

Clinical Article

Dynamic stabilization of lumbar motion segments by use of Graf's ligaments: results with an average follow-up of 7.4 years in 39 highly selected, consecutive patients

T.-M. Markwalder¹ and M. Wenger²

¹Attending Neurosurgeon FMH, Bern-Muri, Switzerland

²Surgical Department, The Hirslanden Group, Klinik Beau-Site, Bern, Switzerland

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Summary

Background. In recent years considerable effort was undertaken in order to replace rigid lumbar stabilization by soft stabilization in certain instances. The Graf soft system stabilization technique is such an interesting novel alternative to lumbar arthrodesis in the treatment of mechanical low-back disorders. The current retrospective analysis reports the long-term results in 39 consecutive patients treated with Graf's ligaments for painful lumbar instability.

Methods. Young patients with lumbar mechanical disorders resistant to conservative treatment with 1) no or mild facet joint degeneration, 2) minor disc degeneration, 3) well trained low back muscles, 4) pain relief after trial anaesthesia and 5) probatory rigid plastic jacket underwent lumbar ligamentoplasty according to Graf. The patients were assessed clinically and they filled in an extensive questionnaire at an average period of observation of 7.4 years.

Findings. After 7.4 years the clinical results in 39 patients were excellent, good, fair, unchanged and worse in 43.6%, 20.5%, 10.2%, 23.1% and 2.6%, respectively. Seven unchanged patients were converted to arthrodesis. In the questionnaire 66.6% reported total disappearance of back pain, in 25.7% it was significantly less and in 7.7% back pain was a bit less. Visual analogue scale for low back pain was 0 in 69.2%, 2.5 in 15.4% and 5 in 15.4% of patients. For leg pain it was nil in 92.3% and 2.5 in 7.7%.

Interpretation. Soft system stabilization of lumbar motion segments in young patients with painful mechanical disease resistant to conservative treatment yields favourable long-term results only in a highly selected patient population.

Keywords: Graf system; ligamentoplasty; soft system stabilization; lumbar spine.

Introduction

Graf's soft system stabilization (SSS) technique [5] represents an interesting alternative operation to lum-

bar arthrodesis in the treatment of low-back disorders of mechanical origin. The technique consists of a so-called dynamic or "soft" stabilization of an unstable motion segment by inserting pedicle screws which are linked together by polyester threaded bands creating regional lordosis.

Between 1991 and 2001 forty-one patients have been treated by SSS for a painful mechanical disorder of the lumbar spine. A part of this highly selected patient population (representing 1 percent of 4000 operations of the lumbar spine in this period of time) has been object of two previous reports with analysis of early (mean 30.4 months) [15] and mid-term results (mean 50 months) [1]. It is our aim in this report to present the long-term clinical outcome (average period of observation of 7.4 years) of 39 out of 41 patients operated by the soft stabilization technique.

Patients, materials and methods

Patients

Thirty-nine out of 41 patients have been reexamined and were asked to fill in a questionnaire. Two patients were lost to follow-up.

Among these 39 patients there were 26 female and 13 male patients with ages between 17 and 45 years (average 33.5 years). The average period of postoperative follow-up was 7.4 years (range 4.5 to 10 years).

Indication for operation

We restricted our indication for a SSS-procedure to young patients presenting with a mechanical disorder of one or several lumbar motion segment(-s) resistant to conservative treatment over at least a half year's period. Each patient presented with symptoms of irritation of facet joints with or without pseudoradicular pain in the lower limb(-s).

In one patient, facet joint irritation was present in conjunction with bilateral severe radicular pain due to two-level disc herniations, treated previously by microdiscectomy and a L4-S1 SSS-procedure. Two other patients, in whom SSS was used as a preventive measure adjacent to a multilevel internal fixation, were excluded from the study because the reason for operation differed from the series presented.

All patients underwent a specific diagnostic protocol, comprising probatory anaesthesia of the articular nerves of the corresponding facet joints and trial immobilization in a removable rigid plastic jacket allowing ambulation.

Patients with low-back pain with or without non-radicular leg pain underwent operation when they fulfilled the following criteria:

1. no or only mild arthrotic changes of facet joints
2. minor disc degeneration
3. well-trained low back muscles
4. pain-relief in response to anaesthesia of articular nerves
5. pain-relief while wearing a probatory jacket.

