

# Nerve management during open hernia repair

A. R. Wijsmuller<sup>1</sup>, R. N. van Veen<sup>1</sup>, J. L. Bosch<sup>2,3</sup>, J. F. M. Lange<sup>4</sup>, G. J. Kleinrensink<sup>5,6</sup>, J. Jeekel<sup>1</sup> and J. F. Lange<sup>1,6</sup>

Departments of <sup>1</sup>Surgery, <sup>2</sup>Epidemiology & Biostatistics, <sup>3</sup>Radiology, and <sup>4</sup>Neurosciences, Erasmus MC, University Medical Center, Rotterdam, The Netherlands, <sup>5</sup>Department of Surgery, Isala Clinics, Zwolle, The Netherlands, and <sup>6</sup>Lowlands Institute of Surgical and Applied Anatomy, Rotterdam, The Netherlands

Correspondence to: Professor J. F. Lange, Department of Surgery, Erasmus University Medical Centre, PO Box 2040, 3000 CA Rotterdam, The Netherlands (e-mail: j.lange@erasmusmc.nl)

**Background:** Peroperative identification and subsequent division or preservation of the inguinal nerves during open hernia repair may influence the incidence of chronic postoperative pain.

**Methods:** A systematic literature review was performed to identify studies investigating the influence of different types of nerve management.

**Results:** Based on three randomized studies the pooled mean percentage of patients with chronic pain after identification and division of the ilioinguinal nerve was similar to that after identification and preservation of the ilioinguinal nerve. Two cohort studies suggested that the incidence of chronic pain was significantly lower after identification of all inguinal nerves compared with no identification of any nerve. Another cohort study reported a significant difference in the incidence of chronic pain in favour of identification and facultative pragmatic division of the genital branch of the genitofemoral nerve compared with no identification at all.

**Conclusion:** The nerves should probably be identified during open hernia repair. Division of and preservation of the ilioinguinal nerve show similar results.

Paper accepted 7 December 2006

Published online in Wiley InterScience (www.bjs.co.uk). DOI: 10.1002/bjs.5651

## Introduction

A review by Poobalan *et al.*<sup>1</sup> of studies of inguinal hernia repair between 1987 and 2000 showed the incidence of chronic postoperative pain to be up to 53 per cent (range 0–53 per cent), making it the most frequent complication after surgery. The commonest types of chronic postoperative pain are somatic and neuropathic<sup>2–4</sup>. Causalgia syndromes affecting all three inguinal nerves (ilioinguinal and iliohypogastric nerves, and the genital branch of the genitofemoral nerve) have been described. There is no consensus on whether or not to identify and subsequently divide or preserve these three nerves together, or separately, during surgery<sup>5</sup>. Lichtenstein and his successor Amid<sup>6,7</sup> recommend preservation of all three nerves, whereas Wantz<sup>8</sup> recommends intentional severance based on the concept of ‘no nerve, no pain’. This review evaluates the influence of peroperative inguinal nerve

identification and subsequent division or preservation on the incidence of chronic postoperative pain.

## Methods

Studies on the effect of peroperative inguinal nerve identification and subsequent division or preservation were included if they contained data on pain lasting longer than 3 months after operation<sup>9</sup>. Randomized, prospective and retrospective cohort studies were included. Reviews and references of the articles retrieved were checked for additional studies. Letters to the editor, abstracts and comments were excluded. English, German and French articles were reviewed.

Studies were identified by searching PubMed, The Cochrane Library (Issue 1, 2006), scholar.google.com and Current Controlled Trials (search across multiple registers including the National Health Service in England and US ClinicalTrials.gov). Search terms used and cross-checked were ‘pain, postoperative’, ‘pain, chronic’, ‘hernia, inguinal’, ‘denervation’ and ‘neurectomy’.

The Editors have satisfied themselves that all authors have contributed significantly to this publication

Data were extracted by two authors (A.R.W, R.N.v.V.) independently. Study quality was assessed according to a number of variables, such as the quality of methodological reporting, whether studies were randomized, non-randomized, prospective or retrospective, method of randomization and allocation concealment, blinding of outcome assessors, attempts made to minimize bias, sample sizes and ability to measure 'true effect'. Levels of evidence were assessed according to the Oxford Centre for Evidence Based Medicine levels of evidence<sup>10,11</sup>. Discrepancies were resolved by consensus. The following data were abstracted: type of study, number of patients, baseline characteristics, type of repair, peroperative nerve treatment, follow-up period, incidence of chronic pain and type of assessment.

