Suture length to wound length ratio and healing of midline laparotomy incisions

The effect of suture length to wound length ratio on the healing of midline laparotomy wounds closed with a continuous suture was evaluated in a prospective clinical trial. All patients undergoing abdominal procedures through a midline incision were included except those with an incisional hernia after previous midline operation. The total incidence of wound infection was 36 of 454 patients (7.9 per cent) and wound dehiscence requiring reoperation occurred in three patients (0.7 per cent). Incisional hernia was found in 18.7 per cent of 363 patients alive 12 months after surgery. Multivariate analysis identified the suture length to wound length ratio, age and major wound infection as independent risk factors for the development of hernia, which occurred in 9.0 per cent of patients when the suture length to wound length ratio was ≥4 and in 23.7 per cent (P = 0.001) when it was <4. The suture length to wound length ratio is an important parameter for healing of midline incisions closed with a continuous suture technique. The incidence of incisional hernia is lower when such wounds are sutured with a ratio ≥4.

Closure of midline laparotomy incisions with a single layer of continuous monofilament suture is a well established method. Trials have compared interrupted and continuous suture techniques and found the latter to be more rapid, whereas the safety of the two methods appears to be similar. Experimental evidence suggests that continuous suturing gives the best results when the suture length to wound length ratio is 4:1, i.e. the length of suture material consumed is four times the length of the wound. An optimal suture length to wound length ratio has yet to be determined in a clinical trial. This prospective study assessed how this ratio affects early and late healing of midline laparotomy wounds.

Patients and methods

A prospective trial was started in August 1989 in which all surgeons, including residents in training, participated. All patients undergoing abdominal surgery through a midline incision were eligible for the trial, only those with an incisional hernia after previous midline surgery were excluded. Patients were stratified according to age, sex, previous midline laparotomy, urgency of operation and degree of operative contamination.

The fascia was sutured with a continuous single-layer mass-closure technique including all layers except skin. The surgeon was free to choose whether peritoneum was included in the suture or not. The starting knot was a modification of the half blood-knot, and the suture was ended with a chain stitch knot. For reasons not relevant to the present study, patients were randomized to closure with polydioxanone or nylon, no. 1, delivered in lengths of 150 cm (Figure 1: Table I). The length of the incision was measured after closure of the fascia and the length of suture consumed (150 cm – length of suture remnants) measured for calculation of the suture length to wound length ratio.

Early wound complications were recorded. Infection was defined as purulent discharge from the wound; bacteriological cultures were not mandatory. Wound infection was classified as minor or major. Major wound infection was accompanied by general symptoms and an increased length of hospital stay. Patients alive 12 months after surgery were examined for the presence of incisional hernia. This was defined as a palpable defect in the fascia, or a protrusion beyond the level of the fascia with the patient examined supine lifting both legs and coughing or straining in an erect position. Examinations were carried out by the same surgeon (L.A.I.) except when patients had moved from the area, when they were examined by a local physician.

Univariate statistical analysis used the χ² test with Yates’ correction or Fisher’s exact test as appropriate. Factors identified as significant on univariate analysis were subjected to multivariate analysis using multiple linear regression. Differences were regarded as significant at P < 0.05.

Results

From August 1989 to March 1991, 454 patients were entered into the trial. The length of the laparotomy incision ranged from 10 to 86 (mean 27) cm. The mean suture length to wound length ratio was 3.6.

Early results

Minor and major wound infection each occurred in 4.0 per cent of patients. The suture length to wound length ratio did not affect the incidence of infection. Wound dehiscence requiring reoperation occurred in three patients (0.7 per cent). In one of these, suture and wound lengths were not registered, but closure in the other two patients was with a suture length to wound length ratio of 1.25.

