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## ORIGINAL ARTICLE

# NERVE GRAFTING AT THE TIME OF RADICAL PROSTATECTOMY: SHOULD WE BE DOING IT?

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**Background:** With increasing numbers of younger men being diagnosed with prostate cancer and subsequently undergoing radical prostatectomy, there is an increasing focus on quality of life postoperatively, especially potency. In patients with locally advanced disease, it has been suggested that use of nerve grafts at the time of radical prostatectomy may improve potency. The technique was first described in 1999 and several papers have been published about its utility. However, there is still controversy over its use because of the lack of any large, blinded trials, the anatomy of the cavernous nerves and the necessity of excising the neurovascular bundles (especially bilaterally). In addition, the results achieved with nerve grafting, a procedure not without significant morbidity and mortality, do not exceed those produced by surgeons carrying out nerve-sparing procedures.

**Results:** In the published work reviewed, erections sufficient to produce vaginal penetration following unilateral nerve grafting (with contralateral nerve sparing) were evident in 41.7–63.6% of patients. This is similar to the rates of 23–64% with unilateral nerve sparing alone. The rates of erectile function sufficient to produce vaginal penetration following bilateral nerve grafting were 34–72%, whereas it is widely accepted that very few men without nerve grafting would have any degree of potency.

**Conclusions:** Currently, there does not appear to be a widespread role for nerve grafting at the time of radical prostatectomy.

**Key words: erectile function, nerve grafting, prostatectomy.**

Abbreviations: NVB, neurovascular bundles; PSA, prostate-specific antigen.

## INTRODUCTION

Since the advent of PSA testing in the early 1990s, the average age of men diagnosed with prostate cancer has fallen and simultaneously, the number of men aged <55 years undergoing radical prostatectomy has increased.[1–3] In young, potent men with localized prostate cancer, the quality of life, postoperatively, will be almost as important as cure of the disease. One of the chief constituents of quality-of-life post-radical prostatectomy is erectile function.[1] As such, various centres have suggested a variety of operative techniques to maximize the rates of potency postoperatively. These include the anatomical nerve-sparing prostatectomy, carried out by either an open, laparoscopic or a robotic approach.[4–6] All these techniques are based on the premise that erectile function, post-radical prostatectomy, is related to the preservation of the cavernous nerves that run in the neurovascular bundles (NVB). As a corollary, preservation of both NVB produces the greatest postoperative potency rates and wide excision of both NVB essentially condemns the man to impotence.[7–9]

In 1999, Kim *et al*. described the use of the sural nerve as an interposition graft for the cavernous nerves following wide excision of the NVB.[10] This has been followed by several other centres publishing their experiences of nerve grafting at the time of radical prostatectomy. Concurrently, there is a contrary view that this technique will probably be neither anatomically nor clinically feasible. This paper aims to review the published work thus far on nerve grafting at the time of radical prostatectomy, and in the absence of a randomized control study in the area, offer some conclusions.

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## METHODS

The PubMed database was searched from 1950 to April 2007 for English language articles using the terms: 'sural nerve', 'nerve grafting', 'radical prostatectomy' and 'erectile dysfunction'. In all, six studies were retrieved that directly dealt with erectile function following interposition nerve grafting at the time of radical prostatectomy (Table 1). In addition, recent papers reporting erectile function following nerve-sparing retropubic, laparoscopic and robotic prostatectomies were reviewed to gauge these results against the results reported with nerve grafting so as to form conclusions on the efficacy of nerve grafting.

## RESULTS

In large, contemporary series from centres of excellence, preservation of both NVB at the time of open prostatectomy produces potency rates of 40–76%, whereas unilateral nerve sparing produces rates of 23–64%.[17–23]

Initial work on nerve grafting for the cavernous nerves was carried out by Quinlan in 1991.[24] This produced promising results in a rat model; however, it has since been elucidated that the rat model is *quite dissimilar* to humans. A fundamental difference is