Patients were excluded from a SSS-procedure when functional radiological studies revealed a x-axis hyperrotation or z-axis translation.

Surgical technique

We used the technique proposed by Graf [5]. Care was taken to avoid damage to the joint capsules and articular nerves. We avoided extensive tightening of the polyester bands in order to prevent nerve entrapment in the lateral recess and/or foramen. Foraminotomies and recessotomies were not necessary because we restricted the indication for operation to patients who did not have loss of disc height.

Postoperative measures

We used the postoperative treatment protocol as reported previously [15]. Briefly, patients had to wear the

jacket for a two to three weeks, followed by a rehabilitation program consisting in isometric training of low back muscles.

Complications

There were no intra- or postoperative complications. Potential complications of this surgical technique are mainly in relation to misplacement of the pedicular implants.

Assessment of outcome

All patients were reexamined clinically at the time of follow-up. The latter consisted in an assessment of spinal mobility with respect to pain and of neurological status.

As in our previous study [1] patients were asked to fill in a questionnaire consisting of the Oswestry Disability Questionnaire [3], the SF-36 [22, 23], the Modified Somatic Perception Questionnaire (MSPQ) [14], the Zung Depression Scale [24] and Huskisson's Visual Analogue Scale (VAS) [10].

Classification of results

The results of the clinical reevaluation and of the questionnaire were classified into the following five categories:

- excellent: normal working and social life; back to sport; occasional minor symptoms
- good: minor restrictions in sport and daily life; back to work; occasional analgesics
- fair: better than before surgery but significant restrictions in work and social life
- unchanged: similar overall level of pain and similar disability as before surgery
- worse: increased overall level of pain and disability compared with the period before surgery.

Results

At an average follow-up of 7.4 years, the results of the 39 consecutive patients were graded excellent, good, fair, unchanged and worse in 17, 8, 4, 9 and 1, respectively [Table 1].

Among the 9 patients whose pain was unchanged, 7 underwent fusion which was followed by an excellent result in 4, good in 1, fair in 1 but the pain remained

Table 1. Literature review of surgical results after soft system stabilization

Result category	Markwalder <i>et al.</i> Present Study Follow-up: 7.4 yrs n = 39 (percentage)	Legaye <i>et al.</i> [13] 1994 1.5 yrs n = 19	Guigui <i>et al.</i> [8] 1994 2.4 yrs n = 26	Grevitt <i>et al.</i> [7] 1995 2 yrs n = 50	Salanova <i>et al.</i> [20] 1997 4 yrs n = 88	Skinner <i>et al.</i> [21] 1998 2 yrs n = 25	Moon <i>et al.</i> [17] 1999 5.3 yrs n = 51
Excellent	17 (44%)	10 (53%)	8 (31%)	–	48 (55%)	10 (40%)	–
Good	8 (21%)	–	6 (23%)	–	–	5 (20%)	–
Excellent and Good	–	–	–	36 (72%)	–	–	40 (78%)
Fair	4 (10%)	5 (26%)	9 (35%)	5 (10%)	22 (25%)	6 (24%)	4 (8%)
Unchanged	9 (23%) ^a	–	–	8 (16%)	–	–	4 (8%)
Poor	–	–	–	–	–	4 (16%)	–
Worse	1 (2%) ^b	4 (21%)	3 (11%)	1 (2%)	18 (20%)	–	3 (6%)

^a Seven patients converted to fusion; implants removed in 2 patients. ^b Excellent for 2 years postoperatively, now worse.

unchanged in one patient. The implants were removed in the 2 other patients whose pain was unchanged thereafter.

The patient whose pain was judged as worse at final evaluation had been rated as an excellent result 2 years after operation; he refused further therapeutic intervention measures. The patient who underwent two-level microdiscectomy and ligament stabilization L4-S1 had an excellent result.

