Artificial Intervertebral Disk

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Spinal fusion is reported to provide satisfactory results in degenerative or traumatic spinal disorders, but it is accompanied by the loss of mobility and accelerated degeneration adjacent to the fused segment. The disadvantages of lumbar spine fusion have bolstered the requirement for a reconstruction method that preserves natural segmental motion without eliminating spinal stability. In recent years considerable efforts have been invested in developing a dynamic intervertebral disk replacement.

The pioneer of artificial disk implant was Fernstrom, who published his experience with a metal ball-type prosthesis [1]. Buttner-Janz and co-workers [2] developed the SB Charité endoprosthesis, whose third-generation offshoot, the LINK® SB Charité III, is the most commonly used prosthesis today.

Pros and cons of artificial disk versus fusion

Although short spinal fusion is considered as the golden standard for surgical treatment in patients with intractable low back pain, artificial disk implantation serves as a reasonable substitute for fusion in selected cases. The long-term results of lumbar spine fusion show that as many as 45% developed signs of instability and 42% stenosis during a follow-up period of 33 years [3]. Late problems include, in particular, the development of degenerative changes, either proximal or distal to the fused segment [4–6]. For nucleus replacement implants, conceptually they should maintain disk height and motion [7] and therefore could be used as an adjunct to diskectomy as they are designed to address the pitfalls associated with diskectomy while not sacrificing any of its benefits. However, the potential risk of nucleus replacement may be higher than that of diskectomy or fusion [8]. Most candidates for implantation of an artificial disk are relatively young people. Assuming natural wear of the implanted or ongoing degeneration of the neighboring disks, the need for repeated surgery must be taken into account. One should bear in mind the technical difficulties and high complication rate expected in those cases. The relatively short follow-up available today leaves the fate of the long-standing artificial disks unknown. The longest published follow-up for the Charité-type prosthesis presented 105 cases with a mean follow-up of 51 months [9].

Indications and contraindications

The most common indication for artificial disk implantation is a long-standing symptomatic degenerative disease of the intervertebral disk that is unresponsive to conservative treatment [9,10]. The use of an artificial disk may be considered in cases with degeneration of a disk adjacent to a preexisting lumbar fusion [9,11] or in combination with short fusion in multilevel degeneration [11].

As for the contraindications, degeneration of the facet joints may be responsible for severe back pain not alleviated or even accentuated by the implantation of an artificial disk [12]. While degeneration of the posterior elements is often regarded as a contraindication for prosthetic disk implantation [9,12], some researchers adopt a more liberal attitude [7]. Additional contraindications for nucleus replacement prosthesis include disk height less than 5 mm, signs of incompetent anulus and Schmorl nodes [8], as well as spinal deformities including coronal plane imbalance [9,11]. Another contraindicating condition is advanced age and osteoporosis, as implant subsidence through the endplate into the vertebral bodies may occur [9]. Infections, localized or systemic and severe medical disorders are obvious contraindications for artificial disk implantation.

Types of implants

The metal ball type was pioneered by Fernstrom [1]. These implants, after the initial satisfactory clinical results, failed due to subsidence into the spongy bone of the vertebral bodies. This type of implant is no longer in use.

The multi-part artificial disk, first introduced by Buttner-Janz and co-workers [2], was improved and the third-generation Charité SB III is the one most commonly used today. Another member of this group is the Pro-Disc developed by Marnay [13].

The nucleus pulposus replacing implant has several advantages over a total disk prosthesis. In cases where the anulus and endplates are unharmed, this procedure may preserve their function and reduce the complexity and risk of the implantation. Ray [7] introduced the prosthetic disk nucleus, which is still under investigational use in the United States but is available for use in other countries.

The articulating implant is a new device based on a hinge-spring mechanism that was introduced by Hedman and colleagues [14]. Despite intensive biomechanical investigation, this implant is not in use today. The flexible spacer, aimed to replace the anulus and nucleus, was introduced by several investigators. Enker et al. [11] reported their clinical results using a disk prosthesis composed of a hexan-based polyolefin rubber core vulcanized to two titanium endplates. Kadoya et al. [15] developed a new three-dimensional fabric artificial disk coated with hydroxyapatite for better attachment to the bone.

Outcome

The results of artificial disk implantation can be evaluated according to various clinical and radiologic parameters. Zeegers et al. [16], reporting 50 patients with the SB Charité III prosthesis after a mean follow-up of 2 years, showed 70% satisfactory clinical results. Better results were noted in patients younger than 45, without previous surgery, and in those with one-level degeneration. Twelve patients required re-operation (7 with complication) with beneficial results in only 3. Lemaire et al. [9], also using the SB Charité prosthesis, reported their results in 105 patients, age 24–50, after an average follow-up of 51 months. They reported amelioration of back pain in 90.5% and of radicular pain in 96.6% at the end of 3 months and the results were definitely stable after 1 year. Poor results were attributed to either incorrect indications such as osteoporosis, facet joint arthritis or thoracic kyphosis, or to non-return to work. It should be stressed that 87% did actually return to work – some to the same preoperative activity and others to reduced-activity employment. Griffith et al. [10] reported 93 patients with the SB Charité III prostheses after an average follow-up of 11.9 months. They reported significant improvement in leg pain and to less extent in back pain. No difference in work status was found before and after disk implantation.

Caspi et al. report their experience in this issue of *IMAJ* [17]. Using the SB Charité III model in 20 patients with the same age range as that in Lemaire's series and similar indications with follow-up of up to 2 years, they report good to excellent results in 80% and poor outcome in 20%, half of them requiring fusion. The authors stress the point that in all four patients with poor results the postoperative radiographs were satisfactory; nonetheless all four were involved in different stages of litigation.

Complications

Zeegers et al. [16] reported 44 minor and temporary complications among 50 operated patients. An additional eight permanent complications included dysesthesia of the legs in three, symptoms attributed to lumbar sympathectomy in four, and in one patient the prosthesis was not in the correct position. Griffith and co-workers [10] reported a 6.5% complication rate among 93 patients with the SB Charité III, including device failure, migration or dislocation, vein injury, and post-sympatectomy signs including retrograde ejaculation. Caspi et al. [17] report 10% migration of the prosthesis requiring revision surgery, 5% with laceration of the ureter and 5% with thrombosis of the iliac artery.

Summary and future prospects

The development of an artificial disk represents a substantial step in the treatment of chronic, disabling low back pain. The variety of concepts and models introduced by many researchers reinforces the point that the desired solution has not yet been found. Besides artificial disks, other treatment modalities should be considered, such as allograft transplantation to replace the damaged intervertebral disk, or regeneration of the nucleus pulposus by cells from cell cultures from autodonation.

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