5 Posterior 'Motion Preserving' Procedures (Frykholm)

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5.1 Introduction

Cervical radiculopathy from degenerative disease is a common problem with an incidence of 0.83–1.79 per 1000 person years. It can be caused by a cervical disc herniation, bony foraminal stenosis or spinal canal stenosis.

Upon failure of conservative therapy or a significant motor deficit surgical treatment is indicated. The technique presently regarded as the gold standard of surgical treatment is an anterior cervical discectomy followed by fusion as already described in the 1950ies by Smith/Robinson and Cloward. However alternative surgical techniques are available for selected cases as total disc replacement (Chap. 4) or a posterior foraminotomy. Both techniques aim to preserve segmental motion by the avoidance of fusion. While total disc replacement evolved in the 1990ies, posterior foraminotomy was already described in 1951 by Ragnar Frykholm and still carries his name as Frykholm procedure. It describes a posterior approach to the cervical spine and posterior laminoforaminotomy to decompress cervical nerve roots from laterally localized disc herniations or foraminal stenoses.

This chapter will outline the indications and limitations of posterior cervical foraminotomies, briefly the surgical steps and the outcome.

At the end of this chapter the reader should be aware of the advantages and disadvantages of posterior foraminotomies to treat cervical radiculopathy.

5.2 Case Description

A 37 y/o female patient suffered from neck pain and right-sided brachialgia with acute onset. Pain distribution was according to the dermatome C7, her neurological examination revealed a right-sided paresis of elbow extension grade 4 out of 5. A MRI scan of the cervical spine showed a right-sided laterally located disc herniation at the C6/7 level (Fig. 5.1). A preoperative CT scan excluded a relevant bony foraminal stenosis or further degenerative osteophytic changes.

After diagnosis of the herniated disc a conservative therapy was initiated. However, as the conservative treatment could not control the patient's symptoms, surgical treatment was indicated. A posterior tubular transmuscular approach to the level C6/7 at the right side was performed. After reaching the bony spine the laminas of C6 an C7 and the joint C6/7 were identified. A partial laminotomy of C6 and 7 and partial facet joint resection was performed as illustrated in Fig. 5.2 and thereby creating a posterior foraminotomy at the

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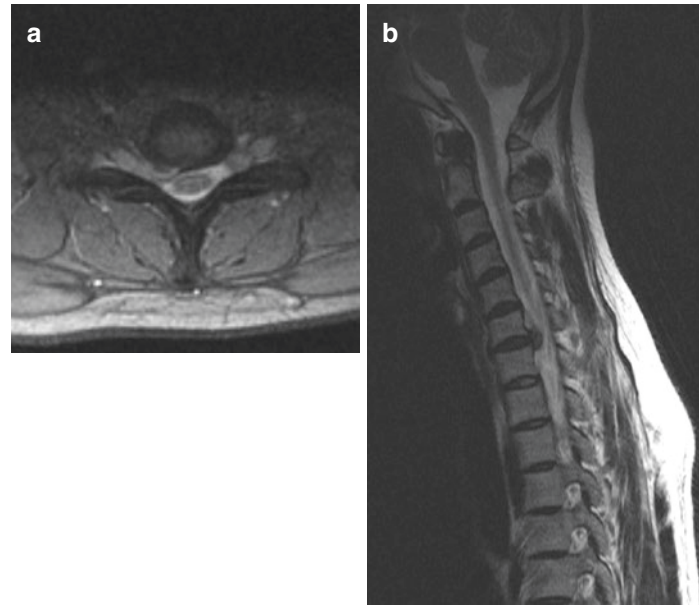

Fig. 5.1 Preoperative MRI scan of the cervical spine in an axial (**a**) and sagittal (**b**) orientation. The MRI scan shows a right-sided lateral C6/7 disc herniation causing C7 root compression. The herniated disc is laterally located i.e. the majority of the herniation is lateral to the spinal cord

Fig. 5.2 Bony surgical access. A 3D reconstruction of a bony spine after a posterior foraminotomy is shown. The extent of the bony drilling necessary to achieve posterior access to the foramen is shown, the stability of the facet joint is maintained

level C6/7 (Fig. 5.2). The soft disc fragment was removed thus decompressing the nerve root.

Early after surgery the patient was pain-free regarding the radicular arm pain. The paresis recovered within a few days. The patient initially complained of some neck pain which recovered completely during follow-up.

5.3 Discussion of the Case

5.3.1 Indication for Surgery

The patient described in the case suffered from a cervical radiculopathy with pain and a mild paresis. The causative soft disc herniation was laterally localized at the segment C6/7.

Usually, cervical radiculopathies from soft disc herniations recover well under conservative therapy [3, 20], but symptoms refractory to conservative therapy as well as significant pareses are an indication for surgery. So far, no data from well-designed studies provide information on when and who to operate. Few smaller studies assessed the difference between ongoing conservative therapy and surgery providing contradictory results [8, 11, 16, 18]. The CASINO trial is currently examining the difference of conservative and operative therapy in a

well-designed prospective randomized controlled study and is still recruiting patients [22].

Due to the lack of conclusive data the decision for surgery is mainly based on experience and can vary at different centers. A commonly accepted indication for surgery would be a persisting, quality of life reducing, radicular pain despite conservative therapy or a paresis of 3 out of 5 or worse.

However, the question remains which technique to choose for decompression, or – for this chapter – when is a posterior cervical foraminotomy an option and what are the potential advantages or disadvantages.

