Review Article

Lumbar facet joint stabilization for symptomatic spinal degenerative disease: A systematic review of the literature

ABSTRACT

Objective: Lumbar spinal degenerative disease (LSDD), unresponsive to conservative therapy, is commonly treated by surgical decompression and interbody fusion. Since facet joint incompetence has been suggested as responsible for the entire phenomenon of spinal degeneration, facet stabilization can be considered as an alternative technique to treat symptomatic spinal degenerative disease. The purpose of this study was to systematically review the literature for studies utilizing lumbar facet joint fixation techniques for LSDD to assess their safety and efficacy.

Methods: A systematic literature review was performed following the preferred reporting items for systematic reviews and meta-analyses statement, with no limits in terms of date of publication. Demographic data, inclusion criteria, clinical and radiological outcome, frequency of adverse events (AEs), and follow-up time were evaluated.

Results: A total of 19 studies were included with a total of 1577 patients. The techniques used for facet arthrodesis were Goel intra-articular spacers in 21 patients (5.3%), Facet Wedge in 198 patients (15.8%), facet screws fixation techniques in 1062 patients (52.6%), and facet joints arthroplasty in 296 patients (26.3%). Clinical outcomes were assessed through the evaluation of pain relief and improvement in functional outcome. Radiological outcomes were assessed by the evaluation of proper positioning of instrumentation, solid bony fusion rate, and preservation of disk height. AE's mainly observed were pseudoarthrosis, reoperation, instrumentation displacement/malpositioning/migration, neurological impairment, deep vein thrombosis, and infections. The mean follow-up time ranged from 6 months to 11.7 years.

Conclusion: Our data demonstrate that facet joint arthrodesis appears to be effective in managing LSDD. These findings, however, are limited by the small sample size of patients. Accordingly, larger series are needed before formal recommendations can be made.

Keywords: Facet fixation, lumbar spinal degenerative disease, neurogenic intermittent claudication, spinal stenosis

INTRODUCTION

Pedicle screw (PS) is considered the gold standard for posterior instrumented lumbar spinal surgery in lumbar spinal degenerative diseases (LSDDs) unresponsive to conservative therapy.[1-3] However, PS fixation method is characterized by some possible complications including PS failure, screw mispositioning, rod breakage, and adjacent segment disease given the restriction of the range of motion (ROM) in lumbar spine.[4,5] Another compelling argument about PS is the invasiveness of the open procedure, which requires substantial dissection and damage to the paraspinous muscle, thus contributing to spinal stability.[3,6]

In order to overcome these critical issues and to guarantee a less invasive and equally efficacious method of fixation, facet fusion techniques have been developed. From a biomechanical point of view, the zygapophyseal joints play a key role in

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spinal stability: Their alterations are closely related to the pathogenesis of various degenerative conditions of the lumbar spine, which are characterized by low back pain (LBP).[7] Many facet screw fixation techniques have been described. Boucher first described the "transfacet technique" in 1959,[8] while Magerl proposed the "translaminar technique" in 1984.[9] The latter was thought by most surgeons to be provided with greater biomechanical efficacy and, as a consequence, it achieved the greatest popularity among neurosurgeons, even if technically demanding.[10] In recent years, other facet fusion modalities have been explored, leading to the creation of devices that are increasingly customized to fit the individual conformation of the zygapophyseal joints. As a matter of fact, many efforts have been made to combine high fusion rates while preserving the spinal biomechanics and ROM of stabilized vertebral segments to preserve the natural kinematics of lumbar spine.[11-14]

The aim of this systematic review was to identify and examine studies utilizing different facet joints arthrodesis techniques for the treatment of the LSDD to evaluate the efficacy and safety of this surgical intervention.

