characteristics. This has to be assessed carefully, especially in pneumonectomy and co-factors. The manual closure seems to be the more preferable method in high-risk patients. An additive support suture following stapling on the bronchial stump did not decrease the risk of BPF.

Deschamps et al. [7] analysed factors affecting the incidence of empyema and BPF after pneumonectomy in 713 patients who underwent pneumonectomy for different conditions. Univariate analysis demonstrated that the development of BPF was significantly associated with bronchial stump reinforcement ($P = 0.03$). Bronchial stump closure with staples had a protective effect against BPF compared with suture closure ($P = 0.009$). The group concluded that multiple perioperative factors were associated with an increased incidence of BPF after pneumonectomy including the prophylactic resection of the bronchial stump with viable tissue; however, mechanical stump closure had a protective effect against the development of BPFs. It is important to note, however, that although this study did not demonstrate a reduced incidence of BPFs with tissue reinforcement, the group practice included the routine reinforcement of stumps in patients deemed most likely to develop BPFs and therefore represent a selection bias.

Al-Kattan et al. [6] studied the outcomes in 471 pneumonectomies that were performed by one surgical team for primary lung cancer. In this study, all operations were performed using a uniform hand suture technique. There were 7 cases of BPF (incidence of 1.5%). This study demonstrated clearly the importance of surgeons’ experience as the senior author performed 374 pneumonectomies with 2 fistulas (0.5%), while other surgeons in training performed 97 pneumonectomies with 5 fistulas (5.1%). The group concluded that suture closure to the bronchial stump after pneumonectomy provides a cheap and reliable technique that is applicable in all situations and can be taught to surgeons in training with an acceptable risk.

**CLINICAL BOTTOM LINE**

The risk of BPF development post-lung resection can be multifactorial. There is actually very little objective evidence of the superiority of manual stump closure over mechanical stapling closure in anatomical lung resection. Furthermore, there is very little objective evidence regarding the superiority of either technique in terms of training opportunities. Further studies are needed to assess safety, effectiveness and training variation between the two approaches.

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**REFERENCES**


**eComment.** Bronchial stump closure techniques: experimental and histological diversity

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We read with great interest the article entitled ‘No evidence that manual closure of the bronchial stump has a lower failure rate than mechanical stapler closure following anatomical lung resection’ by Zakkar et al. [1]. This thorough and well-designed review showed that there is a lack of clinical evidence to either support or counter the superiority of one technique over the other regarding lower failure rates after lung resection.

There are, however, several experimental studies that report an interesting variety of results. Two of the major advantages of animal trials are the resistance test and histological examination of the bronchial stump after euthanasia, which allow detailed investigation of the morphological aspects.

It has been demonstrated that the sutured bronchial stump heals primarily through secondary closure [2]. Therefore, it is speculated that the level of attachment between the stump and surrounding tissues, and the magnitude of granulation tissue formation at the bronchial stump, should be important factors in stump healing or broncho-pleural fistula formation.

In order to investigate the healing process, Isumi et al. [2] examined the bronchial stump one week after right upper lobectomy in dogs, and compared the morphology between stapler and manual suture closure. The incidence of adhesion formation between the surrounding tissues, the thickness of granulation tissue over the stump and its vessel density were significantly reduced in the stapler group in comparison to the suture group.

Other studies aimed to determine the resistance to pressure of a bronchial stump depending upon the closure technique. Bof et al. [3] concluded that mechanical suture of the bronchial stump, submitted to pressure immediately after closure, is more resistant than manual suture in dogs submitted to pneumonectomy. Two years before, Ludwig et al. [4] conducted a similar study using sheep as an animal model. A statistically significant difference existed between the two groups, demonstrating that the resistance to pressure of the mechanical suture was better than that of the manual suture. In contrast to the results obtained in this study on freshly slaughtered pig trachea, the same research team reported that 14 days after pneumonectomy, under ideal conditions, there was no longer any difference in favour of the automatic stapling device. The higher stability and therefore the increased resistance to pressure of the mechanical suture disappeared once the bronchial stump has healed, becoming equal to that of the manual suture [4].

It is a fact that experimental studies show diverse results. Bronchial stump closure techniques, their histological healing patterns and possible bronchial stump complications after pneumonectomy need further experimental and clinical investigation. The new strategy should also aim to enhance and promote the healing process of the bronchial stump and its vessel density were significantly reduced in the stapler group in comparison to the suture group.

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