From the data provided in the individual studies, the pooled means for chronic pain after hernia repair and their 95 per cent confidence intervals (c.i.) were calculated using the random-effects model described by Laird and Mosteller<sup>12</sup>. A pooled mean percentage of patients with chronic pain at 6 months after operation was calculated from three randomized clinical trials investigating the influence of ilioinguinal nerve preservation or division<sup>13–15</sup>.

## Results

Thirteen articles on the influence of inguinal nerve management were identified, of which one letter to the editor, one editorial and one comment were

excluded<sup>16–18</sup>. Two studies that investigated the influence of iliohypogastric and ilioinguinal nerve division in one group were excluded as there were no comparable groups in which these nerves were preserved<sup>19,20</sup>. Another study investigating the influence of ilioinguinal division compared with preservation was excluded as not all the required data were reported<sup>21</sup>. This left seven studies for analysis, including three randomized trials and four cohort studies (of retrospective and prospective character) (Table 1)<sup>13–15,22–25</sup>. Of these seven studies, four investigated the influence of ilioinguinal nerve division compared with ilioinguinal nerve preservation<sup>13–15,22</sup>, including the three randomized trials. In addition, two other studies compared the influence of no inguinal nerve identification with identification and preservation of all inguinal nerves<sup>23,24</sup>. Finally, one study compared the influence of no identification with identification and subsequent pragmatic facultative division of the genital branch of the genitofemoral nerve<sup>25</sup>.

Table 2 shows the baseline characteristics of patients included in this review by study and by treatment group. Most of the characteristics were not significantly different between treatment groups. A significant difference was, however, present in the proportion of patients with a combined or direct inguinal hernia in the study by Tons and Schumpelick<sup>25</sup> (Table 2).

All four studies investigating the influence of ilioinguinal nerve division or preservation reported the incidence

**Table 1** Characteristics of studies

| Reference  | Type                   | Study location | No. of institutions/surgeons | Study period | Surgical technique       | Level of evidence* |
|--|------------------------|----------------|------------------------------|--------------|--------------------------|--------------------|
| <b>Ilioinguinal nerve division versus preservation</b>   |                        |                |                              |              |                          |                    |
| Ravichandran <i>et al.</i> <sup>13</sup>   | RCT double-blind pilot | UK             | 1/1                          | NR           | Tension-free mesh repair | 2b                 |
| Picchio <i>et al.</i> <sup>14</sup>  | RCT double-blind       | Italy          | 4/NR                         | 1997–2002    | Trabucco                 | 1b                 |
| Mui <i>et al.</i> <sup>15</sup>  | RCT double-blind       | China          | 1/4                          | 2003–2004    | Lichtenstein             | 1b                 |
| Dittrick <i>et al.</i> <sup>22</sup>   | Cohort retrospective   | USA            | NR/2†                        | 1997–2003    | Lichtenstein             | 2b                 |
| <b>No identification of any nerve versus identification and preservation of all nerves</b>                             |                        |                |                              |              |                          |                    |
| Izard <i>et al.</i> <sup>23</sup>  | Cohort prospective     | France         | 1/1                          | 1979–1992    | McVay                    | 2b                 |
| Alfieri <i>et al.</i> <sup>24</sup> ‡  | Cohort prospective     | Italy          | 11/NR                        | 2002–2003    | Lichtenstein or Trabucco | 2b                 |
| <b>No identification of genital branch versus identification and facultative pragmatic division of genital branch§</b> |                        |                |                              |              |                          |                    |
| Tons and Schumpelick <sup>25</sup>   | Cohort prospective     | Germany        | 1/NR                         | 1985–1988    | Shouldice                | 2b                 |