METHODS

Using PubMed and MEDLINE databases a systematic literature review was conducted following the preferred reporting items for systematic reviews and meta-analyses guideline.[10] The search strategy was tailored without a backward data limit. We use the following medical subject headings and free-text terms: "facet device," "facet wedge," "facet instrumentation," "facet screw fixation," "facet fusion," "lumbar spine surgery," "arthroplasty" combined using Boolean operators "AND" and "OR." To avoid the potential omission of relevant studies, we manually screened reference lists of the articles included and previous systematic reviews and meta-analyses regarding facet fusion techniques. Duplicate reports were eliminated using Microsoft Excel 16.37. Details of the search strategy are shown in Figure 1.

Study selection and inclusion criteria

The research strategy initially relied on title and abstract analysis. The article's full text was retrieved for further investigation if the title and abstract met the inclusion criteria. Three authors (L.B., F.B., and S.M.) independently assessed eligibility, and differences were resolved by discussing and comparing the different points of view of investigators. Only articles published in the English language were included. Finally, each article that met the eligibility criteria underwent a full-text review. Studies that did not have full text available were excluded. Articles that did not evaluate facet fusion techniques were excluded. Articles detailing the use of hybrid surgery (for instance, transpedicular screw fixation in association with transfacet screw fixation) were also rejected. Case reports, technical notes, cadaveric studies, animal studies, biomechanical studies, reviews, and meta-analysis were excluded from the study. The data collection process was conducted without using any automated tools. No ethical approval was required for this study.

Data extraction

Four authors (F.B., L.B., S.M., and P.M.S.) collected data on study characteristics (authors, publication year, study design, and country), patients characteristics (number of patients included, age and sex), kind of pathology, treatment modality and surgical technique used, levels of the lumbar spine treated, clinical and radiological outcomes, adverse events (AEs) and follow-up duration.

RESULTS

Study selection

After duplicate removal, 688 articles were selected. Based on the title and abstract screening, we excluded 347 and 225 papers, respectively. Finally, we eliminated other 97 papers due to incompatibility with our eligibility criteria. Hence, 19 published studies were included in this literature review.

Demographic and clinical features

The studies selected included a total of 1577 patients. Eleven studies were retrospective (57.9%) and eight prospective (42.1%) [Figure 2]. In the wide scenario of lumbar degenerative disease, the pathologies treated were various: Lumbar spinal stenosis (LSS), foraminal stenosis, lumbar disk degeneration and herniation, facet joints degeneration, spondylolisthesis, osteoarthritis, instability following surgery of posttraumatic changes, scoliosis. The techniques described to perform facet arthrodesis were the following: Goel intra-articular spacers (5.3%), Facet Wedge (FW) (15.8%), Facet screws fixation techniques (52.6%), and Facet joints arthroplasty (26.3%) [Figure 3]. Screws had been placed in the lumbar (L1–L5) region of the spine and the first sacral vertebra.

The outcome was evaluated both clinically and radiologically. The clinical outcome was evaluated by considering pain relief, through Oswestry Disability Index (ODI) and Visual Analog Scale (VAS) scores, and improvement in the functional outcome, according to Macnab's criteria; the radiological outcome was assessed through the evaluation of several parameters: Proper positioning of instrumentation, solid bony fusion rate and preservation of disk height.