**Table 1.** Studies of nerve grafting at the time of radical prostatectomy

| Author | Graft used | Unilateral/Bilateral | Study cohort | % Achieving intercourse | Mean follow up (months) |
|---|---|---|---|---|---|
| Kim *et al*.[10,11] | Sural | Bilateral | 12 | 58.3 | 21 |
| Sim *et al*.[12] | Sural | Unilateral | 41 | 62.3 | 24 |
| Chang *et al*.[13] | Sural | Bilateral | 18 | 72 | 15 |
| Nelson *et al*.[14] | Genfem | Unilateral | 22 | 63.6 | 14 |
| Porpiglia *et al*.[15] | Sural | Unilateral (laparoscopic) | 12 | 41.7 | 18 |
| Secin *et al*.[16] | Sural | Bilateral | 44 | 34 | 60 |

that the rat's cavernous nerve is a relatively large and distinct structure, whereas in humans, extensive anatomical studies have shown that the cavernous nerve is, in fact, a tiny plexus of nerves intermingled with vessels. In addition, the nerves in this NVB innervate not only the corpora cavernosa, but also the rectum, prostate and levator ani.[4,25]

The first researchers to carry out nerve grafting at the time of radical prostatectomy were Kim *et al*. In 2001, the group published an article describing their method for nerve grafting.[11] It involved use of the sural nerve and emphasized the importance of loupe magnification, a tension-free anastamosis, precise identification of both ends of the NVB and use of a graft 10–20% longer than the defect to be grafted. In this study, they had a 12-man treatment group, all of whom had bilateral NVB resections. The mean follow up was 21 months, and over this time, seven men (58.3%) had erections sufficient for sexual intercourse (either with or without sildenafil). Of the matched controls (also 12 men having bilateral NVB resection) none had erections sufficient for sexual intercourse.

In 2006, Sim *et al*. published their results for 41 men who had unilateral sural nerve grafts using the same technique described by Kim *et al*.[12] At 24 months, 63.2% had rigid erections sufficient for intercourse *with or without* use of sildenafil. This was similar to the institution's database of radical prostatectomies with unilateral NVB excision where 26.5% of men had erections sufficient for intercourse at 2 years.

Also in 2006, Nelson *et al*. studied the efficacy of genitofemoral nerve grafts at the time of radical prostatectomy in 27 patients.[14] The rationale for the use of the genitofemoral nerve was that it obviated the need for a separate incision to harvest the nerve graft (as is necessary for the sural nerve). At a mean follow up of 14 months, 63.6% of the 22 men who had unilateral nerve grafts had erections sufficient for sexual intercourse. This included those men requiring medication (either sildenafil or alprostadil).

In line with increasing utilization of laparoscopy for radical prostatectomy, in 2005, Porpiglia *et al*. reviewed 15 men with laparoscopically carried out unilateral sural nerve grafting.[15] Follow up was complete for 12 men and the mean follow-up period was 18 months. A percentage of 41.7% of men had erections sufficient for vaginal penetration with or without sildenafil. In the control group of 10 men, 30% had erections sufficient for vaginal penetration.

The most recent paper in the MEDLINE database was by Secin *et al*. in 2007.[16] They carried out bilateral nerve grafts following bilateral wide excision of the NVB in 44 men. At the 5-year follow up, 34% of men could achieve erections sufficient for intercourse with or without oral medication. Their control group of six men all failed to achieve meaningful erections at 5 years. These results are in contrast to those published by Chang *et al*. in 2003.[13] That study, an 18-man cohort with bilateral nerve grafts, had 13 (72%) who could achieve intercourse at a mean of 15 months. This group used Cavermap (Blue Torch Medical Technologies, Ashland, MA, USA) to facilitate the nerve grafting.

Although all these papers have shown some degree of efficacy for nerve grafting at the time of radical prostatectomy, a paper by Walsh in 2001[17] challenged both the necessity and the efficacy of nerve grafting. In his study group of 12 men (6 treatment and 6 control) he found no difference between the erectile function in the two groups at 5 years. It was these results that have challenged the efficacy of nerve grafting at radical prostatectomy.

## DISCUSSION

The technique of using autologous nerve grafts in humans at the time of radical prostatectomy was first described by Kim *et al*. in 1999.[10] However, there is controversy regarding its necessity and efficacy based on three issues: lack of a large randomized controlled trial; the anatomy of the cavernous nerves in humans; and the necessity of wide excision of the NVB at the time of radical prostatectomy.

As shown by Table 1, the size of the largest treatment group in any study published on nerve grafting is 44 patients. As such there has been no large randomized control multicentre study adequately powered to effectively show the efficacy of nerve grafting. The difficulty in achieving this is how to blind the study if the sural nerve is to be used, as all members of the treatment group will have an incision site at their ankle that members of the control group will not have. In addition, *the subjectiveness of an end-point such as 'erectile function sufficient to produce sexual intercourse' makes cross correlation of results at different centres difficult.* Although several centres have attempted to compensate for this by using measurements such as nocturnal tumescence with Rigiscan (Timm Medical Technologies Inc, Eden Prairie, MN, USA) the final analyses have centred around the percentage of patients reporting erections sufficient for penetrative intercourse.

