DIE TRANSFUSION DES BLUTES

BY: Dr LEONARD LANDOIS (1875)

A TRANSLATION OF PAGES 316-325 OF THIS BOOK
BY PHIL LEAROYD

OPERATIONSMETHODEN: INSTRUMENTE.
(Surgical methods: Instruments)

A copy of the book 'Blood Transfusion' by Leonard Landois, which includes the sub-heading: 'An attempt to establish a physiological justification based on our own experimental investigations with consideration of the history, the indications, the operative technique and the statistics', published in 1875 in Leipzig [by Verlag F.C.W. Vogel] can be viewed of downloaded from the following sites:

https://openlibrary.org/books/OL24972761M/Die_Transfusion_des_Blutes

https://dlcs.io/pdf/wellcome/pdf-item/b21063023/0

https://books.google.co.uk/books/about/Die_Transfusion_des_Blutes.html?id=Cqq8zQEACAAJ&redir_esc=y

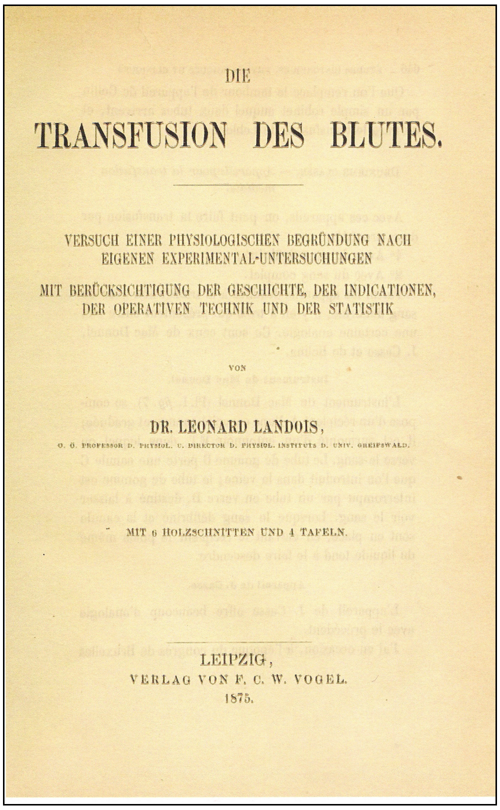
NOTE: I have also translated the 'Historical Section' of this book (pages 1-26) into English – see separate document.

This book, of over 350 pages, includes only a relatively short section on the methods used for blood transfusion and as the section title suggests concentrates more on the surgical techniques used for the different types of transfusion rather than on the instruments used to achieve it. In this respect, Landois presents a completely different approach to his colleagues of that era, such as Belina-Swiontkowski (1869), Jullien (1875) and Oré (1876).

Landois comments on the transfusion of defibrinated blood by indirect techniques as well as whole blood transfusion by both direct and indirect techniques. His method of transfusing defibrinated blood into a patient's vein uses a simple burette and hydrostatic pressure. He also however covers arterial transfusion and venous transfusion, as well as artery to vein and vein to vein direct transfusions. The author also comments on the use of the syringe for transfusion, as well as describing his modified Aveling apparatus for direct transfusion. Although he comments on certain devices developed by other people his comments on instruments mainly relates to aspects of their design, i.e. the cannulas employed and the type of syringe used (including the 'air catcher' developed with Eulenburg, which he does not illustrate). His general comments indicate his 'distrust' of 'over-engineered' equipment developed for indirect transfusion of whole blood by other researchers and is adamant in his belief that "the simplest is necessarily the best."