\*Oxford Centre for Evidence Based Medicine ([http://www.cebm.net/levels\\_of\\_evidence.asp](http://www.cebm.net/levels_of_evidence.asp))<sup>10,11</sup>. †Two surgeons of whom one routinely divided and one routinely preserved the ilioinguinal nerve. ‡Groups included in this analysis are part of a broader prospective cohort study by Alfieri *et al.* In group I ( $n = 380$ ) all nerves were identified with the following subgroups: subgroup A, all nerves preserved ( $n = 310$ ); subgroup B, all nerves divided ( $n = 10$ ); and subgroup C, one or two nerves injured/divided ( $n = 60$ ). In group II no nerves were identified ( $n = 189$ ). Group III ( $n = 404$ ) consisted of two subgroups: subgroup D, one nerve was not identified ( $n = 260$ ); and subgroup E, two nerves were not identified ( $n = 144$ ). §Genital branch of the genitofemoral nerve was divided in 24 per cent. RCT, randomized clinical trial; NR, not reported.

**Table 2** Characteristics of patients

| Reference  | No. of patients | Men (%) | Mean age (years) | Hernia type (%) |        |          |       | Preoperative pain (%) | No ilioinguinal nerve identified (%) |
|--|-----------------|---------|------------------|-----------------|--------|----------|-------|-----------------------|--------------------------------------|
|  |                 |         |                  | Indirect        | Direct | Combined | Other |                       |                                      |
| <b>Ilioinguinal nerve identification and division</b>                      |                 |         |                  |                 |        |          |       |                       |                                      |
| Ravichandran <i>et al.</i> <sup>13</sup>                                   | 20*             | 100     | 65*              | NR              | NR     | NR       | NR    | NR                    | 0                                    |
| Picchio <i>et al.</i> <sup>14</sup>  | 405             | 92      | 57               | 68              | 30     | 3        | 0     | 55†                   | 10                                   |
| Mui <i>et al.</i> <sup>15</sup>  | 50              | 100     | 65               | NR              | NR     | NR       | NR    | 10‡                   | 0                                    |
| Dittrick <i>et al.</i> <sup>22</sup>                                       | 66              | 77      | 68               | NR              | NR     | NR       | NR    | NR                    | 0                                    |
| <b>Ilioinguinal nerve identification and preservation</b>                  |                 |         |                  |                 |        |          |       |                       |                                      |
| Ravichandran <i>et al.</i> <sup>13</sup>                                   | 20*             | 100     | 65*              | NR              | NR     | NR       | NR    | NR                    | 20                                   |
| Picchio <i>et al.</i> <sup>14</sup>  | 408             | 89      | 59               | 66              | 30     | 4        | 0     | 49†                   | 13                                   |
| Mui <i>et al.</i> <sup>15</sup>  | 50              | 100     | 63               | NR              | NR     | NR       | NR    | 14‡                   | 0                                    |
| Dittrick <i>et al.</i> <sup>22</sup>                                       | 24              | 79      | 58               | NR              | NR     | NR       | NR    | NR                    | 0                                    |
| <b>No identification of any nerve</b>                                      |                 |         |                  |                 |        |          |       |                       |                                      |
| Izard <i>et al.</i> <sup>23</sup>  | 441             | NR      | NR§              | 64#             | 21#    | 5#       | 9#    | NR                    | NA                                   |
| Alfieri <i>et al.</i> <sup>24</sup>  | 189             | 97¶     | 55¶              | NR**            | NR**   | NR**     | NR**  | NR**                  | NA                                   |
| <b>Identification and preservation of all inguinal nerves</b>              |                 |         |                  |                 |        |          |       |                       |                                      |
| Izard <i>et al.</i> <sup>23</sup>  | 891             | NR      | NR§              | 67#             | 17#    | 6#       | 10#   | NR                    | NA                                   |
| Alfieri <i>et al.</i> <sup>24</sup>  | 310             | 97¶     | 55¶              | NR**            | NR**   | NR**     | NR**  | NR**                  | NA                                   |
| <b>No identification of genital branch</b>                                 |                 |         |                  |                 |        |          |       |                       |                                      |
| Tons and Schumpelick <sup>25</sup>   | 237             | 100     | NR               | 52              | 18     | 30       | 0     | NR                    | NA                                   |
| <b>Identification and facultative pragmatic division of genital branch</b> |                 |         |                  |                 |        |          |       |                       |                                      |
| Tons and Schumpelick <sup>25</sup>   | 223             | 100     | NR               | 51              | 28     | 21       | 0     | NR                    | NA                                   |

