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Minimally invasive disc surgery: a review

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Introduction

Minimally invasive surgery has invaded all fields of surgery, and techniques have been revolutionised by improvements in instrument design. Particular benefits have been seen in orthopaedic surgery; however, the advances in joint surgery have not been seen in spinal surgery.

History

Invasive approaches to the spinal canal for diagnostic purposes were first described in the early 1930s [43, 44]. The instrumentation required, however, was quite large and there was considerable associated morbidity. Ottolenghi et al. [42, 54] described both diagnostic and therapeutic techniques. Hult [18] in 1951 described posterolateral fenestration via a small retroperitoneal approach, with good results in 73% of cases, a figure which compares favourably with current results following minimally invasive techniques. In 1956 Craig [8] described the use of a posterolateral approach to acquire biopsy material and drainage of an abscess, with an excellent description of this approach to all levels of the thoracic and lumbar spine, which is still used as the standard uniportal approach for many procedures. In the same year Feffer described the injection of hydrocortisone into the disc space for the treatment of disc pathology [10]. In patients with back pain and sciatica, the primary site of pathology was considered to be intervertebral disc [32]. It remained so until various studies including that of Holt in 1968 questioned the use of discography as a reliable aid to diagnosis, based on a finding of 37% false-positive discograms in a group of asymptomatic patients [17].

Chemonucleolysis

Enzymatic absorption of the nucleus pulposus by means of chymodiactin was suggested by Smith in 1963 [51, 52]; and the effectiveness of chymodiactin chemonucleolysis has been reported in several double-blind studies [5, 12, 20]. After approval by the US Food and Drug Administration (FDA) in 1982 chemonucleolysis gained widespread acceptance. However, reports followed of a significant complication rate, including mortality [37, 38]. The incidence of mortality is extremely small – about 0.02% [14, 47]; and a 0.5% incidence of anaphylaxis was reported by Agre et al. in 1984 [1]. This could be reduced to 0.02% by prior testing for chymodiactin sensitivity and by excluding patients with a history of sensitivity [25]. Intrathecal injection of enzyme causes microvascular damage with a small incidence (0.03%) of paraplegia [1]. The incidence of infection after discography may be reduced to 0.7% by using an appropriate two-needle technique [13]. Significant muscle spasm, which occurs in the immediate postoperative period and is self-limiting, may occur in up to 40% of cases [14, 27]. Strict guidelines to ensure appropriate patient selection and safe techniques were introduced in 1987; since then no major neurological or anaphylactic complications have been reported [21]. The efficacy of chemonucleolysis remains well proven, with success rates of 70–80% in most series [22] and the results may be superior to those after foraminal decompression [29]. Decompression may be satisfactorily performed after chemonucleolysis, whereas the success rate decreases dramatically in patients requiring repeated decompression. Treatment by chemonucleolysis is significantly more cost-effective [21]. Further developments include the use of other agents such as chondroitinase ABC and collagenase [19, 39].

Percutaneous discectomy

Techniques for percutaneous disc surgery have been extensively described [48, 49, 50, 53]; however, most are

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retrospective uncontrolled studies, descriptions of technique or case reports. There are two groups of procedures: (a) intradiscal decompression; (b) selective removal of prolapsed disc material. The latter group may be further subdivided according to the surgical approach which may be transforaminal, translaminar or by epiduroscopy, usually via a sacral approach combined with a second approach at the required level.

