressure by CSF external drainage relieves the symptoms or also the fact that pain increases in the sitting position, but is relieved when lying down. The numerous symptoms reported in the various publications are tabulated in the paper. They usually present as a chronic cauda equina syndrome, with a female predominance. Clinical characteristics of communicating cysts as compared with the non-communicating cysts are presented. In the latter case, pressure inside the cysts is higher than in the spinal canal and axons in the cysts are more compressed than in the communicating cysts. Overall, the authors are strong believers that TCs can be symptomatic and refer to a recent systematic review of 31 case series on the surgical treatment of TCs, indicating that a large majority of patients experienced partial or complete relief of pain. However, the authors recognize that non-believers still outnumber believers and then discuss the main reasons why TCs are often overlooked. In their conclusion, the authors propose that TCs should be part of the differential diagnosis of low-back pain and sciatica. Will this paper convince the non-believers?

### Reoperation rates for degenerative lumbar diseases

The aim of the study by Lang et al. [32] in the June issue is to conduct a systematic review of the literature, comparing the reoperation rates, their causes and timing between decompression alone and decompression with fusion in the surgical treatment of degenerative lumbar diseases, comprising disk herniation, degenerative disk disease, stenosis and spondylolisthesis. The literature search finally included 35 publications. Characteristics of the studies are listed in separate, appropriate tables. The rate of reoperation after decompression alone was highly variable, depending on the follow-up time, the type of decompression and the differences in studies. However, the major causes of reoperation after decompression alone were located at the same segment: recurrent disk herniation, recurrent stenosis and others: same segment disease (SSD). The reoperation rate of fusion surgery is highly affected by the length of follow-up time and in contrast with decompression alone, the underlying etiology is adjacent-segment degeneration, referred to as an adjacent-segment disease. Twelve studies, ten retrospective and two prospective directly compared the reoperation rates after the

two procedures. The main finding of the review was that, on average, both surgeries resulted in similar operation rates but for different causes. Interestingly, reoperation rates were not found to decrease in patients operated recently, compared with those reported in early times, in spite of the newer techniques used. The findings of this important piece of work are an invitation for further research on the mechanisms of reoperation in both surgeries.

### Imaging versus no imaging for low-back pain

The paper by Lemmers et al. [33], published in the May issue, is a rigorous, high-quality systematic review, dealing with the difficult problem of imaging for low-back pain. The aim of this research is to determine whether imaging (X-ray, MRI or CT scan) in patients without red flags leads to increased costs, increased healthcare utilization and absence from work. Criteria of inclusion in the review were: patients with or without sciatica, older than 18 years, and that outcome measures contained costs, healthcare utilization and absence from work. The methodological quality of the studies was appraised by appropriate tools. The reference selection used the PRISMA statement. Finally, fourteen studies were included: six RCTs and eight observational studies. Due to the heterogeneity of the studies, meta-analysis could not be performed. Overall results of the review disclosed that all studies reported higher mean costs in the imaging group. In all studies except one, the average amount of healthcare utilization was significantly higher in the group with imaging for at least one criterion: medication, injections, surgery. However, the evidence is conflicting for absence from work. These results are in line with the recommendations of the guidelines. The question is why and how the rates of prescription of imaging are still increasing in clinical practice, even for acute low-back pain. The paper contains an interesting discussion as well as suggestions for future research.

### Treatment of chronic low-back pain

The article by Groot et al. [34], published in the July issue, reports the results of an intensive cognitive behavioral pain management program, as provided by RealHealthNL. The most interesting point of this paper is that it evaluates the long-term follow-up of this program with a minimum of 5 years. Results are compared with those observed after 1 year, where favorable results were disclosed. A total of 277 patients, aged 18–70 years (85% response), were included with a median follow-up of 6.5 years. Inclusion criteria were: CLBP for at least 6 months, willingness to change behavior, willingness to participate in a 2-week program,

delivered by a multi-disciplinary team, including a psychologist, a physiotherapist, an occupational therapist and a movement teacher. Exclusion criteria were: psychiatric disorders, litigation and compensation claims. Overall, the patients included at the start of the program were mild to moderately disable and most of them were still at work. Results indicate that the positive 1-year follow-up results were maintained after 5 years: ODI decreased from 40 to 27 at 1 year and to 28 at 5 years. Pain intensity (NRS 0-100) improved from 60 to 39 in the first year, and to 33 at 5 years. SF36 was also maintained at 6.5 years, and healthcare consumption had decreased as well as costs. There is an interesting discussion comparing the positive results of this program with those of the literature. However, the authors recognize that for financial reasons, such a program—2 weeks, hotel based, 8 h a day—would be difficult to achieve in many countries.

### Follow-up of degenerative lumbar spine surgery: PROMs

The paper by Parai et al. [35], published in the September issue, aims to evaluate the outcome of lumbar surgery, measured by patient-reported outcome measures (PROMs) at 1 and 2 years after surgery, and to investigate whether there are differences in outcome between 1 and 2 years. The analysis was performed using data collected on the Swedish Spine Register. Patients operated between 1998 and 2017 were divided into three groups: lumbar disk herniation ( $n$ : 31,314), lumbar spinal stenosis ( $n$ : 53,043) and degenerative disk disease ( $n$ : 14,375). The outcome variables were VAS for back and leg pain, ODI, EuroQol-5 dimensions, satisfaction and global assessment (GA) for back and leg pain. The study design is an equivalent study. The proportion reaching the minimal important change (MIC) in VAS, ODI and EuroQol at 1 and 2 years, respectively, was calculated. GA and satisfaction were examined, using the McNemar test. Threshold values for successful outcome based on the final scores of each PROM were determined at one and 2 years, post-surgery. Results indicate that improvements of clinical importance do occur post-surgery, after the first year, irrespective of diagnosis and of which PROM is used. More importantly, the differences in proportions reaching MIC of each PROM at 1 and 2 years indicate a minor deterioration at 2 years (<2%), irrespective of the diagnosis group. The proportion of “success” in global assessment for back and leg pain at 1 year, changing into “no success” at 2 years is as follows: 8.5% versus 8% in the LDH group; 11 versus 10% in the LSS group; and 10 versus 8% in the degenerative group. The authors conclude that “when a PROM is the outcome variable, a 1-year follow-up is sufficient in clinical effectiveness studies.”

### Compliance with ethical standards

**Conflict of interest** The author of this review declares that he has no conflict of interest.

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