Late results

Eighty-six patients died within 12 months of surgery, three were excluded from late follow-up because of early wound dehiscence and two were ineligible because of violation of the study protocol. The remaining 363 patients were all available for follow-up examination. The overall incidence of incisional hernia 12 months after surgery was 18.7 per cent. The incidence of hernia was related to the suture length to wound length ratio. When the ratio was <4, hernia occurred in 23.7 per cent of patients (57 of 241), whereas the incidence was 9.0 per cent (11 of 122) if the ratio was ≥4 (P = 0.001; Table 2). The two groups of patients were comparable with regard to all variables recorded (Table 1). The association between suture length to wound length ratio and hernia was similar for both suture materials used (Figure 1).
On univariate analysis, sex, previous midline laparotomy, emergency operation and minor wound infection were not related to the subsequent development of hernia whereas age, length of incision and major wound infection were significantly correlated. Hernia was found in 62 of 279 patients (22.2 per cent) older than 45 years compared with six of 84 (7 per cent) aged 45 years or younger ($P < 0.001$; Figure 2). The hernia rate was 25.2 per cent (33 of 131) when incisions were longer than 27 cm and 15.1 per cent (35 of 232) for those of 27 cm or shorter ($P = 0.03$). The incidence of hernia was six of 14 patients with major wound infection compared with 58 of 332 when there was no infection ($P = 0.04$). The suture length to wound length ratio affected the hernia rate even in the presence of major wound infection; hernia occurred in six of eight of these patients when the ratio was <4 but in none of six when it was $\geq 4$ ($P < 0.001$).

Stepwise forward multiple linear regression analysis was performed, testing the suture length to wound length ratio, age, major wound infection and length of incision as predictors of hernia. Multivariate analysis identified the suture length to wound length ratio, age and major wound infection as independent risk factors, whereas wound length was not found to affect the incidence of hernia significantly.

**Discussion**

It has previously been proposed that the suture length to wound length ratio is associated with the incidence of complications of continuously sutured incisions\(^1\). The present results support this hypothesis, as a strong correlation between the ratio and subsequent incisional hernia was demonstrated (Table 2). A ratio <4 resulted in a 2.5-fold higher incidence of hernia than was found for wounds sutured with a ratio $\geq 4$.

Concerning early complications, the incidence of wound infection did not correlate with the suture length to wound length ratio and patients with wound dehiscence were too few to permit analysis. The low incidence of dehiscence indicates that suture quality and basic surgical technique, such as suture handling and knotting, were adequate. Two instances of wound dehiscence occurred in patients with an extremely low suture length to wound length ratio; this should be regarded as a failure in suture technique.

The overall incidence of incisional hernia in the present study may seem high, but others have applied similar criteria of fascia healing 12 months after surgery and reported comparable rates\(^23-25\). Furthermore, with the liberal inclusion criteria used in the present trial, several factors considered to increase the risk of postoperative hernia were present in a substantial proportion of patients, including old age, incision through scar tissue, emergency operation, length of incision exceeding 18 cm, and major wound infection\(^6,26,27\). Of these, the present study identified a suture length to wound length ratio $<4$, age above 45 years and major wound infection as significant and independent risk factors. To date, 14 of the 68 patients (21 per cent) who developed hernia have needed operative repair. This shows that, although the definition of hernia was rather broad, a significant number of patients have already presented with symptoms severe enough to require surgical intervention.

An association between wound sepsis and incisional hernia has been reported by others\(^8\). It is an interesting finding in the present study that proper surgical technique may reduce the incidence of hernia even in this high-risk group of patients.

The suture length to wound length ratio depends on the size of tissue bites, the distance between bites and the tension on the suture. The relative importance of these factors for subsequent wound healing is uncertain, as clinical studies on this issue are few\(^16\). As the trial continues, it might be possible to assess the separate effect of these technical factors on clinical outcome.

An intervention was made in the trial when preliminary results became available in April 1991. Participating surgeons were then urged to adjust their suture technique towards a suture length to wound length ratio of 4:1. The compliance of the surgeons with these recommendations as well as possible benefits of altered technique will become evident as the study continues.
Healing of laparotomy incisions: L. A. Israelsson and T. Jonsson

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References

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