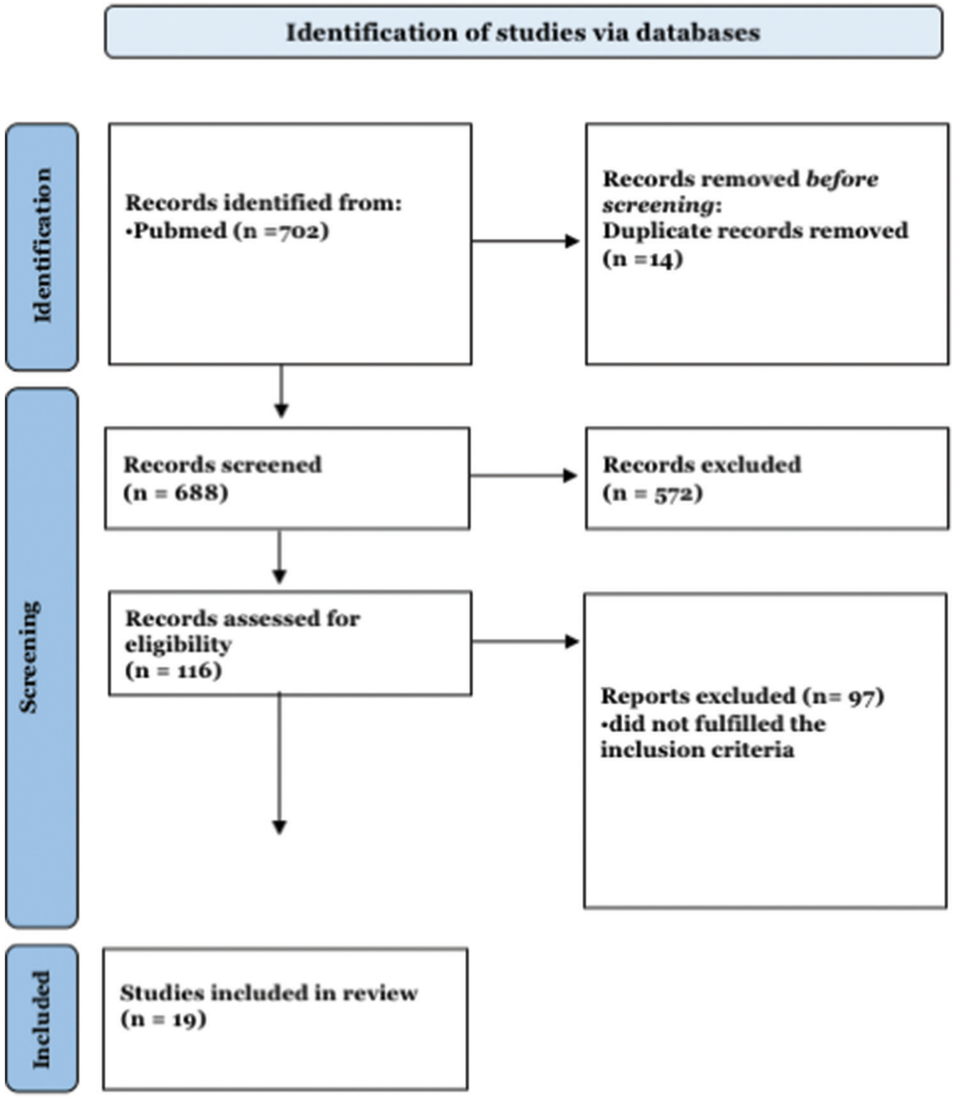

Figure 1: Figure showing details for the search strategy

Both clinical and radiological outcome were evaluated during the postoperative follow-up time, which among the studies ranged from 6 months to 11 years. The AEs observed included: pseudoarthrosis, reoperation, instrumentation displacement/mispositioning/migration, neurological impairment, deep vein thrombosis, and infections.

Pathologies treated, levels, clinical and radiological outcomes, AEs, and follow-up time are detailed in Table 1.

DISCUSSION

LBP is a leading contributor to disabilities worldwide.[14] The elements that constitute the lumbar spine (i.e., soft tissues, vertebrae, zygapophyseal and sacroiliac joints, intervertebral disc, and neurovascular structures) are subject to a variety of stressors and, each of them, alone or in combination, can contribute to the genesis of LBP.

Ravindra *et al*.[34] in their meta-analysis, tried to estimate the proportion of LSDD in patients suffering from LBP, finding that 6 million individuals (3.63%) worldwide have LSDD and LBP each year, with the highest incidence in Europe (5.7%).

