

# What would you do first? A survey of treatment priorities for patients with hip-spine syndrome among spine and hip surgeons

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## Abstract

**Purpose:** The aim of this study was to investigate the preferences and rationale for the sequence of surgical treatment of different hip-spine syndrome scenarios among potentially interviewed specialists. **Methods:** A questionnaire survey was administered to German hip and spine surgeons regarding their preferred surgical sequence and treatment rationale for five fictional clinical presentations of hip-spine syndrome. The scenarios included symptomatic hip osteoarthritis and: 1) lumbar spinal stenosis with neurological claudication, 2) lumbar degenerative spondylolisthesis with leg pain, 3) lumbar disc herniation with leg weakness, 4) lumbar scoliosis with back pain, and 5) thoracolumbar disc herniation with myelopathy. A further cross-nation comparison of the German findings was made with the previous same questionnaire conducted in the United States. **Results:** German hip and spine surgeons demonstrated a surgical order preference paradigm characterized by prioritizing spine-first for spinal disease with neurological deficits (scenario 1, 3, 5), otherwise hip-first preferred without neurological deficits (scenario 2, 4). US surgeons had different patterns of surgical order preference, consistent with German surgeons in some scenarios and not in others. There was also a certain tendency of surgical order preference in different specialists. The surgeons' preference decision was primarily influenced by the severity and time urgency of symptoms, spine-pelvis-hip biomechanics, and ease and therapeutic effect of hip and spine surgery. **Conclusions:** The sequence of hip and spine surgery in different hip-spine syndrome scenarios has different preference patterns, with professional preferences and cross-nation differences, affected by many factors including disease and treatment regimen.

**Keywords:** Hip-spine syndrome • Degenerative spine disease • Spinopelvic diseases • Hip osteoarthritis • Sequence of treatment • Surgery

## Introduction

The hip-spine syndrome was first described by Offierski et al. in 1983, who defined this condition as the presence of concomitant hip and spine pathology and categorized it as "simple", "complex", "secondary" and "misdiagnosed" [17]. In simple categories, the prioritization of surgical treatment may be clear due to straight forward of symptoms; however, in complex cases, the prioritization of surgical treatment for the hip-spine syndrome is challenging due to the substantial overlap of symptomatology. Moreover, there is currently no consensus on which pathology should be addressed first [5; 17]. Previous studies mainly focused on the effects of the sequence of total hip arthroplasty (THA) for hip disease and spinal fusion surgery for spinal disease on each other's outcomes [9; 14-16; 24], while few studies have focused on the patient-centered benefits based on the different clinical presentations for the hip-spine syndrome. Different

scenarios of the hip-spine syndrome may benefit differently from the surgical sequences, such as ankylosing spondylitis, spinal stenosis, and degenerative spondylolisthesis with concomitant hip OA [21; 26]. Therefore, it is clinically important to investigate the patient-centered treatment sequence of different diseases.

In the clinical setting, joint surgeons and spine surgeons must face whether patients with symptoms in the hip and lumbar spine who require surgical treatment should have the hip or the spine operation first. Currently, the surgical sequence of treatment for hip-spine syndrome is controversial from the perspective of spine or arthroplasty surgeons [7; 19]. There are currently no explicit guidelines for the hip-spine syndrome, which is why an interprofessional consultation with hip surgeons (HS) and spine surgeons (SS) is clinically important. A collaborative research team from Stanford University consulted HS and SS across the USA on the preferred treatment sequence of five fictional scenarios in patients with hip OA and common degenerative lumbar diseases and found that there are still controversies in some clinical situations, even among experienced surgeons [13]. Due to the different training patterns of orthopedic surgeons in the USA and Germany [11], this may lead to different preferences for the surgical sequence in patients with the hip-spine syndrome between the two countries and warrants further investigation. Spine surgery is also performed in neurosurgery, in addition to orthopedic surgery in the USA and Germany, while differences in structured surgical residency training during neurosurgery and orthopedic residency in Germany [10] the USA [20] and the aforementioned differences between two countries [4; 11; 25] may also result in different treatment options of surgical sequence.