The results of the questionnaire were as follows: back pain had completely disappeared, was significantly less or a bit less in 26, 10 and 3 patients, respectively (Fig. 1). Leg pain (n = 25) had disappeared in 20 patients and was significantly less in 5 patients (Fig. 2). Analgesics were not consumed in 71.8%, occasionally in 23.1% and 5.1% of the patients consumed every day (Fig. 3). 87.2% of patients worked in the same profession, 12.8% had a new profession. 74.4% worked full time, 15.4% part time and 11.2% worked 50% (Fig. 4). 84.6% would have the same operation redone and rec-

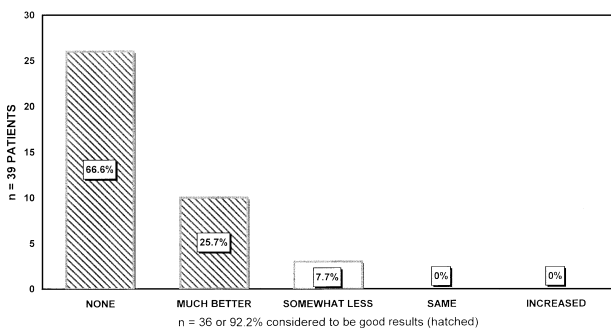


Fig. 1. Results of questionnaire assessing the outcome of back pain at an average of 7.4 years after surgery

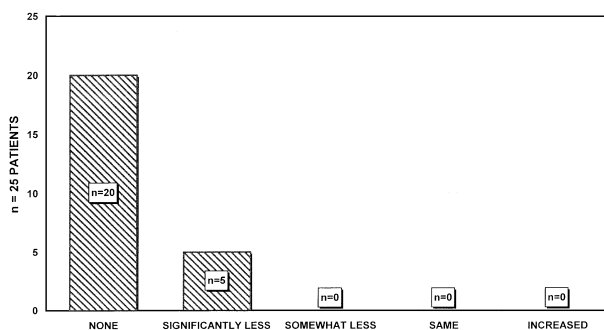


Fig. 2. Leg pain

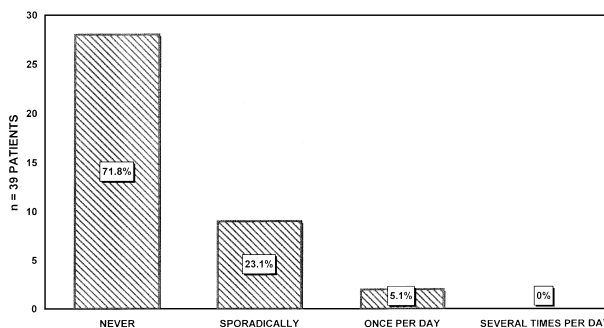


Fig. 3. Use of analgesics

ommend it to others, and 15.4% were not sure to have it redone or recommend it (Fig. 5). The VAS for low back pain was 0 in 69.2%, 2.5 and 5 in 15.4% and 15.4%, respectively. The VAS for leg pain was 0 in 92.3% and 2.5 in 7.7%. There is a discrepancy between the patient's indications concerning leg pain in the questionnaire and the VAS. However, in general, patient's answers are somewhat difficult to interpret because of the subjective nature of pain description.

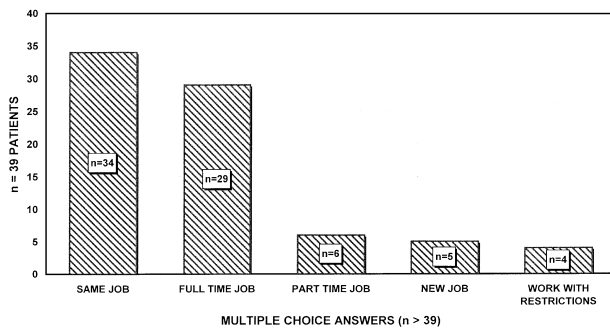


Fig. 4. Working capability

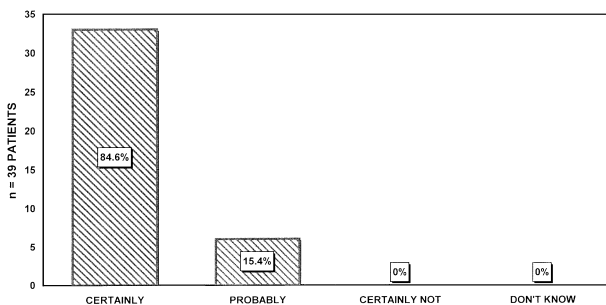


Fig. 5. Willing to undergo same surgery again and its recommendation to others

Discussion

Graf's [5] introduction of ligament prosthesis mounted on pedicle screws represented the first operation attempting to maintain the functionality of a lumbar motion segment.

