New Instruments for Thoracic Surgery*

P. I. ANDROSOV, M.D.

Moscow, U.S.S.R.

Thoracic surgery has achieved great results in recent years. Surgical operations on the lung, esophagus, heart and cardiac vessels have become possible. These complicated operations can be performed by a great number of surgeons because of the reliability of the newest precision suturing instruments which have been developed in the Soviet Union.

The instruments allow mechanical suturing that has a great advantage over the old manual method.

Substitution of hand methods by mechanical ones considerably simplifies the operation, cuts the required time, decreases surgical injury, and ensures a complete, hermetic union which has a favorable effect on the result of the operation.

The instruments are simple in design. No tools are required for their assembly and disassembly. The instruments are controlled outside the operative site, and are reliable in operation which is of great importance.

The following instruments for thoracic surgery are manufactured by our industry:

- Instrument for suturing the sternum and ribs SGR-20;
- Instrument for suturing the bronchial stump UKB-25;
- Instrument for suturing bronchial stump UKB-16;
- Instrument for suturing hilum of the lung UKL-60;
- Instrument for suturing the hilum of the lung UKL-40;
- Instrument for suturing auricular appendage of the heart YYC-23;
- Instrument for suturing arterial duct UAP-23.

All the instruments, except the SGR-20, are designed for sewing soft tissues and adjust to the size and shape of the suture to be applied.

U-shaped staples of tantalum and cobalt alloys are used for suturing since they are inert to living tissue and do not cause inflammations. After suturing, the staples bend to assume a B-shape.

To clean the instruments of coagulated blood, tissue particles, etc., after operation, they are disassembled into seven or eight parts without using any tools. The instruments are sterilized in an autoclave or a sterilizer in boiling distilled water.

Instruments for Suturing the Bronchial Stump UKB-25 and UKB-16

The previous hand methods for suturing the bronchial stump have a number of essential shortcomings, chief of which are complexity and long duration of the operation, and postoperative complications in the area of the suture, the result of soft ligation applied as a suturing material.

The use of the instrument, which can place a mechanical staple suture which meets all the demands of pulmonary surgery, entirely solves the problem of the bronchial stump treatment.

The instrument is simple and convenient for manipulating in deeply placed wounds. It simplifies the method of suturing and cuts the time of the operation.

The parallel arrangement of staples with respect to the bronchial axis provides a hermetic union of the suture and does not disturb the blood circulation in the stump, thus promoting a better healing of the wound.

The use of metal staples as suturing material avoids complications (mainly the bronchial fistulae) occurring as a result of applying soft ligatures.

The surgeon chooses size of staple, depending upon the thickness of the stump to be sutured.

The instruments are available in two models, UKB-25 and UKB-16, which only differ in size (Fig. 1).

When performing pneumonectomy and lobectomy to remove cancer, bronchiectasis or pulmonary tuberculosis, etc., the bronchi of adults up to 25 mm. should be sutured with UKB-25 instrument.

The UKB-16 instrument permits suturing of bronchi up to 16 mm. in diameter.

The UKB-16 (of smaller dimension) should be used when performing lobectomy in adults or pneumonectomy in teen-agers and children. It can be used for pneumonectomy in adults by double application.

The patients can be placed in any position—on the side, supine, or prone. The working part of the instrument is brought under the open bronchi and the latter is firmly grasped by the die and magazine planes as near as possible to the place of the tracheal bifurcation. Then the bronchial walls are clamped by bringing them closely together. This ensures a hermetic union after suturing (before a final cicatrization of the bronchi). The sewing of the bronchial walls is accomplished by a single motion, i.e., by a single-pressure on the instrument (Fig. 2).

The effort applied to the handle should not exceed 15 kg. The suturing operation, including the bringing of the instrument under the bronchi, takes only two or three minutes.

After suturing, the marginal section of the bronchi is severed along the instrument edge, the lung or its portion is removed and, having been freed from the bronchial stump, the instrument is carefully withdrawn from the operational wound.