Therefore, the aim of this study was to investigate the interprofessional choice of surgical sequence for different hip-spine syndrome scenarios between German HS and SS (orthopaedic spine surgeon (OSS) and neurosurgical spine surgeons (NSS)), and to compare the findings with the same questionnaire previously conducted in the USA to raise awareness of the complex treatment algorithm for patients and use it for "patient-centered shared decision-making". The hypothesis of this study was, that surgeons may have different surgical order preferences for different hip-spine syndrome scenarios, based on professional preferences between different specialists, and cross-nation differences between German and US surgeons.

## Methods

### 2.1 Questionnaire design

An online questionnaire in English with five fictional hip-spine syndrome scenarios was previously designed by the Stanford University research team, including clinical history, current symptoms, further diagnosis and related images of the hip and spine [13]. Five fictional hip-spine syndrome scenarios describe symptomatic hip OA with five common degenerative spinal diseases: 1) degenerative lumbar spinal stenosis with neurogenic claudication, 2) degenerative lumbar spondylolisthesis with leg pain, 3) a single-level lumbar disc herniation with weakness in the leg, 4) lumbar scoliosis with the sagittal imbalance and back pain and 5) thoracolumbar disc herniation with signs of myelopathy. The surgeons' preferences for the order of treatment were collected for each scenario, and to provide a reason for their choice in free-text comments. Additionally, they had to select which kind of hip articulation (standard size head, large head >32mm, dual mobility implant or constrained liner) they would choose if they chose THA first (Fig. S1). The English questionnaire was translated into German in this study (Fig. S2) and sent to German surgeons using an online survey platform "LimeSurvey" (LimeSurvey GmbH, Hamburg, Germany).

### 2.2 Survey

This survey was then sent to 2500 members of the "German Spine Society" (OSS and NSS) on March 26th, 2021, and 883 members of the "German Society for Joint Replacement" (Arbeitsgemeinschaft für Endoprothetik,

mostly HS) on April 8th, 2021. The choices of different German specialists in each scenario, and the relation between the year of experience and choice were analyzed. Text-mining was used to analyze the free-text comments and to identify the most frequently used words. It was conducted with R version 4.0.4 using word frequency packages tidyverse (version 1.3.1), tidytext (version 0.3.2), wildyr, igrph and ggraph. Then, the list of the words was sorted alphabetically in Excel to summarize words with an equal meaning in main groups. For the transfer to Excel the packages readxl (version 1.3.1) and xlsx (version 0.6.5) were used. The density for each word was calculated as the number of the specific word divided by the total word count. The comments were summarized into key points explaining the most commonly used words. The results of the survey of surgeons in Germany were further compared, point-to-point, with the same survey of surgeons in the USA previously done by Stanford University [13]. In particular, the surgeons participating in this survey in Germany were HS from the German Society for Joint Replacement and SS from German Spine Society, including NSS and OSS, while the surgeons participating in the survey in the USA were HS from the North American Hip Society and SS from the Scoliosis Research Society, not further divided into NSS and OSS [13]. Therefore, merging the German NSS and OSS into an overall SS was performed, when comparing the results of the surveys of SS between German and USA.

### 2.3 Statistical analysis

Data were presented as percentages or mean (range) in this study using SPSS version 20 (SPSS, Inc., Chicago, IL, USA) and choices between two groups were compared using the chi-square test.  $P \leq 0.05$  was considered statistically significant.

## 3. Results

### 3.1 Participants

7.02% (62/883) of the German HS and 3.88% (97/2500) of the SS responded to the survey. In total, 159 German surgeons participated in this study, consisting of 38.3% HS, 24.1% NSS, and 35.8% OSS. The USA survey received 88 surgeon responses to the survey, 46% (51/110) of HS responded and 37% (37/101) of SS responded [13]. The US survey had a relatively high response rate compared to the German survey, which may be due to the different sample selection methods. The US adopted a sample survey method while Germany selected a full-sample survey.

### 3.2 Preference patterns of surgical sequence

Overall, a consistent pattern of surgical preference was achieved among German surgeons, in which spine-first preferred in scenarios 1, 3, and 5 and hip-first preferred in scenarios 2 and 4. Although SS and HS have different percentage preference for surgical sequence, none of the five conditions were statistically different. In scenario 1, SS had a higher proportion of spine-first than HS, which was not statistically significant, while NSS significantly preferred spine-first to OSS. In scenarios 2 and 4, the difference of selection ratio between SS and HS was not significant, but OSS preferred hip over NSS at a significantly higher rate in scenario 2. In scenario 3, either the OSS or the NSS favored spine-first over the HS. In scenario 5, spine-first was preferred by most of HS and SS (OSS and NSS) in Germany.