The main accepted view for LSDD pathogenesis identifies deterioration of the disc, due to dehydration or herniation, as the primary event that leads to a cascade of processes responsible for vertical spinal instability, such as the reduction of facet joint space and subsequent facet override, loss of disc space height, bulge of the posterior annulus and the posterior longitudinal ligament, and infolding of the ligamentum flavum.[35] Therefore, various structures of the lumbar spine could be addressed for LBP treatment:

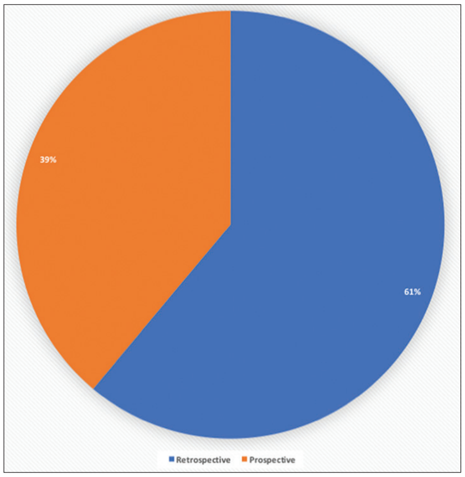

Figure 2: Figure showing the type of the studies recruited for the review

Intervertebral discs, facet joints, sacroiliac joints, and nerve roots.[36] Overall, the optimum treatment for LSDD should aim to remove the compression on the neural structures while preserving or restoring the spinal stability. In this regard, various microdecompression (MD) techniques have been introduced although most of them are based on the general concept that the main pathogenetic mechanism underlying LSDD is strictly related to a cascade of processes starting with disc degeneration.[37,38]

However, several lines of evidence have suggested that facet can be directly considered as a possible cause of lumbar stenosis.[39] Following the first suggestion goel properly argued that facet damage could start and foster spinal degeneration.[31,40] Briefly, he suggested that the reduction of the interfacet distance, and the subsequent instability, may play a role in the pathogenesis of the entire spectrum of spondylosis including stenosis of the spinal canal and intervertebral neural foramina, reduction in disc height, bulge of the posterior annulus/posterior longitudinal ligament, invagination, and hypertrophy of the ligamentum flavum.[31]

In this systematic review, the surgical techniques for facet joint arthrodesis, indications, and outcomes were reviewed.

Goel intra-articular spacer

Quite the opposite to the traditional pathogenetic hypothesis, Goel *et al*.[40] argued that the entire phenomenon of spinal degeneration is secondary to facet incompetence. Facet degeneration and reduction of the interfacet distance can start and foster the entire spectrum of spinal changes that lead to stenosis of the spinal canal and intervertebral neural foramina, and vertebral instability. The primary representation of this degenerative cascade is the lumbar facet hypertrophy seen in canal stenosis, which may reflect the facet overload and the consequent back pain.

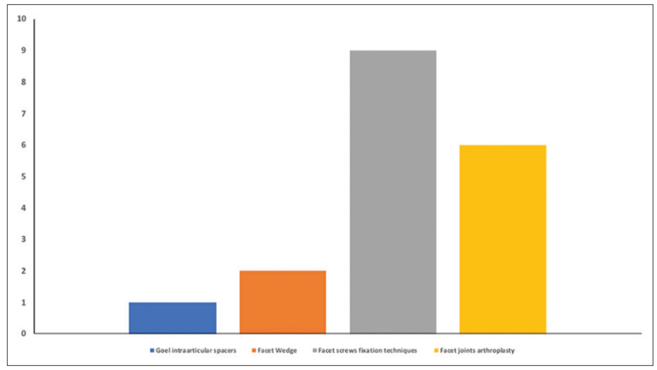

Figure 3: Bar graph showing the techniques for facet arthrodesis in the studies reviewed

In a cadaveric study of 647 lumbar spines, Eubanks *et al*.[41] found that degenerative changes in lumbar zygapophyseal joints begin in the third decade, with a peak during the seventh decade. The highest grade of degeneration was found at L4–L5 levels.