I have translated this section of the book from the original German into English in the hope that the content may be appreciated by a wider audience. Whilst I am obviously aware that instantaneous computer-generated translation is possible, this process struggles with specialist terminology and also produces a 'colloquial style' not always representative of the original text. I have purposely produced this translation to be 'un-interpreted', in that I wanted to maintain the author's original meaning / wording as much as possible. As with any translation the wording may be purposely or inadvertently altered to 'make it read better' but in doing so there has to be an element of personal interpretation involving something on the lines of 'I believe that this is what the author is actually trying to say'. I wanted to avoid that as much as possible and try to present what the author actually wrote and as such the reader may find that the English text does not 'flow' as well as it could.

Although I have taken great care not to misrepresent the author's original wording I cannot guarantee that this work does not contain 'translational errors' and the reader is recommended to check specific details against the original French text. I have in a small number of places included words or comments in square brackets to explain a particular term or word used by the author.


DIE

TRANSFUSION DES BLUTES.

VERSUCH EINER PHYSIOLOGISCHEN BEGRÜNDUNG NACH EIGENEN EXPERIMENTAL-UNTERSUCHUNGEN

MIT BERÜCKSICHTIGUNG DER GESCHICHTE, DER INDICATIONEN, DER OPERATIVEN TECHNIK UND DER STATISTIK

VON

DR. LEONARD LANDOIS,

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MIT 6 HOLZSCHNITTEN UND 4 TAFELN.

LEIPZIG,
VERLAG VON F. C. W. VOGEL.
1875.

Title page of Die Transfusion des Blutes (1875)
(Image credit: Wellcome Collection)

Leonard Landois
(Photo credit: en.wikipedia.org)

LEONARD LANDOIS – BIOGRAPHICAL INFORMATION

Leonard Landois (1837-1902) was a German physiologist. He studied medicine at the University of Greifswald and later became a professor and director of the Institute of Physiology at Greifswald and a member of the German Academy of Sciences Leopoldina. Although his early work involved research in the field of parisitology, Landois was a pioneer in the study of blood transfusion. In 1874-5 he demonstrated inter-species incompatibility of blood by showing that the serum from one species of animal was capable of agglutinating or haemolysing the red cells of an animal of another species. He also linked this phenomenon with the appearance of black urine after a heterologous blood transfusion, establishing scientifically the dangers of transfusing blood of another species into humans. Extensive details of his *in vitro* inter-species experiments are included in a section of ‘Die Transfusion des Blutes’.

It is no surprise therefore, given his interest in inter-species incompatibility, that Landois makes the point in a number of places during his historical resume regarding the observation that heat was frequently noted to have occurred along the person’s vein when they were being transfused with animal blood. He does however also, from a German’s viewpoint, give an interesting comparison between the English and French approach to the early development of transfusion, by especially comparing the work by the members of the ‘Royal Society’ (particularly Robert Boyle) in England and the antagonism shown towards the work of Jean Baptiste Denis in France – and provides background information regarding both these situations. Although he does comment on ancient references to transfusion in various different texts he strongly believes it highly unlikely that a transfusion could have been performed before Harvey’s discovery of the ‘great circulation of blood’.

SURGICAL METHODS: INSTRUMENTS

1. The transfusion of defibrinated blood into the veins. ("Venous transfusion")

Profuse blood-letting - the blood is defibrinated in a perfectly clean vessel by beating it with a fork or a chopstick, and passing through a dense cloth (preferably Atlas, less well-washed linen), without the cloth being finally pressed or squeezed out. The blood thus collected and placed in a glass, is placed in a bowl with blood-warm water. The best blood-transferring instrument to be recommended, and which I have always used recently, is an ordinary graduated chemical burette, grasping 100 ccm, not tapered at the top, but cut off smoothly, with a ground glass stopcock at the bottom. At the lower end, approximately hand-length, 1½ mm diameter of the rubber tube is inserted and a glass cannula, bent in the shape of a knee, tapering towards the tip and not sharp at the outflow hole, is inserted into this. A number of such cannulas, which anyone can easily pull out of a glass tube over a spirit lamp, are kept ready, partly thicker, partly thinner, partly more curved and partly straighter. The apparatus is filled by dipping the outflow cannula into the blood and sucking it up at the upper end of the burette. (This is the best way to avoid air in the apparatus.) Now blood is allowed to flow out again in part as a test, the valve is closed, and every further filling of the apparatus is now brought about by refilling from above. The skilled person can do without a small glass funnel. The blood sinks into the vein solely through hydrostatic pressure; the position of the cock permits rapid and slow inflow, which can always be controlled at the level of the liquid.