A further German-American comparison found that the German-US preference patterns were consistent in scenario 2 (HS and SS), scenario 5 (HS and SS), scenario 3 (SS), and 4 (SS), but reversed in scenario 1 (HS and SS). The preferences of HS in the USA were debated in scenarios 3 and 4. In scenario 1, more American surgeons (HS and SS) preferred to hip-first, whereas more German surgeons (HS and SS) preferred to spine-first. In scenario 2, both American and German surgeons prioritized the hip-first. In scenario 3, German surgeons as well as SS in the USA preferred spine-first, while HS in the USA showed a debate about the preference of the surgical sequences. In scenario 4, German surgeons and American SS prefer hip-first, while American HS had no clear preference for order of surgery. In scenario 5, both American and Germany surgeons (HS and SS) preferred to spine-first.

## Result

No adverse events were detected during the surgical procedure which was well tolerated for all patients and conducted without local anesthesia. The amount of infiltrated filler was approximately 0.6-0.8 ml, depending on the pain feedback expressed by the patient. During the procedure, an enlargement of the joint space of the TMJ was detected radiographically in all patients.

No local alteration was detected, no patient developed signs or symptoms of local superinfection at the site of infiltration.

Periodic outpatient evaluations were performed according to the study protocol by the same operator, measuring the NRS, the DASH-score and evaluating joint function with strength tests. MR imaging checks were performed as per protocol by all patients except one who did not show up for follow-up.

The data extracted from the questionnaires and strength tests were summarized in a digital database. A second database was created to collect data detected during radiological examinations. All the results were noted on the patient's medical record, filed at the Hand Surgery Unit, University Hospital of Verona - Italy.

The study population consisted of patients with grade I (4.65%), II (48.84%) and III (46.51%) rhizarthrosis sec. Eaton-Littler. Laterality was distributed as follows: 37.21% right hand; 62.79 left hand. Group A consisted of 22 patients (51.16%) and group B of 21 patients (48.84%). The most frequently used words from the free-text comments are shown in Figure 1. In scenario 1, German surgeons preferred hip-first due to considering "hip" to be more "symptomatic" and therefore increasing lordosis of the spine and recommending THA first, and while spine-first was preferred because spinal "stenosis" was considered more "symptomatic". American surgeons preferred hip-first considered that THA can improve spine-pelvic biomechanics and thereby spinal symptoms "relief", while those who chose spine-first believed that untreated neurogenic claudication may hinder the "recovery" of THA. In scenario 2, German surgeons preferred THA first because of the severe "symptomatic coxarthrosis" in the "right hip". After THA, the patient's mobility and spinal alignment would improve significantly, resulting in improved spinal symptoms, and also conducive to better rehabilitation training for subsequent spinal surgery. The American surgeons considered hip problems to be "serious" or "more severe" than radicular leg pain in the absence of neuromotor deficits, and THA was also thought to provide more predictable pain "relief" than "spinal fusion", leading to hip-first preferred. In scenario 3, some German surgeons prioritized hip-first, as "femoral head necrosis" is an urgent "indication" for "hip", while those who choose spine-first considered the neurological symptoms from the "disc" herniation, such as muscle strength weakness and paralysis, to be signs of impending nerve damage, therefore spine-first preferred. Similarly, most American surgeons prioritized spine-first because muscle "weakness" is a "neurological deficit", and "discectomy" is relatively simple for an extruded "disc". In scenario 4, most German surgeons considered that "scoliosis" represents a chronic event compared to severe hip symptoms, whereas THA will provide significant pain relief and has a positive effect on chronic back pain, while some surgeons preferred spine-first to correct "sagittal" imbalance of spine. Many US THA surgeons commented that balancing the spine first was important to optimize the "position" of subsequent THA components as this allows for "changes" in the spine-pelvic alignment due to spinal surgery, while many THA surgeons still treat the hip-first, assuming the patient's "nerves" were intact, and spine surgery was not urgent. Prioritizing hip-first was a practical consideration for most US spine surgeons, as THA is an "easier" procedure with more "predictable" results and faster than scoliosis surgery recovery. In scenario 5, most of German surgeons would treat spine-first showing signs of "myelopathy" and spinal cord "compression" to prevent irreversible neurological deficits. Likewise, "myelopathy" caused by "compression of the spinal cord" by the American surgeons was considered more urgent than the hip OA [13].