The difference in the anatomy of the rat and the human with regards to the cavernous nerves gives rise to another criticism levelled at nerve grafting. The preliminary work on sural nerve grafting by Quinlan was in a rat model.[24] In the rat, with its relatively large and distinct cavernous nerve, grafting of any defect seemed feasible. However, separate anatomical studies by Walsh and Costello[4,25] have shown the complexity of the cavernous nerves in humans. The cavernous nerves run as multiple small branches in a NVB (with branches of the inferior vesical artery and vein). At the prostatic base, the neural constituents of the bundle may be as much as 3 cm apart (in anteroposterior measurement). They then run outside the prostatic capsule and condense at the mid-prostatic level; however, they then diverge

again as they approach the level of the prostatic apex – where the distal end of the nerve graft would be placed. To further confound graft placement, the nerves in the NVB innervate not only the corpora cavernosa, but also the prostate, rectum and levator ani. And, in general, whereas, the nerves to the corpora are located anteriorly at the level of the apex, identifying them at the level of the prostatic base is very difficult as there is no definite functional organization at this level.[19] Therefore, the anatomy of the cavernous nerves makes grafting a difficult prospect, as there is no distinct nerve to the corpora, and identification of the correct nerves, especially if a high proximal resection has to be carried out (for instance in a patient with seminal vesicle involvement), is difficult.

There is no universal agreement as to when to widely excise the NVB at radical prostatectomy. In most of the studies on nerve grafting, there was generally a decision made at the time of operation; however, preoperative planning to excise one or both bundles was often made based on Ohori's nomogram for predicting extracapsular extension.[26] Walsh has challenged the necessity for NVB excision in many patients. Although it is generally accepted that patients with organ-confined disease can have both NVB preserved, Walsh has stated that many patients with extracapsular extension may also have their NVB preserved based on the histopathological characteristics of prostate cancer. When prostate cancer breaches the capsule, it travels less than 2 mm laterally in 75% of patients before extending cephalad toward the seminal vesicles. As the average distance of the NVB from the prostate is 4.9 mm, it is still often feasible to preserve the NVB even in the presence of extracapsular extension.[4,17,27] The cues used by Walsh at the time of surgery to suggest that the NVB does need to be excised are induration of the lateral pelvic fascia; adherence of the NVB to the prostate; and inadequate tissue covering the posterolateral aspect of the prostate once it has been removed.

Using these cues, Walsh had a positive margin rate of 5%. He carried out bilateral nerve sparing in 86.6% of patients, unilateral nerve sparing in 13% and excised both NVB in only 0.4%. Given his indications for excision of the NVB, it would be very rare that a patient requiring bilateral wide excision of the NVB would be a candidate for surgery, as he would most probably have disseminated disease by this stage. In addition, high pathological stage was shown to be an independent predictor of poor recovery of sexual function on multivariate analysis.[4] Similar rates of NVB excision were produced by Lepor and Kaci.[28] He carried out bilateral nerve sparing in 81%, unilateral nerve sparing in 16.6% and excised both NVB in 2.4%. These datasets show that bilateral nerve grafts should be extremely rare events.

One caveat to these results is that they represent highly selected patient populations and surgeons doing larger numbers of radical prostatectomies rather than the experience of most urologists in Australia and New Zealand. Although these results can be achieved in specific settings, in most institutions, the standard practice is still to excise the NVB on the side of a positive prostate biopsy.[29–31] Even in the presence of wide local excision, positive surgical margins in unscreened populations are found in 16–30% of patients.[29,30,32]

A factor to be considered when deciding the role of nerve grafting, more so when using the sural nerve, is the associated morbidity of the procedure. As stated by Kim *et al*. the possible risks include: haematoma, infection, pain, sensory loss on the lateral aspect of the foot, neuroma formation, reflex sympathetic dystrophy, infection and increased blood loss and operating time.[11] However, whereas most men in each series developed a sensory deficit of 6 cm × 3 cm on the lateral aspect of the sole of the foot that was evident even at 12 months, this was not considered bothersome. The only other reported complication was one instance of wound infection. In addition, no series reported increased transfusion requirements in the patients undergoing nerve grafting.[11–16] This suggests that concerns regarding morbidity of nerve grafting alone should not preclude its use.

