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Side effects and complications of automated percutaneous lumbar nucleotomy

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Abstract We reviewed the records of 243 patients treated at 271 disc levels to determine the incidence of side effects and complications of percutaneous nucleotomy. In our early experience there were 7 technical failures (2.5 % of all attempts), of which 6 were at the 5th disc level. The success rate dropped from 67 % at 3 months to 60 % 1 year after treatment due to recurrences in 16 patients (6.6 %). Extruded or sequestered fragments were found in 6 patients (2.4 %), and may have been caused by nucleotomy. However, only one was accompanied by aggravation of symptoms. Discitis was seen in 2 patients (0.8 %), both treated at two separate disc levels. About half the patients experienced increased low back pain, mean duration 9 days, after treatment, and 3 (1.2 %), of whom 2 also had nonorganic disorders, needed admission to hospital because of severe pain. Mild spasm and a sensation of instability were noted by 9.6 % and 25 % of the patients respectively. Injury to nerves, bowels, vessels or ureters or a dural leak never occurred. The study confirms earlier reports that the rate of serious complications is low.

Key words Intervertebral disc, hernia · Nucleotomy · Complications

Introduction

Percutaneous nucleotomy was introduced by Hijikata in 1975 [1]. A variety of publications have focused on the clinical results [2–5]. Success rates in the 60–85 % range and low complication rates have been reported in a majority of publications [2–4, 6]. However, damage to nerves [7, 8], vessels [7] and the ureter [9], iatrogenic sequestered fragments at the annulotomy site [10–12] and severe lumbar pain [13] have been reported. Because the majority of complications have been published as case reports [9, 12–14], their frequency is uncertain. We therefore carried out the present investigation to quantify these problems.

Patients and methods

We reviewed 243 patients aged 17–77 years, mean 37,2 years, 129 women and 114 men, treated for 271 herniated or posteriorly bulging lumbar discs with the Nucleotome R system. All patients had failed to respond to conservative treatment including bed-rest, analgesia, physiotherapy and exercise, for at least 3 months prior to nucleotomy.

Pretreatment imaging was with CT, with continuous 5-mm sections through the disc spaces in 152 patients, and with CT, CT-discography with manometry and MRI at 0.5 T in 91.

Following other workers [2, 3], we used the following grading for the outcome: very good – complete relief of pain, return tu preinjury functional status, negative straight leg raising test, minimal or no neurological deficit; good – definite improvement, but incomplete pain relief and/or some residual neurological deficit, occasionally requiring analgesia; unchanged – no improvement; poor – more disabled than preoperatively. The very good and good results were combined and classified as successes, the others as failures. The result was classified as a success only if the patient was satisfied.

With a few modifications [15], we used the nucleotomy technique of Onik et al. [16, 17]. Under C-arm fluoroscopic control, all nucleotomies were conducted in the myelography room of the radiology department with the patient in the lateral decubitus position, awake, and under analgesia and sedation. The first 80 patients were admitted to hospital overnight; thereafter treatment was given on an outpatient basis. After nucleotomy anti-inflammatory medication was given for 2–3 days and analgesics when needed.

The patients were advised to avoid lifting, bending or prolonged sitting for 1–3 weeks, and to resume physiotherapy and exercise in 2–6 weeks, depending on the clinical situation.

CT or MRI was repeated if adverse effects or complications occurred.

Results

Technical

There were 7 technical failures (2.6 %). Of these, 6 were at the 5th disc level using a 2.5-mm nucleotome, caused by disc-space narrowing in 2 patients, disc-space narrowing and osteophyte formation in another, a hypertrophic facet joint in one and steep angle between the needle course and disc space in one. Two other procedures were not completed because of severe pain, one at the 5th and one at the 4th disc level. With a 2-mm probe even narrow discs could be treated in all attempted cases.

We discontinued four procedures after suction times of 5–18 min because of a combination of blood-tinged saline in one patient, pain in another patient and both pain and blood staining of the saline in 2.