\*The procedures were performed in one group of 20 patients with bilateral hernia and a mean age of 65.2 years. The ilioinguinal nerve was divided on one side and preserved on the other side, determined by randomization. †Pre-operative pain (no significant difference). ‡At least mild pain pre-operatively at rest on a four-point verbal scale: 0, none; 1, mild; 2, moderate; and 3, severe (no significant difference,  $P = 0.54$ ). §An age distribution was given for the whole group. #Hernia type distribution among patients with follow-up greater than 5 years (911 patients in total). ¶Mean percentage of men and the mean age of the total study group. \*\*Type of hernia and type of repair were recorded for the total group. No correlation was found between moderate to severe pain and type of hernia or repair technique used ( $P = 0.67$  and  $P = 0.2$ , respectively). NR, not reported; NA, not applicable.

of chronic pain at 6 months after surgery. The three randomized studies, on which the calculated pooled mean percentage of patients with chronic pain was based, reported results of 851 procedures (428 with ilioinguinal division and 423 after ilioinguinal nerve preservation) (Table 3). No significant difference was found in the pooled mean percentage of patients with chronic pain after identification and subsequent division of the ilioinguinal nerve (21 (95 per cent c.i. 0 to 43) per cent) or identification and subsequent preservation of the ilioinguinal nerve (23 (95 per cent c.i. 0 to 47) per cent) (Table 3). Both studies in which the influence of identification and preservation of all nerves was compared with no identification at all reported a significant difference in chronic postoperative pain in favour of identification (Table 4)<sup>23,24</sup>.

Tons and Schumpelick<sup>25</sup> recorded persistent pain after a mean (range) of 16.4 (12–25) months in a group of 237 patients in whom the genital branch of the genitofemoral nerve was not identified and in a group of 223 in whom the genital branch was identified and divided facultatively on a pragmatic basis. This cohort study showed a significant

difference in the percentage of patients with chronic pain, determined by two independent researchers and including three neurological tests and a nerve block to determine the neuropathic character of the problem, in favour of the group in which the genital branch was identified and pragmatically divided (4.2 *versus* 1.4 per cent;  $P < 0.05$ ).

## Discussion

Chronic pain may be somatic, neuropathic or visceral in origin. Cunningham *et al.*<sup>3</sup> reported that the commonest type of chronic pain after surgery was of somatic origin, whereas Poobalan and colleagues<sup>2</sup> and Kehlet and co-workers<sup>4</sup> believe it to be predominantly neuropathic in character. Neurectomy and mesh or staple removal as a treatment for chronic pain after hernia repair has yielded variable results<sup>26</sup>.

The present study has shown that the incidence of chronic pain is significantly less after identification of all three inguinal nerves than after no identification at all in both of two cohort studies (Table 4)<sup>23,24</sup>. No pooled mean was calculated from these studies as the type of operation

**Table 3** Pain after ilioinguinal nerve division or preservation

| Reference  | No. of patients | Pain at 6 months (%) |
|--|-----------------|----------------------|
| Ilioinguinal nerve identification and division     |                 |                      |
| RCT  |                 |                      |
| Ravichandran <i>et al.</i> <sup>13</sup>           | 20              | 5†                   |
| Picchio <i>et al.</i> <sup>14</sup>                | 358             | 34‡                  |
| Mui <i>et al.</i> <sup>15</sup>                    | 50              | 8§                   |
| Mean*  |                 | 21 (0, 43)#          |
| Cohort   |                 |                      |
| Dittrick <i>et al.</i> <sup>22</sup>               | 65              | 3¶                   |
| Ilioinguinal nerve identification and preservation |                 |                      |
| RCT  |                 |                      |
| Ravichandran <i>et al.</i> <sup>13</sup>           | 20              | 5†                   |
| Picchio <i>et al.</i> <sup>14</sup>                | 354             | 37‡                  |
| Mui <i>et al.</i> <sup>15</sup>                    | 49              | 29§                  |
| Mean*  |                 | 23 (0, 47)#          |
| Cohort   |                 |                      |
| Dittrick <i>et al.</i> <sup>22</sup>               | 23              | 26¶                  |