A view of the bronchi sutured by means of metal staples is shown in Fig. 3.
Instruments for suturing the lung hilum UKL-60 and UKL-40

The known method of separate treatment of the lung hilum (arteries, veins and bronchi) has a number of essential shortcomings:

1. Long duration of the pulmonary operation (pneumonectomy, lobectomy, segmentectomy) in which more than half of the time is spent by the surgeon only for the dissection of the elements of the lung hilum (vessels and bronchi);
2. Complexity of methods for performing pulmonary operations;
3. Risk of possible grave complications when opening the vessels and the bronchial hilum (shock, hemorrhage, separation of the bronchial stump, etc.);
4. Impossibility of dissecting the elements of the lung hilum because of strongly developed cicatrix and adhesions leading to the abandonment of the operation.

An innovation in pulmonary surgery, developed first in the USSR and unparalleled in the surgical practice of other countries, is a method of suturing the lung hilum as a whole ("en masse") with instruments placing a staple suture.

The instruments are available in two models: UKL-60 and UKL-40, which differ only in size (Fig. 4).

The instruments are widely used in serious traumatic injuries of the lung, or in processes with wide cicatricial changes in the hilar area, in non-malignant tumors, cavernous forms of tuberculosis, and in malignant tumors located on lung margins, provided there are no involved lymph nodes or they have been completely removed from the area of application.

The use of the instrument in bronchogenic carcinoma of the lung hilum is contraindicated.

The instruments speed up and simplify radical surgical operations on the lung, exclude the shock-producing dissection of the elements of the lung hilum, diminish hemodynamic disturbances during operations, and safely and tightly sew the bronchi, the blood vessels and the pulmonary tissue.

The placing of a mechanical suture minimizes the occurrence of complications and has a favorable effect on the postoperative period.

The staples make two linear rows of stitches having a staggered arrangement. They are of standard size, the same for the two instruments, 0.3 x 4 x 4.8 mm. The staples do not slip off the stump, or
cause necrosis or inflammatory infiltration of the tissue.

The UKL-60 instrument is recommended for performing a single-motion suturing of the lung hilum or a portion of the lung hilum, a bundle of the lung hilum vessels, the pulmonary tissue and other soft tissues by the placement of linear double-stitch suture with metal staples.

The UKL-40 instrument, having smaller dimensions, should be used in suturing the hilum of the lung segment in adults, and the hilum of the whole or a portion of the lung in children.

The use of the instruments frees the surgeon from the arduous and dangerous stage of the operation—dissection of the lung hilar elements (vessels and bronchi) from the surrounding tissues and placing hand sutures on the pulmonary tissue.

The method for placing a mechanical suture is similar for both instruments.

**Figure 5:** Suturing the lung hilum. The instrument handles are brought together as far as they will go.

**Figure 6:** A. Severing the hilum and removing the lung. B. Double-row staggered suture placed with the UKL instrument.
The patient can be placed in any position during the operation: on one side, supine or prone. The instrument hook is brought under the lung hilum in an upward direction (from the lower lobe vein to the bronchi) simultaneously drawing the whole lung outwards so as to place the working part of the instrument at a right angle to the hilar axis as near as possible to the tracheal bifurcation. This is essential in obtaining a bronchial stump of a minimum length. Then the hilum is clamped between the die and the magazine planes as tightly as possible.

Suturing of the lung hilum (Fig. 5) is accomplished by a single motion, a single pressure of the instrument handle (the effort applied to the handles not exceeding 15 kg.). The suturing operation and positioning of the instrument under the hilum lasts only three to five minutes.

Then a rigid clamp, curved at a right angle, is applied to the marginal section of the lung hilum, and the latter is cut off along the instrument jaws from the marginal part by a scalpel and the lung is removed (Fig. 6). Having liberated the lung hilum stump, the instrument is carefully withdrawn from the wound.