In this study, we found that soft system stabilization of lumbar motion segments, according to Graf's technique, produced long term benefit in a very restricted patient population who presented with facet joint irritation. An absence of arthrotic changes and only minor disc degeneration were essential criteria for selection. The fact that SSS surgery was performed in only 41 out of 4000 operations on the lumbar spine over a ten-year period reflects our rigorous indication for this kind of surgery. All of the patients were operated upon by the same surgeon (TMM) using the same approach and technique. On the other hand, limitations of our study include its retrospective nature, the lack of an independent observer and the limited number of patients.

Other surgeons have extended the indication for this kind of surgery include patients with problems due to major instability of the lumbar spine, such as isthmic and degenerative spondylolisthesis, degenerative sco-

liosis, postdiscectomy related instability; although early results were encouraging [7, 8, 12, 17, 20, 21] the long-term outcome has been less promising [8, 9, 19, 20]. Table 1 reviews published results of SSS with the Graf implant. Overall results from the literature indicate that excellent and good outcomes were obtained in only 46% after an average period of observation of 4.1 years. In our series, excellent and good results were obtained in 64.1% of patients, probably because of our restriction of selection of patients to those with non-structural and temporary segmental destabilization.

Widening of indications for SSS-surgery has led to discredited of the technique and provoked extensive discussions amongst spine surgeons [4]. We think that the statement made by Gardner *et al.* [4] represents the most clear-cut rationale for a SSS-procedure: "As elsewhere in the body SSS is for soft-tissue problems whereas arthrodesis is for bone problems with irreversible soft tissue incompetence".

Graf [6] stated: "The prosthesis is not a replacement ligament but rather an auxiliary one that permits a temporary reorganization of intervertebral movement, compensatory for the plasticity of the disc and reestablishing the equilibrium of intervertebral articulations".

It can be argued that the patients who had excellent or good long-term results had simply recovered from a temporary disturbance of intervertebral function through healing of annular tears and of other soft tissue incompetence of the affected motion segment(-s). The mode of action of the ligament prosthesis has been widely discussed [1, 5, 7, 18]. Figures 6 and 7 depict the mode of action of the ligament prosthesis mounted on pedicular screws. The insertion of ligaments recreates regional lumbar lordosis, the latter increases tension on the anterior longitudinal ligament, leads to facet locking and increases intradiscal pressure, as demonstrated by intraoperative stress profilometry [7]. Therefore the painful stimulation of articular nociceptors decreases and there will be fewer noxious agents emerging from the disc. In addition, long-term radiological studies have demonstrated that adverse effects on adjacent-segment morbidity is probably less important than after internal fixation and fusion [1, 11, 16].

An increasing number of spine surgeons try to avoid fusion and aim to maintain segmental function. Another implant designed to maintain function is the dynamic neutralization system (Dynesys [2]) which allows a controlled range of motion with the advantage