In this regard, facet distraction can be considered the optimum surgical treatment to restore and fuse the facets in their normal alignment. In a preliminary report, Goel and Shah.[42] recruited 36 patients with single- and multilevel cervical spondylotic radiculopathy and myelopathy, performing an innovative surgery. He proposed the so-called "Goel facet spacers" as an effective tool in the treatment of canal stenosis, by reversing the overriding of the facets, restoring the articular height and the spinal canal and root canal dimension.

After surgical treatment, patients had relief from symptoms of pain, radiculopathy, and myelopathy.

Later, this principle was successfully applied also to the lumbar canal. In a pilot study, Goel *et al*.[31] employed the intra-articular spacers in 21 patients affected by LSS. Patient outcome was characterized by a good relief from LBP and radiological postoperative findings showed increasing in spinal canal and intervertebral root dimensions, reduction in buckling of ligamentum flavum, and disk bulge extension into the spinal canal. Joint distraction using spacers can be used as a stand-alone method or can be combined with other fixation techniques.

Facet wedge

FW ®system (DePuy Synthes, Oberdorf, CH, Switzerland) combines the mechanical friction-based blockade mechanism, by distracting the facets at the diarthrodial surfaces with a titanium implant, and the stability of facet screws that are then inserted to strengthen the system. This minimally invasive approach can be used to

Table 1: Selected articles for the study

Authors	Study design	*n*	Pathology	Treatment	Level	Clinical outcomes	Radiological outcomes	AE's	Follow up
Heggeness and Esses, 1991[15]	Retrospective	18	LDD	TLFSF	L4-L5/L5-S1 or both	Pain relief	17 patients obtained solid fusion	Pseudoarthrosis 1 case	37 months
Knappe *et al*., 2021[16]	Prospective	26	Foraminal stenosis; facet degeneration; spondylolisthesis	FJR	L3/L4 (7), L4/L5 (17), L5/S1 (2)	Improvement in mean VAS and ODI Improvement in SF-12	Preservation of disk height and ROM at the indicator and adjacent levels	Failure of system 4 cases	67 months
Amoretti *et al*., 2013[17]	Prospective	107	Spondylolisthesis LDH, LDD	Percutaneous translaminar or facet screw fixation	L4-L5/L5-S1; single level fusion (95), double level fusion (12)	Improvement in functional status	All patients obtained fusion within 1 year	Screw rupture 1 case	24 months
Grasso and Landi, 2017[18]	Prospective	80	LSS	FW system	L4-L5 most common level	Improvement in symptoms and satisfaction for surgery	/	None	12.3 months
Buttermann *et al*., 2020[19]	Prospective	62	LDD	Facet versus PS instrumentation	L5/S1 (26), L4/L5 (6), L3/L4 (3)	Improvement in LBP, VAS and ODI scores	Proper positioning of screw	Revision surgery 34 cases	11.7 years
Grob *et al*., 1992[20]	Prospective	72	LDH, osteoarthritis, LSS, instability	Translaminar screws fixation	N/A	Pain relief	fusion	Screws loosening 5 cases; nonunion 4 cases; reoperation 4 cases; DVT 2 cases; dural tear 1 case; wrong level 1 case	24.4 months
Grasso and Goel, 2020[21]	Retrospective	80	LSS	Facet interarticular spacers along with microdecrompression versus MD alone	Only one stenotic level	Pain relief, improvement in functional outcome	Successful fusion in 90% of the cases	Reoperation 8 cases	61.5 months
de Kelft, 2016[22]	Prospective	8	Facet joint degeneration	FENIX facet resurfacing technique	L3-L4 (2), L4-L5 (4), L5-S1 (2)	Pain relief	Efficacy and safety of the system	Implant dislocation 1 case	24 months
Schmidt *et al*., 1975[23]	Retrospective	102	Osteoarthritis, LDH	Facet inlay bone graft	Multiple segment fusion (58%)	Pain relief, improvement in functional outcome	/	Pseudoarthrosis 2 cases	5, 7 years
Bochicchio *et al*., 2022[24]	Retrospective	46	LSS	Percutaneous lumbar transfacet screw placement with facet-link system	L3-L4 (17), L4-L5 (24), L5-S1 (5)	Improvement in limb VAS, ODI, and SF-36 scores	/	Reoperation 4 cases	24 months
Humke *et al*., 1998[25]	Retrospective	173	LSS, LDH, LDD, posttraumatic changes	Translaminar screws fixation	NA	Pain relief	Solid bony fusion in 94% of the cases	Removal 5 cases; screws loosening 5 cases; broken screws 2 cases; revision 1 case	68 months
Felbaum *et al*., 2016[26]	Retrospective	83	LDD, scoliosis, spondylolisthesis	Percutaneous lumbar transfacet screw fixation	L2-L3 (1); L3-L4 (18); L4-L5 (38); L5-S1 (15); L2-L4 (1); L2-L5 (2); L3-L5 (7); L4-S1 (1)	/	Good positioning of the screws	Screw fractures 2 cases; removal of the screw 1 case	1 years