Exposure of the vein (if preferred after previous local anaesthesia with the ethereal [diethyl ether] douche) approx. 3-4 cm long; above and below, at the border of the exposed piece, a waxed silk thread is pulled underneath. The peripheral is tightened to block the passage of blood. A small flap wound is incised in the existing vein wall with scissors (and tweezers). After one is convinced once more that there is no air in the outflow cannula, it is introduced into the vein, the vein wall is drawn all around the cannula wall by means of the central thread loop, and the glass valve is opened. The instrument remains in the vein as long as it is all transfused. Let it flow in slowly but steadily!

When the transfusion has been completed, both sutures are removed; a thick pad is placed on the skin over the peripheral end of the vein and compressed with a bandage. The wound is sutured; above it an ordinary bandage.

For transfusions in humans, I advise choosing the great saphenous vein, where it lies in front of the inner ankle. I definitely prefer the burette-infuser to any syringe; in my institute, no syringes are needed for transfusions at all.

In the case of a depleted transfusion, the blood can either be withdrawn from the same vein into which the transfusion is to take place, or the blood-letting can be done on the arm as usual.

2. The transfusion of defibrinated blood into the radial artery or post tibial artery. ("Arterial Transfusion")

a. In the peripheral end of the artery.

In my experiments with animals I use the same apparatus for this purpose as for transfusion into the veins; only the rubber pipe has to be about 2 meters long; filling exactly as above; the glass cannula, which has a slight spindle-shaped thickening close to the end, is tied into the artery. An assistant holds the burette high up, and if necessary climbs onto a chair or table. Little blood is required to fill the tube.

Transfusion using a syringe according to Hüter. The artery is completely isolated for 2 - 3 cm and 4 threads are drawn through it. The top one is knotted and the artery is tied with it. The peripheral is attracted by an assistant so that no blood can flow out of the transverse scissors cut into the artery. The attachable cannula, which is filled with water and closed at the top with a small cork, is tied in using another thread (the 4th thread is only a reserve thread).

The filled small metal syringe is then inserted into the cannula, the peripheral thread is released and the injection begins slowly and steadily. Once the syringe has been emptied, after the peripheral thread has been temporarily attracted, it is refilled and plugged in again and so on.

I fully agree with Hüter that he gives preference to arterial transfusion over venous, for the reasons given by him, namely because the blood flows so much more evenly and slowly to the heart, because every tiny air bubble gets stuck in the capillaries, because the danger of phlebitis cannot exist. I also add the advantage that the capillary system, like a further filtrum, [sic] catches any harmful foreign particles (see page 96).

Disadvantages have been identified as the greater difficulty of the operation and the danger of re-bleeding; but these by no means outweigh the advantages.

The statement that the operation requires too strong, tiring pressure is completely unfounded, since even the weakest surgeon can easily overcome a pressure of 600 mm mercury with the tip in one hand. The pressure will only have to be too great if you want to drive in more than can flow out through the capillaries. However, one should not inject excessively quickly, i.e. faster than the blood flows through the arteries in a healthy state. Incidentally, the regulation of the pressure is best achieved with my burette apparatus, in which the stopcock position also permits a lot or a little to be admitted at this or that pressure. By stretching the capillaries of the hand and foot, sometimes of the forearm, the skin becomes reddened with a tingling sensation; pain is rare.

A portion of the blood admitted into the radial artery or the post tibial artery evidently passes through the great arcs and anastomosis into the other main trunks, but must of course first pass through the capillaries from here. Hence the reddening observed on the forearm.