In the current published work, erections sufficient to produce vaginal penetration following unilateral nerve grafting (with contralateral nerve sparing) were evident in 41.7–63.6% of patients. This is similar to the rates of 23–64% with unilateral nerve sparing alone.[11–16] Based on these figures there is not a great difference in erectile function rates, although any true conclusions are severely hampered by the lack of a large-scale study with regard to unilateral nerve grafting. It does seem that with optimal surgical technique, unilateral nerve sparing provides similar return of erectile function without nerve grafting on the contralateral side.

The rates of erectile function sufficient to produce vaginal penetration following bilateral nerve grafting were 34–72%, whereas it is widely accepted that very few men without nerve grafting would have any degree of potency. These results do look impressive, especially the series by Chang *et al*.[13] However, these results must be interpreted with caution because of the small size of the cohorts. Most importantly, bilateral nerve grafting should not be carried out in men who could have a nerve-sparing procedure; this is a view held by both those who support and challenge nerve grafting.[16,17]

One concern raised by Walsh[17] with regard to bilateral nerve grafting is the likelihood that these patients will require adjuvant radiation or hormonal therapy, which will further reduce the likelihood that they will regain erectile function. However, wide excision of the NVB, as would occur in a nerve grafting operation, may lead to lower rates of positive surgical margins than if nerve sparing was carried out. Several centres have shown that in patients with extracapsular extension, nerve sparing leads to a higher proportion of positive surgical margins than wide local excision.[29,33–35] Partin *et al.*[36] reviewed patients with extracapsular extension and compared those who underwent nerve sparing to those who underwent wide excision and found that the rate of positive surgical margins was significantly greater in the group undergoing nerve sparing (55 vs 42%). Although this does indicate that wide local excision is preferable for cancer control, it does show that a significant number of patients with extracapsular extension may require adjuvant therapy even in the presence of wide local resection. Although no studies to date have considered the effect of irradiation or androgen deprivation on erectile function following nerve grafting, it is probable that they would further impair the return of erectile function, as acknowledged by centres carrying out nerve grafting.[14]

Currently, unilateral nerve grafting has not been shown to be better than unilateral nerve sparing in preserving erectile function post-prostatectomy. The main reason for this would seem to be the lack of a definite cavernous nerve. As such, techniques that would aid the identification of the cavernous nerves may improve outcomes with nerve grafting. One such technique may be the use of Cavermap, a device that uses electrical stimulation of nerves to provoke tumescence; the tumescence is then measured with a sensor that can detect a 0.5% increase in penile girth. In a single-blinded multicentre trial involving 61 patients with mean follow up of 1 year, in the group in which the Cavermap was used at the time of nerve-sparing prostatectomy 74% were potent as assessed both subjectively (with a patient questionnaire) and objectively

(with Rigiscan). This was compared to 51% in the control group who had a conventional nerve-sparing operation. It is noteworthy that the treatment group had their operation prolonged by a mean of 17 min and an increase in mean blood loss of 25%.[37] Given these results, it may be possible to use the Cavermap to identify the proximal and distal ends of the cavernous nerve at the time of nerve grafting, which may improve the efficacy of the procedure.[30] Indeed, Cavermap was used by Chang to produce his impressive results of 72% potency following bilateral nerve grafts.[13] However, as mentioned by Klotz in his review of the Cavermap technology, there are concerns about the lack of specificity of the tumescence response and that, whereas nerve stimulation is an aid, it does not replace surgical judgement or experience.[19]

Use of various chemotactic and neurotrophic factors in rats at the time of nerve grafting have been shown to improve results compared with grafting alone.[38] These agents included nerve growth factor[39] and acid fibroblast growth factor[40] whereas Schwann cell-impregnated tubes produced better results than grafts alone.[41] None of these factors has been used in human trials, and although their efficacy in animal models is promising, trials using them in humans are necessary.

## CONCLUSION

The use of nerve grafts following excision of the NVB at radical prostatectomy has now been occurring for more than 9 years. However, there is still controversy over its use because of the lack of any large, blinded trials, the anatomy of the cavernous nerves and the necessity of excising the NVB (especially bilaterally). Although the success rates of bilateral nerve grafting are encouraging, those of unilateral nerve grafting are not significantly better than unilateral nerve sparing alone. At present, there is no widespread performance of nerve grafting in Australia and New Zealand and results to date indicate that complete nerve resection with subsequent nerve grafting is not a substitute for nerve sparing if this is possible.