Clinical

In the first 3 months after treatment, 164 of the patients (67 %) experienced a beneficial effect, with good or very good results (Table 1). As there were recurrences in 16 patients, 148 patients (60 %) were classified as successful after 1 year. The reasons for relapse were a fall in 3 patients and a traffic accident and slipping in cross-country skiing in one patient each. The remaining 11 were spontaneous.

Complications ascribed to the procedure appear in Table 2. Surgical findings and follow-up imaging revealed a total number of 6 extrusions not evident on pretreatment imaging. One patient experienced increasing low-back and sciatic pain in the first 24 h after nucleotomy. CT-discography prior to treatment had demonstrated a contained central herniation at the 5th disc level. The next day, however, CT revealed a large free fragment, confirmed at emergency surgical discectomy. In 4 other patients, whose clinical status was unchanged after nucleotomy, noncontained herniations were also found at surgery. In the last patient, with a small herniation on pretreatment CT, a large extrusion was noted on MRI as part of a prospective study the day after nucleotomy (Fig. 1). However, this patient made a satisfactory recovery. Thus, only one of the 6 extrusions encountered was associated with aggravation of symptoms.

Table 1 Clinical results after percutaneous nucleotomy in 243 patients

Result	Time after nucleotomy					
	1 month		3 months		12 months	
		%		%		%
Very good	15	6	54	22	70	29
Good	125	52	110	45	78	32
Unchanged	86	35	66	27	47	19
Poor	16	7	7	3	5	2
Operated	1	0	6	3	43	18

Table 2 Complications of automated nucleotomy of 271 discs in 243 patients

Complication	Patients	%
Iatrogenic extrusions[a]	6	2.4
Discitis	2	0.8
Severe pain	3	1.2

[a] Some may have been overlooked on pretreatment imaging

Two patients developed clinical and radiological changes consistent with discitis. At repeat nucleotomy for bacteriological examination sterile samples were obtained in both cases. The patients were treated with long-term antibiotics; one had a good outcome, but the other made a poor recovery.

Half of the patients did not experience any increase in low-back pain after nucleotomy; 12 % had a slight increase, mean duration 7 days (range 2–30 days), 14 % a moderate increase, mean 17 days (range 5–70 days) and 23 % reported a considerable increase, mean duration 15 days (range 3–60 days). Of these patients, 3 reported severe pain, and were admitted to hospital for 1 day, and 3 and 6 weeks, respectively. The 2 patients with the longest admission also had nonorganic disorders.

Mild spasm in the extensor muscles was reported by 9 % of the patients, and a mild to moderate sensation of instability by 25 %.

One patient, who made an uneventful initial recovery after nucleotomy, developed functional paresis of the lower limbs 1 month after the treatment.

Injury to nerve roots, bowels or ureters, severe haemorrhage or dural leak never occurred. Follow-up imaging and surgical findings after failed nucleotomy never showed scar formation.

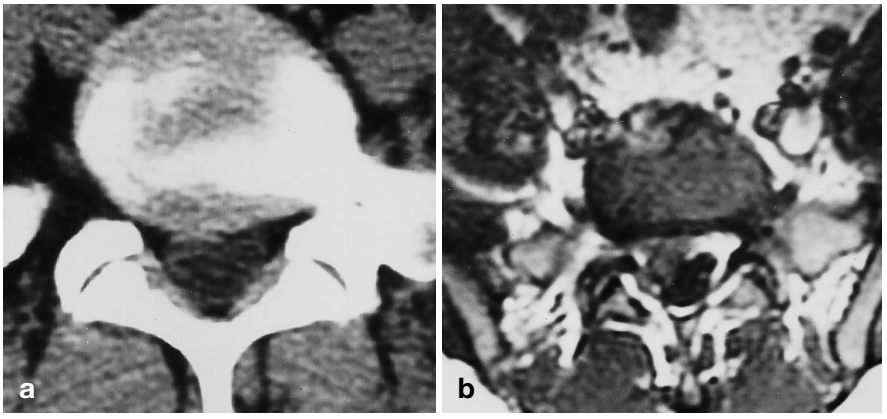

Fig. 1 **a** CT demonstrates a small posterolateral herniation on the right at the 5th disc. **b** Routine MRI the next day reveals a large sequestration on the right

Discussion

Of the 7 technical failures, 6 occurred in the first 120 attempts. With increasing experience the failure rate was reduced, only one occurring in over 150 procedures.