The UKL-60 and UKL-40, besides their direct designation, are also used in abdominal surgery. They are successfully used for suturing the duodenal stump, stomach, esophagus and intestines.

**YKB-25 and YKL-60 Instruments**

From the end of 1957 to May, 1962, 65 resections of the lung were done with the aid of the YKB-25 and YKL-60 suture appliances, including 50 cases with purulent infections and 15 with tumors. The operations included 21 pneumonectomies and 44 lobectomies. In the majority of the cases, after exposure, the pulmonary hilum and lobes were sutured as a whole, either by the YKL-60 appliance (in pneumonectomy) or by the YKL-40 appliance (in lobectomy). The last resections of the lung for cancer were performed with separate treatment of the bronchi and the blood vessels. In antero-lateral approach for pneumonectomy, the bronchus was exposed as near as possible to the bifurcation, and then, after suturing by the YKB-20 appliance, the bronchus was divided. Next, all the vessels were sutured by the YKL-60 appliance, and after division of these, the lung was removed. In lobectomies, separate treatment of the bronchi and of the blood vessels depends on their anatomic interrelations.

After resection of the lung, the bronchial and vascular stumps distal to the appliance are clamped by Allis forceps and only after this is the appliance removed. In no case did the bronchial suture prove to be non-hermetic, and only in one patient did blood ooze from the pulmonary vein. Failure of the vascular suture was eliminated by placing two additional silk sutures.

Employment of these appliances has considerably simplified the technique of resection of the lung, rendered the operation less time-consuming, and decreased the extent of traumatization. This is of considerable importance in resecting the lung in gravely ill patients, weakened by toxicity from a purulent process. Lesser traumatization also improves the postoperative course. There were no complications resulting from the use of the aforementioned appliances.

**The Fistula Problem**

Three post-pneumonectomy and two post-lobectomy cases developed bronchial fistulae. In two patients, suppuration was noted in the pleural cavity without the formation of a bronchial fistula. It was eliminated by intrapleural administration of antibiotics. We are not inclined to think that formation of bronchial fistula in the first instance was the result of error in technique of application of the instruments. Bronchial fistulae did not result from non-hermeticity of mechanical suture, since the first signs of the fistulae appeared three to four weeks, and in one patient two months, after the operation. Evidently, mechanical suture placed with the aid of the YKB-25 and YKL-60 appliances, although provid-
ing suture hermeticity did not eliminate other causes which could promote formation of bronchial fistula. According to our observations, fistula which formed after pneumonectomy and suturing the stump as a whole, resulted from the following: (a) cancer of the superior lobe of the lung, located in the hilar zone, and necrosis with formation of an abscess; (b) fibro cavernous tuberculous process in the lung; (c) bronchiectasis with abscess, complicated by tuberculosis with the presence of pronounced inflammatory infiltrate in the pulmonary hilum area.

In two cases, bronchial fistulae followed bilobectomy and lobectomy performed in connection with a prolonged chronic purulent process.

In suturing the root of the lung or the lobe as a whole, the following factors may promote development of the bronchial fistulae:

(a) a long bronchial stump, when mechanical suture is placed on the pathologically changed wall of the latter. This is of special importance in neoplastic infiltration of the bronchial wall and in its tuberculous involvement;

(b) excessive crushing of tissues by jaws of the appliance which sometimes occurs, leading to disturbance of the bronchial wall blood supply and necrosis.

The latter may be eliminated at the expense of lengthening of the tantalum staples. Shortening of the bronchial stump may be achieved by separate treatment of the bronchus and the vessels, thus permitting one to suture the bronchus as close as possible to the tracheal bifurcation.

Further observations were carried out in 20 patients operated in 1957-58 in connection with purulent processes in the lung. Control bronchography demonstrated the presence of a long bronchial stump after suturing the pulmonary hilum of the lobe as a whole. However, in not a single case was there any bronchial fistula. Evidently, leaving a long bronchial stump when suturing the pulmonary hilum as a whole with the aid of the appliance is not a contra-indication to employment of the method of resection of the lung in general.