The majority of German HS and NSS had between 11 and 20 years of experience (35.5% and 43.6%, respectively), while most OSS had between 0 to 10 years of experience (39.7%) (Figure 2). On average, German surgeons had 18.3 (2-36) years of experience, with HS, NSS, and OSS having an average of 20.5 (3-36), 20.1 (2-34), and 14.8 (2-34) years of experience, respectively. Average years of experience post-training for HS was 30.8 (14-60 years) and 23.4 (5-34 years) for SS in the American study [13].

## Discussion

Our study allowed to evaluate the infiltration with ChondroFiller Liquid® in the TMJ in patients affected by rhizarthrosis at different stages. It is important to underline that several analyzed patients suffered from bilateral rhizarthrosis, often with different stage and different impact in terms of pain and limitation in daily activities. During the design phase of the study protocol it was decided to not report a comparison with the contralateral limb in order not to add a further bias. The choice of the limb to be treated was made in agreement with the patient, according to the criterion of

treating the most debilitating side. The analyzed cohort was homogeneous between Group A and B, all patients completed the proposed clinical follow-up with the exception of two patients belonging to Group A who did not perform control MRI at T3. The high compliance demonstrated by the enrolled patients can be interpreted as a strong interest in improving a pathological condition with remarkable repercussions in terms of pain and functionality.

This study allowed to confirm the potential use of ChondroFiller Liquid® also in the field of small joints, expanding the classic indication as a filler in osteochondral lesions of large joints (e.g. knee, hip and ankle). The execution of the infiltrations under constant fluoroscopic control has highlighted the dilatation of the joint space secondary to the injection, even in patients with rhizarthrosis in an advanced stage. Since the procedure was performed without local anesthesia, the appearance of pain during the infiltration and therefore during the distraction of the TMJ allowed us to quantify the exact volume of filler, based on pain response.

Statistical processing showed that the cohort within the two groups considered was homogeneously distributed with respect to the variables considered, regardless of whether the patients evaluated belonged to group A or B.

The NRS data showed a significant improvement in pain. It is interesting to underline how the difference between the data detected at T1 and T2 is lower than that detected at T2 and T3. Clinical control carried out at T2 showed that several patients complained of little benefit in terms of pain, contrary to the benefit reported at T3. Probably the steric hindrance of the filler in the joint compartment narrowed by the pathology caused a tension of the capsule with the onset of pain. At the T3 control, the improvement is attributable both to the disappearance of the "capsular distraction pain" and to the mechanical decompression of the articular surfaces of the TMJ. The data relating to the DASH score showed a similar trend to that relating to the NRS, with an overall improvement statistically significant in terms of functionality. Again, no effective benefit was found at T2, probably secondary to the discomfort caused by the infiltration and the fiberglass brace placed after the procedure. However, for these two variables, the analysis of differentials between the times does not always show statistical significance (Table 3). The strongest data is the NRS for both group A and group B, while the DASH score is significant only considering the difference at T2 and T3 in the whole cohort. Probably, this evidence falls within the statistical limits of a numerically small cohort subjected to questionnaire assessments (ie the DASH score) with high intrinsic variability. Moreover, as already explained, the further bias of discomfort secondary to infiltration has been added to this. It is therefore optimal to consider the trend of these variables globally, having verified the almost homogeneity in the two distinct groups.

The data relating to the resistance tests showed a statistically significant improvement in almost all the analysed variables. In particular, the Jamar was significant both globally and in group B, while the Pinch tests were significant in all groups considered (the only exception was for the Pinch - key grip in group B). Therefore, the improvement in strength was more significant for patients with advanced osteoarthritis. This finding could be justified by the remarkable recovery observed in patients with TMJ mobility severely limited by advanced osteoarthritis, who rapidly recover over a greater range of strength than patients with minor stage osteoarthritis. It should be emphasized that a considerable variability was also found for the resistance tests, in consideration of the numerous intrinsic biases of the measuring devices. Despite this, the statistical significance assumes an even more decisive importance in describing the objective improvement following the infiltration.