## REFERENCES


1. Barnas JL, Pierpaoli S, Ladd P *et al*. The prevalence and nature of orgasmic dysfunction after radical prostatectomy. *BJU Int*. 2004; **94**: 603–5.
2. Stanford JL, Stephenson RA, Coyle LM *et al*. Prostate Cancer Trends 1973–1995. SEER Program. Bethesda, MD: National Cancer Institute, September 1999. NIH Publication No.: 99-4543.
3. Ellison LM, Heaney JA, Birkmeyer JD. Trends in the use of radical prostatectomy for treatment of prostate cancer. *Eff. Clin. Pract*. 1999; **2**: 228–33.
4. Walsh PC, Donker PJ. Impotence following radical prostatectomy: insight into etiology and prevention. *J. Urol*. 1982; **128**: 492–7.
5. Park S, Jaffer M, Lotan Y *et al*. Contemporary laparoscopic and open radical retropubic prostatectomy: pathologic outcomes and Kattan postoperative nomograms are equivalent. *Urology* 2007; **69**: 118–22.
6. Goldstraw MA, Dasgupta P, Anderson C. Does robotically assisted radical prostatectomy result in better preservation of erectile function? *BJU Int*. 2006; **95**: 721–2.
7. Walsh PC. Anatomic radical prostatectomy: evolution of the surgical technique. *J. Urol*. 1998; **160**: 2418–24.
8. Guillonneau B, el-Fettouh H, Baumert H *et al*. Laparoscopic radical prostatectomy: oncological evaluation after 1,000 cases a Montsouris Institute. *J. Urol*. 2003; **169**: 1261–6.
9. Menon M, Kaul S, Bhandari A, Shrivastava A, Tewari A, Hemal A. Potency following robotic prostatectomy: a questionnaire based analysis of outcomes after conventional nerve sparing and prostatic fascia sparing techniques. *J. Urol*. 2005; **174**: 2291–6.
10. Kim ED, Scardino PT, Hampel O *et al*. Interposition of sural nerve restores function of cavernous nerves resected during radical prostatectomy. *J. Urol*. 1999; **161**: 188–92.
11. Kim ED, Scardino PT, Kadmon K *et al*. Interposition nerve graftin during radical retropubic prostatectomy. *Urology* 2001; **57**: 211–16.
12. Sim HG, Kliot M, Lange PH. Two-year outcome of unilateral sural nerve interposition graft after radical prostatectomy. *Urology* 2006; **68**: 1290–93.
13. Chang DW, Wood CG, Kroll SS, Youssef AA, Babaian RJ. Cavernous nerve reconstruction to preserve erectile function following non-nerve-sparing radical retropubic prostatectomy: a prospective study. *Plast. Reconstr. Surg*. 2003; **111**: 1174–81.
14. Nelson BA, Chang SS, Cookson MS *et al*. Morbidity and efficacy of genitofemoral nerve grafts with radical retropubic prostatectomy. *Urology* 2006; **67**: 789–92.
15. Porpiglia F, Ragni F, Terrone C *et al*. Is laparoscopic unilateral sural nerve grafting during radical prostatectomy effective in retaining sexual potency? *BJU Int*. 2005; **95**: 1267–71.
16. Secin FP, Koppie TM, Scardino PT *et al*. Bilateral cavernous nerve interposition grafting during radical retropubic prostatectomy: Memorial Sloan Kettering Cancer Centre experience. *J. Urol*. 2007; **177**: 664–8.
17. Walsh PC. Nerve grafts are rarely necessary and are unlikely to improve sexual function in men undergoing anatomic radical prostatectomy. *Urology* 2001; **57**: 1020–24.
18. Catalona WJ, Carvalhal GF, Mager DE *et al*. Potency, continence and complication rates in 1870 consecutive radical retropubic prostatectomies. *J. Urol*. 1999; **162**: 433–8.
19. Klotz L. Cavernosal nerve mapping: current data and applications. *BJU Int*. 2004; **93**: 9–13.
20. Chuang MS, O'Connor RC, Laven BA. Early release of the neurovascular bundles and optical loupe magnification lead to improved and earlier return of potency following radical retropubic prostatectomy. *J. Urol*. 2005; **173**: 537–9.
21. Quinlan DM, Epstein JI, Carter BS *et al*. Sexual function following radical prostatectomy: influence of preservation of neurovascular bundles. *J. Urol*. 1991; **145**: 998–1002.
22. Kundu SD, Roehl KA, Eggener SE *et al*. Potency, continence and complications in 3477 consecutive radical retropubic prostatectomies. *J. Urol*. 2004; **172**: 2227–31.
23. Rabbani F, Stapleton AM, Kattan MW *et al*. Factors predicting recovery of erections after radical prostatectomy. *J. Urol*. 2000; **164**: 1929–34.
24. Quinlan DM, Nelson RJ, Walsh PC. Cavernous nerve grafts restore erectile function in denervated rats. *J. Urol*. 1991; **145**: 380–83.
25. Costello AJ, Brooks M, Cole OJ. Anatomical studies of the neurovascular bundle and cavernosal nerves. *BJU Int*. 2004; **94**: 1071–6.
26. Ohori M, Koh H, Scardino PT *et al*. A nomogram for predicting the side specific probability of extracapsular extension in radical prostatectomy specimens. *J. Urol. Suppl*. 2003; **169**: 1134.
27. Walsh PC, Epstein JI, Lowe FC. Potency following radical prostatectomy with wide unilateral excision of the neurovascular bundle. *J Urol* 1987; **138**: 823–7.
28. Lepor H, Kaci L. Contemporary evaluation of operative parameters and complications related to open radical retropubic prostatectomy. *Urology* 2003; **62**: 702–6.
29. Park EL, Dalkin B, Escobar C, Nagle RB. Site-specific positive margins ar radical prostatectomy: assessing cancer-control benefits of wide excision of the neurovascular bundle on a side with cancer on biopsy. *BJU Int*. 2003; **91**: 219–22.