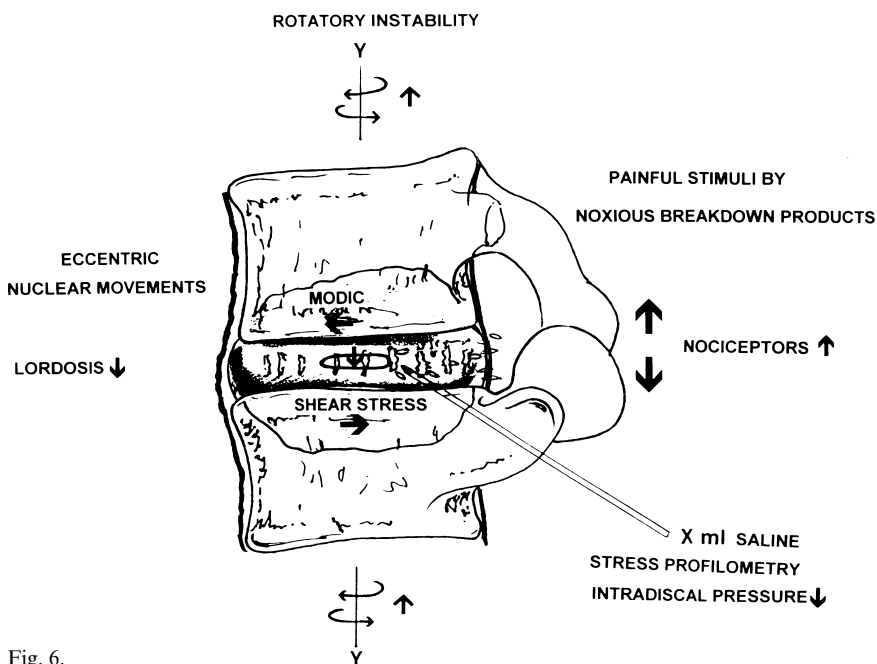


Fig. 6.

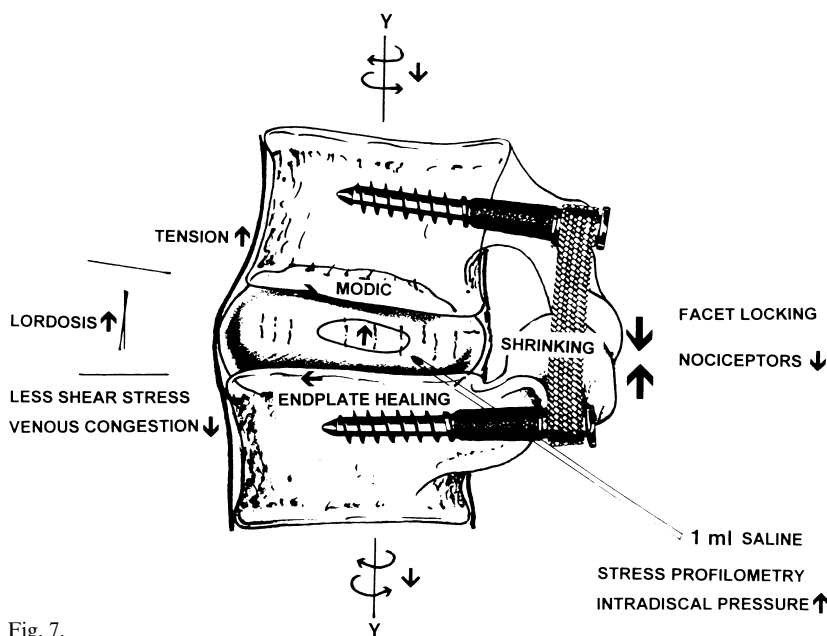


Fig. 7.

Figs. 6 and 7. Mode of action of Graf's prosthesis (see text)

of avoiding facet locking by modular spacers. However, its users mention that its use should be reserved for nonstructural lumbar instabilities.

Ligamentoplasty according to Graf has been abandoned by the majority of spine surgeons because the long-term surgical results are mainly unsatisfactory [Table 1]. The main limitation of the Graf implant is probably the production of joint overlocking in ad-

vanced loss of disc height in degenerative disc disease. We also abandoned this technique because the indications were so highly restricted. Despite the results presented in this study being slightly better than the outcome reported by others, we have shifted to modern non-fusion technology such as total disc arthroplasty. We believe that the latter will allow to treat a larger patient population by non-fusion methods.

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Comment

This article presents the long term results in a carefully selected group of patients who underwent soft spinal stabilisation according to the technique described by Graf. The results are good – better than most reported in the long term.

The authors attribute this success to the fact that their patients represent a highly selected cohort. They point out that the disappointing results which caused most surgeons to abandon this technique can be blamed on extending the indications beyond those originally described. If sound indications are present, then soft stabilisation would seem to give good results.

B. Williamson

Correspondence: PD Dr. med. T. M. Markwalder, M.D., Neurochirurg FMH, Thunstrasse 160, 3074 Bern-Muri, Switzerland.