Contd...

Table 1: Contd...

Authors	Study design	*n*	Pathology	Treatment	Level	Clinical outcomes	Radiological outcomes	AE's	Follow up
Johnsson *et al*., 1997[27]	Prospective	11	LDD, facet joint degeneration	Posterolateral lumbar fusion using facet joint fixation	L4-L5 (4); L5-S1 (7)	/	Stable fusion rates	None	1 years
Francaviglia *et al*., 2018[28]	Retrospective	38	LDH, LSS, foraminal stenosis, spondylolisthesis	Single-level FW implantation	L3–L4 (8); L4–L5 (30)	Improvement in VAS and ODI scores	/	Deep vein thrombosis 2 cases; wound infection 1 case	6 months
Pirris *et al*., 2014[29]	Retrospective	96	LSS, spondylolisthesis, synovial cyst, foraminal stenosis; facet joint degeneration; arthropathy; scoliosis; intradural tumor	Implantation of facet bone dowels	N/A	/	Not solid fusion in 86 cases	/	13.2 months
Trungu *et al*., 2018[30]	Retrospective	25	LSS; facet joint degeneration	Transfacet screw fixation	L4-L5 (18); L5-S1 (7)	Improvement in ODI and SF-36 scores	/	Hardware failure 1 case	12 months
Goel *et al*., 2013[31]	Prospective	21	LSS	Goel intra-articular spacers	L2-3 (6), L3-4 (12), L4-5 (18), L5-S1 (3)	Improvement in ODI and VAS score	Successful fusion in all the patients	None	17 months
Srour *et al*., 2020[32]	Prospective	53	LSS, facet joint degeneration	Facet osteosynthesis with the FFX device	L3-L4 (8); L4-L5 (11); L5-S1 (5); L1-L2-L3 (1); L2-L3-L4 (4); L3-L4-L5 (4); L3-L4; L5-S1 (2) L4-L5-S1 (3); L1-L2-L3-L4 (6); L2-L3-L4-L5 (2); L1-L2-L3-L4-L5 (4): L2-L3-L4-L5-S1 (2); L1-L2-L3-L4-L5-S1 (1)	Improvement in ODI and VAS scores	Good facet fusion rates	Device migration (0.5%), device misplaced (3.9%)	13.5 months
Aepli *et al*. 2009[33]	Retrospective	476	LSS, spondylarthrosis, LDD, LDH, facet joint degeneration; reoperation after FBSS	Translaminar screw fixation	L1-L5	Improvement in COMI score	Good fusion rates	Sensory deficits, motor deficits or both 21 cases; broken screws 2 cases; screws loosening 1 case; persistent pain 1 case; postoperative infection and screw removal 2 cases	10 years

AEs - Adverse events; LSS - Lumbar spinal stenosis; LDH - Lumbar disc herniation; LDD - Lumbar disc degeneration; FBSS - Failed back surgery syndrome; DVT - Deep vein thrombosis; VAS - Visual analog scale; ODI - Oswestry disability index; COMI - Core outcome measures index; ROM - Range of motion; PS - Pedicle screw; LBP - Low back pain; MD - Microdecompression; FW - Facet wedge; TLFSF - Translaminar facet screw fixation; FJR - Facet joint replacement; SF - Short form; / - Not provided immobilize the facet joints at one or two levels, from L1 to S1.