Injection into the brachial artery should always be avoided because of the greater risk, especially since the radial artery is always large enough. Billroth's statement to the contrary is based on underestimation. v. Graefe first drew attention to arterial transfusion in the cholera epidemic of 1866; Hüter then successfully put it into practice.

b. In the central end of the artery.

I have repeatedly practiced this kind of injection on animals. I give it preference when it is necessary to transfuse quickly in asphyctic states. Furthermore, one becomes convinced that the accused excessive pressure does not exist at all, that it is only due to the fact that, with peripheral injection, one wants to press more through the capillaries than can pass through. (See p. 114 and addendum)

The left radial is preferable, in view of the earlier usefulness of the limb. After the operation, the peripheral end of the artery is tied and the wound is sewn; ordinary bandage.

3. The direct transfusion.

a. From artery to vein.

The radial artery of the blood donor (left arm) is laid bare 2-3 cm long, tied peripherally; a clamping tweezers (with grooves that are not too rough) is applied at the top. A cannula 4-5 cm long, cut straight at both ends, slightly curved, inside completely smooth with a grooved upper end, is tied into the opened artery. A light 1½ mm rubber tube is attached onto the cannula. The same is 20-25 cm long and has an extended glass cantle at its end. The cannula and tube are appropriately wetted beforehand with a ½% solution of carbonate of soda.

The exposure of the vein of the blood recipient (great saphenous vein) occurs just as in the transfusion of defibrinated blood into the vein. After the opening has been cut into it, the blood of the blood donor is first allowed to spray out of the tube in a jet in order to remove all air. The run is then interrupted by compressing the tube close to the glass cannula, introducing the latter, and letting it flow in. If the influx occurs too quickly, the rubber hose can be compressed intermittently. If coagulation occurs in the pipe, the hose and cannula are removed and carefully cleaned in the sodium hydroxide solution. (It is advisable to have 2-3 rubber tubes with glass cannulas on hand, so that you can simply plug in another pipe in the event of coagulation.) In the metal cannula, a plug can be easily pulled out with the tweezers, then a few more drops of blood can be rinsed through.

Exactly the same method is followed when animal blood (for example from the carotid of the lamb) is transferred into the vein; only it should be useful to take the hose a little longer.

Treat the recipient's wound exactly as above; the blood donor's artery is tied at the top, the piece of artery that was tied around the cannula is cut out. The skin is sewn; ordinary bandage.

b. From vein to vein; with Aveling’s apparatus, which I modified somewhat. (1)