30. Graefen M, Haese A, Pichlmeier U *et al*. A validated strategy for side specific prediction of organ confined prostate cancer: a tool to select for nerve sparing radical prostatectomy. *J. Urol*. 2001; **165**: 857–63.
31. Huland H, Hubner D, Henke RP. Systematic biopsies and digital rectal examination to identify the nerve-sparing side for radical prostatectomy without risk of positive margin in patients with clinical stage T2, N0 prostatic carcinoma. *Urology* 1994; **44**: 211.
32. Lowe BA, Lieberman SF. Disease recurrence and progression in untreated pathologic stage T3 prostate cancer: selecting the patient for adjuvant therapy. *J. Urol*. 1997; **158**: 1452–6.
33. Villers A, McNeal JE, Redwine EA *et al*. The role of perineural space invasion in the local spread of prostatic adenocarcinoma. *J. Urol*. 1989; **142**: 763–8.
34. Shah O, Melamed J, Lepor H. Analysis of apical soft tissue margins during radical retropubic prostatectomy. *J. Urol*. 2001; **165**: 1943–8.
35. Epstein JI, Pizov G, Walsh PC. Correlation of pathologic findings with progression after radical retropubic prostatectomy. *Cancer* 1993; **71**: 3582–93.
36. Partin AW, Borland RN, Epstein JI *et al*. Influence of wide excision of the neurovascular bundles on prognosis in men with clinically localized prostate cancer with established capsular penetration. *J. Urol*. 2001; **165**: 1943–8.
37. Klotz LH, Jewett MAJ, Heaton J *et al*. A phase 3 trial of intraoperative cavernous nerve mapping during radical prostatectomy. *J. Urol*. 1999; **161**: 592.
38. Syme DBY, Corocran NM, Bouchier-Hayes DM, Costello AJ. Hope springs eternal: cavernosal nerve regeneration. *BJU Int*. 2006; **97**: 17–21.
39. Burgers JK, Nelson RJ, Quinlan DM, Walsh PC. Nerve growth factor, nerve grafts and amniotic membrane grafts restore erectile function in rats. *J. Urol*. 1991; **146**: 463–8.
40. Ball RA, Lipton SA, Dreyer EB, Richie JP, Vickers MA. Entubulization repair of severed cavernous nerves in the rat resulting in return of erectile function. *J. Urol*. 1992; **148**: 211–15.
41. May F, Weidner N, Matiasek K *et al*. Schwann cell seeded guidance tubes restore erectile function after ablation of cavernous nerves in rats. *J. Urol*. 2004; **172**: 374–7.