It is best to leave a short bronchial stump, and in this connection, separate treatment of the bronchus should be performed in hilar tumors of the lung and in tuberculosis of the lung, when involvement of the bronchial wall could be present. In peripheral tumors of the lungs, separate treatment of the bronchus and vessels is also expedient, since it permits better exposure of the affected lymph nodes.

LOBECTOMY

With the aid of the YKL-60 appliance we have often performed marginal resection of the pulmonary tissue (pathologically changed by the inflammatory process) adjacent to the main focus of pathology in the lobe. The upper segment of the inferior lobe or the lingular portion of the superior lobe of the left lung were usually removed in this way. Suture of the pulmonary tissue proved to be hermetic and no postoperative complications were observed.

Now wider use of YKL-60 appliance for resection of the pulmonary tissue is under way. Localization of a purulent process at the place of contact of the two lobes of the lung and pathologic involvement of both with pronounced adhesions not infrequently compels the surgeon to resort to pneumonectomy, after which the patient is an invalid. Because of this, pneumonectomy is especially cruel when performed in young patients. Sometimes it cannot be performed at all due to a number of contraindications. In such a case, the YKL-60 appliance may prove to be of great service for wedge-shaped resection of the lung within the borders of the pathologically changed tissue.

SUMMARY

The search for new designs of appliances providing the least traumatization during surgical intervention on the lung has continued. The task of designing an appliance for mechanical suture (with tantalum staples) of the lung tissue in marginal and wedge-shaped resections with two-row bur-
ied suture has been under study. The expediency of designing such an appliance is considerable. It would permit one to carry out economic resections of the lung both in injury and disease. The number of pneumonectomies and lobectomies resulting in invalidity would decrease. Besides, such an appliance would place the best (double row buried) suture, which almost excludes development of bronchial fistulae and would provide complete pleurization of the suture line.

After extensive investigations we (P. I. Androsov and A. A. Strekopytov) have succeeded in constructing such an appliance.

The design of this appliance is very simple and permits one to disassemble, assemble and load it easily. Any surgeon will find no difficulty in operating this instrument. It may also be used in abdominal surgery for suturing the stomach stump in its resection for cancer and peptic ulcer, and for suturing the ends of intestines in their resection. A total of 85 operations were performed. In all of the cases the suture placed by the appliance proved to be hermetic with correct approximation of the margins of the stomach and intestinal wall, and exhibited reliable hemostasis. In addition, during the operation there was a lesser degree of traumatization of the stomach and intestinal walls and pulmonary tissue. Operations were aseptic and less time consuming. The postoperative course was smooth in all the patients.

In general, appliances for thoracic operations have found very wide application in our country. Data, which are far from complete, indicate that by means of suturing apparatus surgeons have already performed over 7,000 extensive surgical operations on the lungs, heart, and blood vessels. From the published data it can be concluded that the general mortality rate in pulmonary operations ranged from 10 to 14 per cent. With the use of the YKB and YKL appliances the mortality rate has decreased to 3.5 per cent. In individual cases these appliances have made it possible to operate on patients with such infections of the lungs which were regarded as inoperable by the usual manual method of the pulmonary hilar treatment.

Resumen

Se ha continuado la búsqueda de nuevos artificios para producir menos trauma durante las intervenciones en el pulmón. Se ha estudiado la tarea de producir un mecanismo de sutura (con grapas de tantalum) del pulmón en resecciones marginales en cuña con dos hileras de suturas. Es considerable la facilidad de tal proceder. Permite llevar a cabo resecciones limitadas tanto en los traumas como en enfermedades. El número de neumonectomías y lobectomías que producen invalidismo decrecería. Además, tal procedimiento colocaría la mejor sutura, que casi siempre excluye la producción de fístula pleural y proporcionalmente completa pleurización de la línea de sutura. Después de amplias investigaciones los autores han logrado construir tal instrumento. El modo de actuar del instrumento es sencillo y permite que se ensamble y desarme y cargue con facilidad.