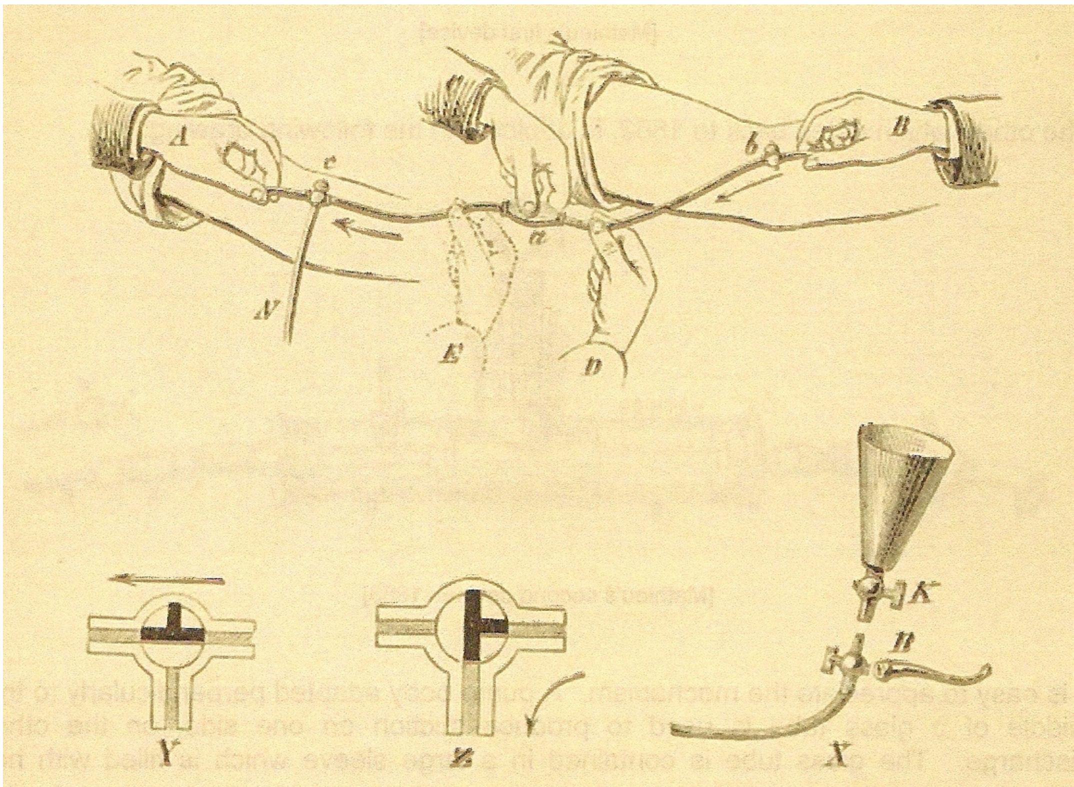

Fig. 6: Aveling direct transfusion apparatus modified by Landois. K: the funnel attachable to X for collecting non-defibrinated blood according to Fryer.

The device consists of a rubber hose with a spindle-shaped extension (a) in the middle. At one end X it has an ordinary metal stopcock (b), to which a slightly curved, straight cut, grooved cannula B can be inserted. This is tied into a vein (in the forearm) of the blood donor. At its other end, the hose has a metal tap (c) with a one and a half hole. This then carries the attachable cannula, which (as already mentioned above) is inserted into the recipient's vein (I always prefer the saphenous vein). The whole tube and the cannulas are filled with a ½% solution of carbonate of soda (by suction) exactly and completely beforehand. Once the cannulas have been inserted and carefully monitored by hands (A and B), the cock (c) is first set as shown in the special figure Z. Now hand D first presses the hose shut and holds it closed, then hand C compresses the spindle a, the liquid will escape from the secondary pipe N. While C is still holding the spindle compressed, hand E now presses the hose shut, D has changed as E. The spindle, a, returning to its shape sucks blood into the tube.

This alternating compression is continued until blood runs out of the secondary tube N. Then you turn the stopcock as in the adjacent figure Y and with the manipulation that is now being carried out, the blood enters the recipient's vein.

c. From artery to artery.
The transfer of the blood from the artery of the blood donor into the artery of the blood recipient in the central or in the peripheral end takes place with the same apparatus with the modifications that result from the methods already discussed. If the arterial flow of the donor is strong enough, the "artificial accessory heart" (a) does not need to be set in motion by manipulating the hands (C D E). It is finally evident that the same apparatus can also be used for the transfer

d. From vein to artery.
It can take place in the central or peripheral end. Special information is superfluous; everything results from what has been communicated above,

4. Indirect transfusion with non-defibrinated blood.

This is done either with my simple burette infuser or also with the Aveling's apparatus, to which the Fryer's (2) funnel (K), which must be graduated, is then attached to the stopcock (b). I advise to wet the same with the soda solution first. Its lockdown is initially closed; the blood flows from the vein of the blood donor into the funnel. If several ounces are already in it, the transfer can begin, during which the blood-letting blood continues to flow into the funnel.

The modifications of the procedure, depending on whether one wants to inject into the vein or into the artery, centrally or peripherally, arise completely automatically.