The first prospective study which aimed to compare and analyze clinical outcome of these implants was conducted by Grasso and Landi.[18] They recruited 80 patients and divided them into two groups of 40 patients treated with implants of FWs and MD (Group 1) versus MD alone (Group 2), respectively. The authors collected clinical data (VAS, Zurich Claudication Questionnaire, and ODI preoperatively, and at 3, 6, and 12 months postoperatively. Although significant statistical differences were found in all the groups (from baseline), a statistically better clinical outcome was observed in Group 1 when compared with Group 2 ($P < 0.01$).

Later, Francaviglia *et al*.[28] recruited 38 patients affected by herniated disk, spinal canal and foraminal stenosis, and Meyerding grade I degenerative spondylolisthesis to evaluate the safety and efficacy of FW and found that low back VAS score and ODI decreased significantly after surgery. Moreover, in neuroimaging follow-up slippage or signs of adjacent segment degeneration were not detected.

In order to evaluate the feasibility of this surgical technique, Grasso and Goel, in their retrospective study,[21] compared the clinical outcome of patients treated with micro-decompression and arthrodesis with intra-articular spacers versus patients treated with micro-decompression alone. They found a lower rate of re-operation in patients surgically treated with intra-articular spacers than with MD alone (10% vs. 30%) and improvements in functional status, assessed using Macnab's criteria, during the 5th years of follow-up (excellent and good score in 85% of the patients vs. 69.4%).

These studies support the concept that facet distraction and fixation with FW system along with MD of the neural structures is an effective procedure to treat LSDD.

Facet screw fixation techniques

The first surgery for facet joint can be attributed to King in 1948.[43] He placed small screws across the facet joints in conjunction with posterior fusion and found a high rate of solid bony fusion (90.9%) and quite low rate of pseudoarthrosis (10.1%).

Later, other two facet screw fixation techniques emerged. The first was the transfacet pedicle approach described by Boucher in 1959,[8] who employed a longer screw directed toward the pedicle with additional cancellous bone graft, thus leading to a lower rate of pseudarthrosis. The second was the translaminar facet approach described by Magerl[9] in 1984, who used a longer screw inserted from the base of the contralateral side of spinous process, through the lamina, traversing the facet joint and ending at the base of the transverse process. Several studies showed that these two techniques provide a similar degree of spinal stability and lower invasiveness compared to the traditional PS fixation.[15,17,19,20,23,25-27,29,30,33,44]

Zeng *et al*.[45] analyzed the changes in intervertebral disc height of 29 patients undergoing percutaneous unilateral translaminar facet screw fixation with interbody fusion. No patient experienced significant postoperative complications. This retrospective study showed an augmentation in postoperative intervertebral disc height versus preoperative ($P < 0.05$).

Jang and Lee.[44] compared percutaneous transfacet screw fixation and PS fixation after anterior lumbar interbody fusion in patients affected by lumbar foraminal stenosis, secondary to degenerative disk disease or degenerative spondylolisthesis, and found an improvement in ODI scale and excellent/good outcome according to Macnab's criteria in patients treated with transfacet screw fixation.