Our clinical results do not approach those of surgical diskectomy, and are also inferior to other reports on automated nucleotomy [2, 4, 10]. However, poorer results, with only 37 % successes after 1 year, have been reported in a multicentre study [5]. At variance with the results of Davis et al. [2] and Bonaldi et al. [10], we observed a higher frequency of recurrences than might be expected after operative treatment. This is not surprising since the herniated disc itself is not removed, only a few grams of nuclear material being aspirated.

Iatrogenic extrusions have been noted by other workers [10–12]. However, since their clinical implications are uncertain, the true frequency of iatrogenic extrusions and sequestered fragments is also uncertain. In a prospective CT follow-up of 69 discs, 6–17 months after nucleotomy, increasing size was noticed in 2 herniations, of which one was associated with a possible extrusion [18]. Some extrusions found at surgery in patients with unchanged symptoms may actually not have been contained prior to nucleotomy, because both CT [19] and MRI [19, 20] have low accuracy in the differentiation between contained and noncontained herniations.

The explanation for this complication is probably weakening of the annulus by performing trepanation at the side of the herniation, as recommended by the pioneers in this field [2, 16]. Because severe annular degeneration and complete annular tears are present at the site of the herniation itself in a majority of cases [21], we recommend entering the disc on the side opposite the herniation. This is consistent with the recommendations using the flexible nucleotome, in which case entry opposite the herniation makes it easier for the tip of the nucleotome to approach the herniation.

The 2 patients who developed discitis had been treated at two levels. Contamination of the instrument when moving from one level to the other may account for this complication. In large series discitis has been reported in 0.2–0.4 % [2, 4] compared to our 0.8 %. In a series of 50 patients the frequency was as high as 4 % [22]. Unlike us, some teams give prophylactic antibiotics [10, 23]. The beneficial effect of such treatment remains unproven, but the risk of this potentially serious complication underlines the need for strict sterile conditions.

Despite the fact that nucleotomy is tolerated well by most patients, causing less pain and spasm than chemonucleolysis [5], increasing low back pain may occur for up to several weeks. Its pathogenesis is not understood. One explanation put forward is that the innervation of the degenerate annulus may be affected by the procedure [13].

Careful patient selection seems to be important to reduce problems with increased low back pain. Patients with nonorganic disorders may react adversely to the intervention, and for many of them adjuvant noninterventional therapy may be preferred. This also applies to the patient with functional paresis occurring 1 month after treatment. The long interval between nucleotomy and onset of symptoms seems to exclude any causal link.

After nonautomated nucleotomy, with instruments inserted through wide cannulae, symptomatic haematomas of the psoas muscle were reported in 18 % of cases [24]. With the automated nucleotome, thinner cannulae with outer diameter 2.8–4.2 mm are used. These may be introduced with less resistance, and cause less tissue damage. A psoas muscle hematoma has, however, been reported even with this equipment [14].

Possible nerve root injury is best avoided by performing the procedure under local anaesthetic, the patient reporting pain whenever the instrument impinges on a nerve; treatment under general anaesthesia is therefore not recommended [2].

For safety reasons, and to facilitate entry into the disc, some workers recommend CT guidance [6]. In our

opinion, pretreatment CT or MRI with a field of view large enough to demonstrate the trajectory to the disc is sufficient to exclude conditions associated with increased risk of complications. These include bowel injury due to the colon lying posterior to the psoas muscle, vascular anomalies and conjoined nerve roots. The first of these is rare, and was never observed in more than 300 patients treated by nucleotomy [10]. Occasionally the iliac vessels may lie behind the midportion of the lumbar vertebra, close to the trajectory. They are more ventral, and less variation in their course has been noted, at L4–L5 than at the L5–S1 level [25].

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