\*Mean based on random-effects model. Values in parentheses are 95 per cent confidence intervals. †Minor wound discomfort (no statistically significant difference). ‡At least mild pain on a four-point verbal scale: 0, none; 1, mild; 2, moderate; and 3, severe (no statistically significant difference). §Incidence of at least mild pain on exertion (statistically significant difference,  $P = 0.008$ ). #No statistically significant difference between pooled mean of the group in which the ilioinguinal nerve was identified and divided and the group in which the ilioinguinal nerve was identified and preserved. ¶Endpoint was presence of neuralgia (statistically significant difference,  $P < 0.001$ ). RCT, randomized clinical trial.

**Table 4** Pain after no identification of any nerve or identification and preservation of all nerves

| Reference                                  | No. of patients | Pain (%)* |
|--|-----------------|-----------|
| No identification of any nerve             |                 |           |
| Izard <i>et al.</i> <sup>23</sup>          | 297             | 3.7†      |
| Alfieri <i>et al.</i> <sup>24</sup>        | 189             | 4.7‡      |
| Identification all nerves and preservation |                 |           |
| Izard <i>et al.</i> <sup>23</sup>          | 614             | 1.6†      |
| Alfieri <i>et al.</i> <sup>24</sup>        | 310             | 0‡        |

\*The study by Alfieri *et al.* examined pain at 6 months after surgery, whereas the follow-up by Izard *et al.* was greater than 5 years. †At least major symptoms (discomfort on effort) and persistent and disabling symptoms measured on a four-point scale: 1, no pain; 2, minor symptoms (often minimal and transient); 3, major symptoms (discomfort on effort); and 4, persistent or disabling symptoms. The difference was statistically significant ( $P < 0.001$ ). ‡Moderate to severe pain based on a four-point verbal rank scale: none, mild, moderate or severe. The difference was statistically significant.

differed between them (McVay, Lichtenstein hernia repair and Trabucco's technique). Studies investigating the influence of division and preservation of the ilioinguinal nerve are conflicting. Two randomized studies found

no significant difference with respect to the incidence of chronic pain<sup>13,14</sup>, but a further randomized trial and one retrospective cohort study suggested a significant difference in favour of division<sup>15,19</sup>.

A pooled mean percentage of patients with chronic pain was calculated on the basis of the three randomized trials as reported pain was similar for severity and time, although the pain scales used were different: at least minor wound discomfort<sup>13</sup>, at least mild pain on a four-point verbal scale (none, mild, moderate or severe)<sup>14</sup> or incidence of at least mild pain on exertion (mild or severe pain)<sup>15</sup>. As all studies determined pain at 6 months after operation, this point in time was used for comparison. The pooled mean did not show any significant difference between the two treatment groups (Table 3). Because of the heterogeneity, the pooled results should be interpreted with caution, but a random-effects model was used to take this variation between studies into account.

Pain assessment in the three studies was limited with respect to the following factors that were not recorded: current pain medication, nerve block to determine the neuropathic character and quantitative sensory testing thresholds. However, light touch and pain sensitivity were assessed by an observer in the studies by Picchio *et al.*<sup>14</sup> and Ravichandran *et al.*<sup>13</sup>. Mui *et al.*<sup>15</sup> assessed skin sensitivity by Semmes–Weinstein monofilament testing. In two studies the level of preoperative pain was included as a baseline patient characteristic and they did not show a significant difference between the groups (Table 2)<sup>14,15</sup>. No pain scores or questionnaires were included from which postoperative pain might be differentiated as of somatic, neuropathic or visceral origin. Kehlet *et al.*<sup>27</sup> have proposed a scheme for uniform assessment of chronic postoperative pain (including the factors mentioned above) that should provide a more exact description of the incidence, the type and the socioeconomic consequences of the chronic pain state.

As appropriate data have not been reported, this review could not assess the incidence of numbness after nerve division or problems deriving from the division of the motor part of the genital branch of the genitofemoral nerve. Tons and Schumpelick<sup>25</sup> reported the cremaster reflex to be absent in all patients after division of the genital branch, and to be absent after no identification and identification of the genital branch in 51 and 46 per cent of patients respectively. The clinical implications of an absent cremaster reflex are unclear.