Bochicchio *et al*.[24] evaluated the effect of percutaneous lumbar transfacet screw placement with a "cross-link" system, called Facet-Link, in 46 patients affected by LSS (with or without mild instability). They found that quality of life (QoL) related questionaries (ODI and SF36) and back/leg VAS improved after surgery. In terms of complications, there were 4 cases of pseudoarthrosis and 4 patients needed further surgeries. Despite that, translaminar screw fixation could be related to different AE, due to the proximity of the facets to nerve roots.[42]

Facet joints arthroplasty

Inflexible spinal fusion can lead to overloading of nonfused segments, increasing like the hood of adjacent segments disease and thus causing pain, wound problems, infections, pseudoarthrosis, and implant failure.[12,16] Therefore, alternative spinal implants were developed, in order to preserve the ROM.

In patients with intact segmental lumbar disk and symptomatic spinal canal stenosis exclusively caused by facet joint hypertrophy, the concept of "Facet joint Replacement" (FJR) is a promising alternative to monosegmental lumbar fusion.[16] Recently, the intermediate- and long-term results of an FJR in 26 patients affected by spondyloarthropathy and intact segmental lumbar disk have been presented.[16] The dynamic system of FJR showed good results in pain relief, assessed by

ODI, VAS back and leg pain scores. This surgical intervention has been shown to improve the patient QoL, and preserve the lumbar spine motion in a follow-up spanning 12 months. In a phase III trial ("*A pivotal study of a facet replacement system to treat spinal stenosis*" NCT00401518) the primary objective was to evaluate the overall success rate of the anatomic facet replacement system in patients with spinal stenosis when compared to a posterior spinal fusion control. In selected patients, FJR seems to be an alternative to rigid fusion in preventing adjacent level disease, improving back and leg pain, and enhancing patient's QoL.[16]

As well as with total joint replacement, motion preservation can be obtained also with facet joint resurfacing. In this regard, the FENIX facet resurfacing implant aims to restore stability while maintaining motion and alleviating pain.[22] This partial prosthesis is composed by three components: superior facet resurfacing implant, inferior facet resurfacing implant and the translaminar locking screw. The first experience with this implant showed a reduction in pain and need for painkillers in patients affected by proven single segmental bilateral lumbar facet joint osteoarthritis as unique pain generator.[22]

Future perspectives

One of the newest concepts of arthrodesis consists in facet fusion devices that fit the facet joint space to prevent facet motion and, thus, instability. Among them, a facet resurfacing device was used and tested in a prospective multicenter study with good results although preliminary.[22] Srour *et al*.[32] recruited 53 patients diagnosed with facet syndrome or LSS and implanted FFX device, alone or in combination with posterior lumbar interbody fusion (PLIF) (in 15 out of 53 patients). The authors found that all pain and disability scores during the follow-up period remained significantly lower than preoperative scores for all patients, regardless of number of levels involved or if the patient received a PLIF or not. Moreover, a high level of radiologically facet fusion at 1 year was found (86,3%). In 8 cases, the implants were misplaced and in 1 case there was a device migration.

Currently, there is an ongoing multicenter clinical trial that aims to evaluate the safety and efficacy of the zLOCK facet fusion system ("*Safety and Efficacy Assessment of Using the zLOCK Facet Stabilization System*" NCT05266521) in patients affected by degenerative spondylolisthesis grade 1, mild to moderate stenosis and facets degeneration. This implant is designed to perfectly fits into the facet joints using the body's natural mechanical structure without adding an external scaffold, able to follow the joints changing geometry. The zLOCK implant can be placed in open or percutaneous technique, thus reducing the invasiveness, procedure duration, and shortening the recovery period.

CONCLUSION

Developing dynamic constructs that can relieve pain, restore physiological mobility, and endure repetitive loads are a tremendous challenge. In the wide scenario of stabilization techniques, facet arthrodesis is raising growing interest in the latest years, due to the mini-invasiveness, efficacy, and lower risk of injury to neural structures. Accordingly, facet fusion techniques are likely to be an important tool in the actual and future management of degenerative spinal diseases deserving further investigations.

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Conflicts of interest

There are no conflicts of interest.

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