RECONSTRUCTIVE UROLOGY

Flap technology for reconstructions of urogenital organs

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Purpose of Review: The purpose of this review is to summarize the different reconstructive options for urogenital indications. The development of various flap techniques to restore congenital and acquired urogenital defects is presented.

Recent Findings: Various reconstructive techniques have been demonstrated recently. On the basis of the reconstructive requirements, two main techniques can be defined: the standard local or regional flap technique (pedicled flap) and the more sophisticated microvascular free flap technique. Free tissue transplantation (transfer) is a procedure that involves microvascular transplantation of a flap (a fasciocutaneous, muscle or composite flap) in one stage from a donor site in the body to a distant recipient site. The viability of the transplanted flap is maintained by microvascular anastomosis between the flap's vessels (at least one artery and one vein) and recipient vessels. Re-innervation and functioning muscle contraction is achieved by suturing the vessels and a motor nerve in the recipient area to a motor nerve of a free transplanted muscle. After regeneration of the nerve and re-innervation of the transplanted muscle, a functioning free transplanted muscle offers enough contractile capacity and strength to replace the function of the missing muscles at the recipient site. The technique of microvascular free tissue transfer necessitates extensive experience in microvascular technique and this approach could be efficiently applied in cooperation with other specialists. Recent studies show the development and clinical application of these new surgical techniques in urology (e.g. in the treatment of bladder acontractility using innervated free latissimus dorsi muscle and in the use of a free microvascular fillet lower leg flap for the reconstruction of a large pelvic-floor defect).

Summary: Various reconstructive requirements define the techniques for reconstruction. The main principle is to obtain optimal anatomical and functional reconstruction with minimal donor site morbidity. Depending on the etiology of the defect, different reconstructive options are available to optimize the reconstructive result. Optimal reconstruction might best be achieved by adopting an interdisciplinary approach in which the primary objective is to provide the best possible outcome for each patient. This review presents the main indications for and principles of flap selection according to the reconstructive requirements.

Editorial Comment

In reconstructive urology as in many other areas indications and possibilities can be considerably improved by co-operation with other disciplines. The current paper written by an expert plastic surgeon published in an urological journal shows how sophisticated flap techniques can be used in urologic surgery.

Another important aspect is the fact that pre-fabrication as seen by these authors is an alternative for reconstruction of segments in the urinary tract. Contrary to tissue engineering, where the organ is primarily generated in the laboratory to be implanted into the body later on, the pre-fabrication technique composes organs with one or several different flaps in the body itself and transplants or transposes the finished "product" to the desired location when it is ready to use. When we look at the many open questions and problems that need to be solved in tissue engineering before we can apply it on a large scale in urology, pre-fabrication may be a way for a broader clinical use in the nearer future.

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Improved sphincter contractility after allogenic muscle-derived progenitor cell injection into the denervated rat urethra

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Objectives: To study the physiologic outcome of allogenic transplant of muscle-derived progenitor cells (MDPCs) in the denervated female rat urethra.

Methods: MDPCs were isolated from muscle biopsies of normal 6-week-old Sprague-Dawley rats and purified using the preplate technique. Sciatic nerve-transected rats were used as a model of stress urinary incontinence. The experimental group was divided into three subgroups: control, denervated plus 20 microL saline injection, and denervated plus allogenic MDPCs (1 to 1.5 10^6 cells) injection. Two weeks after injection, urethral muscle strips were prepared and underwent electrical field stimulation. The pharmacologic effects of d-tubocurare, phentolamine, and tetrodotoxin on the urethral strips were assessed by contractions induced by electrical field stimulation. The urethral tissues also underwent immunohistochemical staining for fast myosin heavy chain and CD4-activated lymphocytes.

Results: Urethral denervation resulted in a significant decrease of the maximal fast-twitch muscle contraction amplitude to only 8.77% of the normal urethra and partial impairment of smooth muscle contractility. Injection of MDPCs into the denervated sphincter significantly improved the fast-twitch muscle contraction amplitude to 87.02% of normal animals. Immunohistochemistry revealed a large amount of new skeletal muscle fiber formation at the injection site of the urethra with minimal inflammation. CD4 staining showed minimal lymphocyte infiltration around the MDPC injection sites.

Conclusions: Urethral denervation resulted in near-total abolishment of the skeletal muscle and partial impairment of smooth muscle contractility. Allogenic MDPCs survived 2 weeks in sciatic nerve-transected urethra with minimal inflammation. This is the first report of the restoration of deficient urethral sphincter function through muscle-derived progenitor cell tissue engineering. MDPC-mediated cellular urethral myoplasty warrants additional investigation as a new method to treat stress urinary incontinence.

Editorial Comment

The idea to enhance urinary sphincter function by injecting in vitro cultivated cells into a dysfunctional sphincter is fascinating. This group as well as others has presented experimental work showing the possible benefit of such a procedure. The authors are the first ones to provide a peer reviewed paper on the outcome of injecting in vitro cultivated progenitor muscle cells. This work is remarkable with regards to two aspects. Apart from an improvement of urethral sphincter function by muscle-derived progenitor cell injection, it also demonstrates the effect of urethral denervation. This denervation resulted not only in a near total loss of function of the skeletal muscle (i.e. rhabdosphincter) but also in a partial impairment of smooth muscle contractility. This confirms clinical findings that autonomic nerve preservation may also have a beneficial effect on urinary continence.

An improvement in sphincter tonus by injecting autologous muscle derived progenitor cell injection has been demonstrated previously by another group (Strasser et al., Eur Urol. 2003; 43: A 350). This work was carried out in pigs, which in many ways have more similarity to the clinical situation than rats. However, no peer reviewed published manuscript exists yet.

As it seems we are entering a new period with regards to the treatment of stress urinary incontinence. Instead of just injecting bulking agents or passively closing the urethra with a silicone cuff, we may be able to restore or improve remnant insufficient rhabdosphincter function.

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