Intradiscal decompression

The original basic concept, which was that the herniated disc returned to the surgically created space within the disc, could not be sustained [15, 22, 55]. The initial reports of successful percutaneous discectomy were by Hijikata et al. in 1975 [16]. Similar techniques were described by Kambin and Gellmann in 1983 [23], and particular credit must go to these workers for the development of appropriate instrumentation and the description of a safe "triangular working zone" [24]; however, the satisfactory early results could not be maintained [9]. Onik et al. described in 1985 the use of a small automated aspiration probe for central nucleus decompression [40, 41] and the ease and safety of this procedure led to its widespread use, with early results of a 90% success rate [33]. However, subsequent reports have shown a success rate of between 37 and 67% in randomised controlled studies [27, 46]. Discoscopy was introduced by a group of Swiss orthopaedic surgeons, with comparable results [30, 48, 49]. In 1987 Choy et al. [7] described the use of lasers in percutaneous disc surgery. As laser vapourisation leads to intermittent elevation of disc pressure, continuous irrigation is required during the procedure. The first operation was performed in Graz (Austria) by Choy et al. [6, 7]. Several authors [31, 36, 50] described modifications of the technique, with similar results to other percutaneous techniques. The initial high interest in laser surgery has declined, due to a combination of expensive technical equipment and moderate clinical results.

Selective removal of prolapsed nucleus tissue

Transforaminal approach

The description of the transforaminal approach represented an advance in disc surgery. The aim is to reach the epidural space at the appropriate level by introducing a rigid endoscope through the small foramen. The triangular work zone defined by Kambin and Gellmann [23] is helpful for the orientation but the primary goal is not the fenestration of the annulus. Matthews et al. [34, 35] described how this procedure is suitable for the removal of far lateral and intraforaminal disc fragments and the development of this technique allowed mediolateral herniated fragments to be removed. Despite the fact that the technique involves transgressing the epidural space, sub-

sequent local fibrosis is rare [53]. Endoscopic orientation requires a significant learning curve [28, 30, 53]; however, further modifications of the transforaminal approach have led to improved visualisation and treatment [30]. Far lateral and intraforaminal herniations are more easily approached by posterolateral endoscopic techniques than by conventional surgery, and appropriate instruments have been developed including automated suction punches and shavers. A 90° laser fibre for shrinking tissues and cautery is also helpful. These instrumentation developments have broadened the indications for percutaneous surgery. Foraminal stenosis previously considered as a contraindication for transforaminal surgery is now, for instance, an indication for percutaneous surgery [26].

Translaminar approach

Translaminar endoscopic discectomy as described by de Antoni et al. [3, 4] has the advantage of reaching the disc space by a conventional approach but with a very small incision and minimal muscle damage. Foley described advances in open microdiscectomy by means of a semi-open, endoscopically assisted procedure [11]; however, few clinical results have been reported.

Epiduroscopy

The development of epiduroscopy required flexible instrumentation. Rigid endoscopes are used for the foraminal approach with a flexible portion allowing limited movement within the epidural space. These flexible instruments are not yet in routine clinical use for the treatment of disc herniations, and clinical data include only case reports. Endoscopic spinal surgery may develop further with these techniques [2, 45].

Summary

Percutaneous disc surgery has a long history, starting in the 1930s. The possible damage to the spinal canal only allowed small advances to be made, with techniques such as lasers, fibre optic systems and special instrumentation. The clinical efficacy of these methods is not yet established. The new techniques lack validation compared with the results after chemonucleolysis or discectomy. No controlled clinical trials involving transforaminal procedures are yet available. It must be assumed that with certain clinical indications percutaneous techniques are superior to standard surgical procedures; and this is, for instance, probably true for far lateral herniations and intraforaminal herniations which are easily accessible by transforaminal approaches. However, chemonucleolysis may remain the preferred treatment for contained disc lesions [30]. Selecting the optimal procedure for each type of herniation is the goal of clinical research in this area.

Endoscopic procedures via a posterolateral approach may give better results but this remains unproven. Better visualisation of herniated disc fragments will improve treatment options. A prerequisite for all comparative studies is excellent surgical technique; it is mandatory that the same surgeons can perform all these procedures – open standard decompression, microdiscectomy and minimally invasive techniques. Studies favouring one or the other technique are biased by differing surgical education. Comparing the procedure, during the learning curve, with a standard method performed over many years may not draw conclusions. Appropriate education of surgeons including all minimally invasive techniques is required in order to select the appropriate procedure for each patient.

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