Ningún cirujano tendrá dificultad alguna para usarlo. Puede usarse también en cirugía abdominal para suturar el muñón del estómago, en la resección por cáncer o por úlcera péptica, así como para suturar los cabos del intestino en la resección. Se han hecho un total de 85 operaciones. En todos los casos la sutura fue hermética con correcta aproximación de los bordes del estómago y del intestino y demostró hemostasia segura. Además, durante la operación hubo menor trauma de las paredes del estómago y del intestino, así como del tejido pulmonar. Las operaciones fueron asépticas y más rápidas. El postoperatorio fue más sencillo.

En general este procedimiento se ha encontrado amplia aplicación en nuestro país. Los datos que están lejos de ser completos indican que por medio de este aparato de suturas los cirujanos han llevado a cabo más de 7,000 operaciones extensas del pulmón, corazón y grandes vasos. Según los datos publicados se concluye que la mortalidad en operaciones pulmonares va de 10 a 14 por ciento. Con el uso de los aparatos YKB y YKL, la mortalidad ha decrecido a 3.5 por ciento. En casos aislados estos instrumentos hacen posible operar a enfermos con tales infecciones del pulmón que se habían considerado inoperables por el habitual método manual para tratar el hilo.

Zusammenfassung

Die Suche nach Neukonstruktionen von Geräten, die die geringste Traumatisierung während eines chirurgischen Eingriffes an den Lungen gewährleisten, hat ihre Fortsetzung erfahren. Die

Im allgemeinen haben Hilfsmittel für Thoraxoperationen in den USA eine weite Verbreitung gefunden. Daten, die weit davon entfernt sind, vollständig zu sein, sind ein Index dafür, daß mit Hilfe von Nahtmaschinen die Chirurgen bereits mehr als 7000 ausgedehnte Eingriffe an Lungen, Herz und Blutgefäßen vorgenommen haben. Aus den veröffentlichten Unterlagen kann der Schluß gezogen werden, daß die allgemeine Sterblichkeitssiffer bei Lungenoperationen zwischen 10 und 14% lag. Unter der Verwendung von YKB und YKL Konstruktion sank die Mortalitätsziffer bis auf 3,5%. In einzelnen Fällen ermöglichten diese Geräte, an Patienten Eingriffe vorzunehmen, die unter Infektionen der Lunge litten, die man mit den gewöhnlichen manuellen Methoden als inoperabel betrachtet hatte.

PULMONARY-RENAL SYNDROME

Three cases of repeated pulmonary hemorrhage followed by renal failure and death occurring in young adults are described. Death occurred despite control of the uremia by repeated peritoneal dialysis in two of the cases and steroids in all three. The pathology is described and the etiology discussed, particularly the relationship to idiopathic pulmonary hemosiderosis. Experience suggests that this is a rapidly fatal condition with the development of renal failure, but it is postulated that milder forms of the disease might be recognized in the future in which the course may not be so fulminating.


HEMODYNAMIC CHANGES IN CHRONIC CONSTRUCTIVE PERICARDITIS

Hemodynamic observations were made in four men with chronic constrictive pericarditis who were subjected to heart catheterization. All four had low stroke volumes at rest and the cardiac output was low in two. The right atrial and the pulmonary artery wedge pressures were high, but the pulmonary vascular resistance was fairly normal. During exercise there was only slight increase in cardiac output and the arteriovenous difference in oxygen content of the blood increased to high values. The right atrial and PCV pressures increased considerably. During an intravenous infusion of histamine, the cardiac output and the stroke volume increased and were higher than during exercise. The calculated stroke work was also increased by histamine. During histamine infusion, the right atrial pressure decreased and the pulmonary artery wedge pressure increased, but comparatively little.