The improvement in strength, pain, and function was detected to be in line with other studies evaluating corticosteroid or hyaluronic acid injection into the TMJ[7]. However, the results we found at T3 are prospectively favorable for hypothesizing a longer duration of benefit compared to the infiltratives currently in use. Limiting ourselves to the adopted protocol follow-up, our study is not inferior to the currently adopted gold standard, with the addition of the chondrogenic potential of the infiltrated filler. ChondroFiller Liquid® could in fact give a more regenerative contribution compared to corticosteroids or hyaluronic acid, with a benefit on the cartilage strongly damaged by the degenerative pathology. In the future, it is hoped that further studies will be conducted to confirm the long-term regenerative potential of ChondroFiller Liquid® also in the context of small joints.

With reference to the comparison between the MRI performed at T1 and that performed at T3 in the patients belonging to group A, considering the most

represented variables, no progression of the deformation or joint degeneration was found. The reduction of bone edema, the reduction of joint effusion and an overall radiological improvement were not detected in most of the patients, instead found in just under half of the treated patients. This contrasts with the clinical improvement observed globally and in individual groups. Probably, a limitation of the study protocol was the timing of the MRI check: perhaps a more deferred evaluation would have shown a radiographic improvement also for these last variables. Further studies will be needed to confirm this hypothesis. In addition, the small number of patients evaluated radiographically likely further limited the finding of joint compartment improvement on MRI. The statistical analysis was limited to the evaluation of the relationship between the variables, which proved to be homogeneous in the two previously exposed trends. In the future, the implementation of a more accurate radiological descriptive protocol could constitute a decisive aspect in the statistically significant detection of the variables considered.

Finally, applying multivariate linear regression models, a statistically significant relationship was found between the Jamar variable and female sex. This data is particularly interesting: despite the intrinsic biases of our protocol, the limited number of the patient cohort and the short observation period, it was possible to detect a known correlation between TMJ osteoarthritis and the female sex, more affected by this pathology as noted above. In particular, in such patients there is a greater increase in grip strength (e.g. Jamar) than in the general population. In addition to the more advanced states, the female sex would be the ideal target for the use of ChondroFiller Liquid® in the treatment of rhizarthrosis.

Therefore, the use of ChondroFiller Liquid® to infiltrate the TMJ has the potential to improve pain symptoms, functional deficit and improve the use of the affected hand in daily activities. The direct consequence is the procrastination of the surgical approach, which can be deferred especially in the advanced stages. Indeed, in the latter, patients frequently present advanced age, an increased risk of anesthesia and sometimes a reluctance to undergo surgery. From this point of view, ChondroFiller Liquid® represents a valid alternative to slow down the course of the pathology and give relief to the patient, without precluding a subsequent surgical time.

In further studies it would therefore be interesting to evaluate a comparison with the contralateral limb, increase the period of observation and the size of the cohort, to reinforce what was detected in our study. It is not yet defined how long the treatment performed can bring benefits to the patient, as the long-term follow-up is still ongoing. Given current valuations, the benefit is likely to be long-term.

## Conclusion

ChondroFiller Liquid® has proven to be a valid alternative to the surgical approach, at least to slow down the progression of painful symptoms and functional limitation. In particular, an improvement in grip strength was found especially in patients with advanced osteoarthritis of the TMJ, while pain and increased functionality were more significant in the entire cohort of treated patients. MRI provided a non-progressive assessment of osteoarthritis degeneration and joint deformation, showing a reduction of bone edema and inflammation. The clinical improvement would therefore justify a less invasive and faster recovery infiltrative approach anticipating the possible subsequent surgical approach.

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All authors played a key role in the study. MC designed and directed the study, reviewed the data and supervised the drafting of the paper; FZ performed the infiltration and reviewed the data; MG, LG, EI, UL contributed to data collection at outpatient follow-up visits and to writing of the paper; VB performed the statistical elaborations; UL managed the paper's writing and publication.

## Competing Interests

All authors declare that they have no conflicts of interest for this study.

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