5.3.2 Surgical Technique

For a posterior foraminotomy (PF) the patient can be placed either in a prone concorde position or a semisitting position. Height localization is performed by intraoperative fluoroscopy which can be demanding in the lower cervical spine in short-necked patients where the shoulders overly the lower cervical spine. The approach is either by a medial incision and detachment of the muscles from the spine or, more commonly, a paramedian transmuscular approach. Endoscopic techniques for PF are available as well. Target at the bony spine is the junction between the laminae of the upper and lower vertebra and the facet joint laterally (Fig. 5.2). As a next step it is necessary to perform lateral partial laminotomy by removing 4–5 mm from the superior and inferior lamina using a high-speed drill to allow visibility of the dura [17]. The junction between the medial thecal sac and the exiting root is the medial border of the exposure, the root can be followed laterally as far as necessary. It is safe to remove up to 5 mm of the lateral mass (for most cases approximately 50% of the facet joint) to allow easy mobilization of the nerve root for sequestrectomy without producing instability [1, 4, 25]. After removing the bone usually brisk epidural bleeding from the venous plexus is experienced. A soft disc herniation is usually localized below the exiting nerve root and a sequestrectomy can be performed here.

5.3.3 Indication, Contraindications, Advantages, Disadvantages, Complications and Outcome of Posterior Foraminotomies

Pathologies which can be approached by a PF are unilateral and lateral to the spinal cord, as the cord cannot be displaced to get access to more medial pathologies. Therefore, a typical indication for a PF is a unilateral soft disc herniation with more than 2/3 of the disc herniation lateral to the spinal cord, or a bony foraminal stenosis. Paramedian or medially located disc herniations are not reachable by a posterior foraminotomy and would be a contraindication. Thus, a PF is suitable for a small subsets of patients with cervical radiculopathies only.

However, if patients are well selected, PF provides as beneficial long-term clinical results as the gold-standard ACDF with good to excellent success rates of up to 94% in most published series [7]. A recent meta-analysis found no differences in patients reported outcome measures following PF versus ACDF, a sufficient pain relief in 75–100% and a success rate of 85% [14].

But why prefer a PF in comparison to ACDF or TDR? Advantages of the PF are (i) the lack of implants and thereby the reduction of implant-related complications and costs, (ii) the non-fusion characteristic of the technique maintaining segmental motion and thereby potentially reducing adjacent segment degeneration and (iii) the avoidance of complications associated with the anterior approach as dysphagia, laryngeal nerve palsy and other soft tissue damage. From a health care economics perspective the lack of implants in PF generates 89% less costs than an ACDF [26]. Studies assessing the segmental motion after PF elucidate that PF was not associated with a reduction of segmental motion in most cases and furthermore was not associated with an increased adjacent segment motion as following an ACDF [6, 13, 19].

However, concerns associated with the technique of PF are regarding (i) a potential instability from a partial resection of the facet joint resulting in neck pain and potential deformity, (ii) persisting approach related neck pain from muscular

damage, (iii) worse outcomes in bony foraminal stenoses and (iv) a higher reoperation rate compared to ACDF at the index level [19]. The complications reported with PF include nerve root injury (especially C5 palsy) and dural tear [5, 19].

Some controversies exist regarding the extent of facet joint resection associated with a segmental instability. While some studies report a higher incidence of instability after >50% of resection, other studies show sufficient stability of the cervical spine even after larger amounts of resection [12, 21, 25]. However, for most cases a facet joint resection of <50% seems sufficient which does not endanger stability [1, 4]. But, as a resection of posterior elements is necessary, a segmental kyphosis or cervical lordosis <10° is regarded as a contraindication for PF as a secondary progressive kyphosis may occur [12].

Faught and colleagues [9] showed an excellent long-time quality of life outcome equally for patient treated with PF for both soft disc or osteophyte disease. In contrast, excellent results for soft disc herniations treated by PF were found in 92.6% by Yoo et al., while cases with foraminal stenosis resulted in excellent results after PF in 55.0% of cases only [24]. The outcome of foraminal stenosis decompression with PF seems to depend on the shape and thereby the extent of stenosis [10]. While V-shaped stenoses, i.e. medial stenosis opening towards the lateral part of the foramen can be treated with good results with PF, parallel stenoses, i.e. extending to the lateral part of the foramen, are associated with potentially inferior results as a decompression far lateral is necessary [10]. Therefore, for medial foraminal stenoses a posterior decompression seems to be suitable. Non good candidates for PF are patients with anterior spurs and a foraminal stenosis extending far lateral. Overall, reoperation rate at the index level after PF receiving ACDF is low [23] Regarding reoperation rates after PF and ACDF a recent comparisons of propensity matched cohort of patients treated with PF versus ACDF revealed a reoperation rate of 6.4% versus 4.8% after PF versus ACDF, respectively, thus with no significant difference [15]. Patient lacking preoperative neck pain have the lowest rate of revision surgery after PF [2].

5.4 Conclusions and Take Home Message

The posterior cervical foraminotomy (PF) initially described by Frykholm is a surgical option for unilateral pathologies of cervical foramina, i.e. lateral disc herniations or medial bony foraminal stenoses. Surgical results in appropriately selected patients do not show significant differences to patients treated with ACDFs. An advantage of PF is the preservation of motion and the lack of necessary implants. Medial or mediolateral disc herniations or foraminal stenoses reaching far lateral should not be approached by a PF. Segmental instability after PF is a rare problem. Contraindications include radiographic evidence of a central compressive pathological entity, kyphosis, or a clinical presentation consistent with myelopathy.

Pearls

- The PF is primarily indicated for foraminal lesions and highly effective in treating cervical radiculopathy caused by a lateral disc herniation
- PF results in excellent quality-of-life outcome results of up to 93–96% of patients.
- PF is motion preserving without requiring additional instrumentation, making it both minimally invasive and cost-effective
- Contraindications for PF include radiographic evidence of a central compressive pathological entity, kyphosis, or a clinical presentation consistent with myelopathy.

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