With respect to handling of injured nerves, only expert opinion has been published. According to Schumpelick<sup>28</sup>, injured nerves should be divided as proximally as possible. In studies investigating neurectomy as a treatment

for postoperative chronic pain, the inguinal nerves under investigation were resected as far proximally as possible<sup>29–31</sup>. Amid<sup>31</sup> resected the three nerves as far proximally and distally as possible, to include the involved segment and account for the numerous neural communications that exist between the three inguinal nerves. Types of proximal nerve-end treatment after division include crushing, ligation by non-absorbable suture to close the neurilemmal sheath, coagulation, and application of either absolute or 12 per cent phenol solution to the nerve end to prevent neuroma formation<sup>29</sup>. One way to prevent nerve scarring in the operative field is to resect the nerve under tension so that it retracts behind the peritoneum; another is to implant the ligated proximal end of the ilioinguinal and iliohypogastric nerves within the fibres of the internal oblique muscle to prevent the ends from adhering to the inguinal ligament and/or external oblique aponeurosis<sup>30,31</sup>. These different types of treatment have been investigated in situations of therapeutic neurectomy after inguinal nerve entrapment but not during primary hernia repair<sup>29–31</sup>.

In conclusion, the available data suggest that the inguinal nerves should be identified during open repair of hernia (grade of recommendation B)<sup>10,11,32</sup>. In terms of outcome, there is little difference between dividing or preserving the ilioinguinal nerve (grade of recommendation A). Pragmatic division of the genital branch of the genitofemoral nerve seems beneficial (grade of recommendation C).

## References

- 1 Poobalan AS, Bruce J, Smith WC, King PM, Krukowski ZH, Chambers WA. A review of chronic pain after inguinal herniorrhaphy. *Clin J Pain* 2003; **19**: 48–54.
- 2 Poobalan AS, Bruce J, King PM, Chambers WA, Krukowski ZH, Smith WC. Chronic pain and quality of life following open inguinal hernia repair. *Br J Surg* 2001; **88**: 1122–1126.
- 3 Cunningham J, Temple WJ, Mitchell P, Nixon JA, Preshaw RM, Hagen NA. Cooperative hernia study. Pain in the postrepair patient. *Ann Surg* 1996; **224**: 598–602.
- 4 Kehlet H, Jensen TS, Woolf CJ. Persistent postsurgical pain: risk factors and prevention. *Lancet* 2006; **367**: 1618–1625.
- 5 Amid PK, Bendavid R, Fitzgibbons RJ Jr, McKernan JB, Murphy JW. Surgery Roundtable: Current Issues in Inguinal Herniorrhaphy, 2000; <http://www.medscape.com/> (accessed 9 September 2005).
- 6 Lichtenstein IL, Shulman AG, Amid PK, Montllor MM. Cause and prevention of postherniorrhaphy neuralgia: a proposed protocol for treatment. *Am J Surg* 1988; **155**: 786–790.
- 7 Amid PK. Lichtenstein tension-free hernioplasty: its inception, evolution, and principles. *Hernia* 2004; **8**: 1–7.
- 8 Wantz GE. Complications of inguinal hernial repair. *Surg Clin North Am* 1984; **64**: 287–298.
- 9 Classification of chronic pain. Descriptions of chronic pain syndromes and definitions of pain terms. Prepared by the International Association for the Study of Pain, Subcommittee on Taxonomy. *Pain Suppl* 1986; **3**: S1–S226.
- 10 Oxford Centre for Evidence Based Medicine. [http://www.cebm.net/levels\\_of\\_evidence.asp](http://www.cebm.net/levels_of_evidence.asp) (accessed 23 July 2006).
- 11 Sackett DL. Rules of evidence and clinical recommendations on the use of antithrombotic agents. *Chest* 1986; **89**(Suppl): 2S–3S.
- 12 Laird NM, Mosteller F. Some statistical methods for combining experimental results. *Int J Technol Assess Health Care* 1990; **6**: 5–30.
- 13 Ravichandran D, Kalambe BG, Pain JA. Pilot randomized controlled study of preservation or division of ilioinguinal nerve in open mesh repair of inguinal hernia. *Br J Surg* 2000; **87**: 1166–1167.
- 14 Picchio M, Palimento D, Attanasio U, Matarazzo PF, Bambini C, Caliendo A. Randomized controlled trial of preservation or elective division of ilioinguinal nerve on open inguinal hernia repair with polypropylene mesh. *Arch Surg* 2004; **139**: 755–758.
- 15 Mui WL, Ng CS, Fung TM, Cheung FK, Wong CM, Ma TH *et al*. Prophylactic ilioinguinal neurectomy in open inguinal hernia repair: a double-blind randomized controlled trial. *Ann Surg* 2006; **244**: 27–33.
- 16 Alfieri S, Di Miceli D, Doglietto GB. Randomized clinical trial assessing impact of a lightweight or heavyweight mesh on chronic pain after inguinal hernia repair (Br J Surg 2005; **92**: 166–170). *Br J Surg* 2005; **92**: 655; author reply 655.
- 17 Pappalardo G. Pain and functional impairment 1 year after inguinal herniorrhaphy. *Ann Surg* 2002; **235**: 311.
- 18 Condon RE. Groin pain after hernia repair. *Ann Surg* 2001; **233**: 8.
- 19 Pappalardo G, Guadalajara A, Illomei G, d'Orta C, Frattaroli FM. Prevention of postherniorrhaphy persistent pain: results of a prospective study. *Int Surg* 1999; **84**: 350–353.
- 20 Tsakayannis DE, Kiriakopoulos AC, Linos DA. Elective neurectomy during open, 'tension free' inguinal hernia repair. *Hernia* 2004; **8**: 67–69.
- 21 Wantz GE. Testicular atrophy and chronic residual neuralgia as risks of inguinal hernioplasty. *Surg Clin North Am* 1993; **73**: 571–581.
- 22 Dittrick GW, Ridl K, Kuhn JA, McCarty TM. Routine ilioinguinal nerve excision in inguinal hernia repairs. *Am J Surg* 2004; **188**: 736–740.
- 23 Izard G, Gailleton R, Randrianasolo S, Houry R. Treatment of inguinal hernias by McVay's technique. Apropos of 1332 cases. *Ann Chir* 1996; **50**: 755–766.
- 24 Alfieri S, Rotondi F, Di Giorgio A, Fumagalli U, Salzano A, Di Miceli D *et al*. Influence of preservation *versus* division of ilioinguinal, iliohypogastric, and genital nerves during open

- mesh herniorrhaphy: prospective multicentric study of chronic pain. *Ann Surg* 2006; **243**: 553–558.
- 25 Tons C, Schumpelick V. The ramus genitalis syndrome following hernia repair. A clinical study concerning its preventability. *Chirurg* 1990; **61**: 441–443.
- 26 Aasvang E, Kehlet H. Surgical management of chronic pain after inguinal hernia repair. *Br J Surg* 2005; **92**: 795–801.
- 27 Kehlet H, Bay-Nielsen M, Kingsnorth A. Chronic postherniorrhaphy pain – a call for uniform assessment. *Hernia* 2002; **6**: 178–181.
- 28 Schumpelick V. Durchtrennung des N. ilioinguinalis bei der Leistenbruchoperation. *Chir Praxis* 1989; **40**: 465–466.
- 29 Madura JA, Madura JA II, Copper CM, Worth RM. Inguinal neurectomy for inguinal nerve entrapment: an experience with 100 patients. *Am J Surg* 2005; **189**: 283–287.
- 30 Ducic I, Dellon AL. Testicular pain after inguinal hernia repair: an approach to resection of the genital branch of genitofemoral nerve. *J Am Coll Surg* 2004; **198**: 181–184.
- 31 Amid PK. A 1-stage surgical treatment for postherniorrhaphy neuropathic pain: triple neurectomy and proximal end implantation without mobilization of the cord. *Arch Surg* 2002; **137**: 100–104.
- 32 Wijsmuller AR, Lange JFM, Kleinrensink GJ, Geldere van D, Simons MP, Huygen FJPM *et al.* Nerve-identifying inguinal hernia repair: a surgical anatomical study. *World J Surg* 2006; in press.