Instruments

For the sole reason that I shall be complete, I will briefly state the instruments that appear to me to be most expediently constructed and which have been indicated by other researchers.

a) Cannulas have been indicated in many ways, straight, angularly curved, arched curved ones; also buttoned and grooved, as well as smooth, for attaching and screwing, of glass or metal. Furthermore, stiletto cannulas in the manner of the trocar are indicated for insertion into the exposed, or not exposed, but swollen vein; also push-in cannulas like those on the subcutaneous injection syringes. The Mancoq [Moncoq] cannula represents a special kind: its peripheral half is a solid stylet; its initial part contains a tube that opens laterally in the middle of the needle. The cannula is pushed transversely through the swollen vein (also subcutaneously), so that the opening in the lumen reads the same. There are curved and straight cantles. It is probably superfluous to further prove the paternity of all these cannulas.

b) Syringes. Dieffenbach used a simple two-ounce tin syringe with a knee-shaped grooved spout; Blasius chose a glass syringe with a hard rubber fitting, holding one ounce; Eulenburg and I chose one with a capacity of 5-6 ounces, had it graduated and provided it with an air catcher (v. B.*). Martin took an ordinary glass wound syringe with a conical discharge tube, holding two ounces. A curved trocar is used to open the vein, the sleeve of which releases the attachable cannula (v. B.). Uterbart relocated the outflow tube to the periphery of the outflow end to better prevent air from entering the veins (v. B.). Mosler moves the piston by turning a screw (v. B.), which causes a more even flow and can generate greater pressure.

A special group of syringes are those in which a device allows a new amount of blood to be taken in for transfusion without removing the syringe from the vein. This is where Blundell's copper syringe belongs. A stopcock at the outlet end is set in such a way that the un-defibrinated blood is sucked from a funnel-shaped blood reservoir when the plunger is withdrawn into the syringe; a turn of the stopcock that now takes place allows the blood to enter the recipient's vein with the plunger advanced (v. B.). C. v. Graefe placed the whole device in a glass skid [sic] filled with warm water, with a thermometer (v. B.).

Mathieu constructed a funnel syringe. At the top, the blood runs through a funnel with a valve into the syringe shaft. The piston rod is pierced and carries the cannula at the bottom; if the plunger is moved upwards, since the funnel valve closes, the blood must run through the plunger rod and the cannula into the vein (v. B.). That will be enough syringes now.

* The name '(v. B.)' after the apparatus means that the same are depicted in von Belina's writing: The transfusion of blood in phys. and medic. Relationship. Heidelberg 1869.

c) Instruments that, like the burette infuser described above, allow the blood to flow in using hydrostatic pressure. In general, these are funnel-shaped, sometimes longer, sometimes shorter containers that come together at the bottom into an outflow tube that carries the cannula with or without the interposition of a soft tube. The oldest instrument of this kind is the Blundell Gravitator, and Casse also had an instrument that was not significantly different. In order to accelerate the flow, Richardson and v. Belina by means of devices on top of the blood column to apply increased air pressure by valve pumps (v. B.), which incidentally is very dangerous because v. Belina's apparatus had already killed a patient by injecting air into a vein.

d) Air catcher. In order to prevent the entry of air into the veins, Eulenburg and I constructed the "air catcher", an apparatus that is switched between the syringe and the cannula (best connected by elastic tube ends); the apparatus is a cylindrical glass container, closed at the top and bottom by hard rubber plates. One is pierced at the top of the edge of the opening to be connected to the discharge tube of the syringe. The other end plate bears the outflow tube at the bottom, which is curved, always surrounded by blood, protruding into the cylinder. (3) (v. B.) The entry of air into the veins is and remains one of the most dangerous accidents during transfusion.

e) Special devices for direct transfer. I can best demonstrate the apparatus with the help of the illustration of Aveling's instrument.

Roussel constructed an apparatus very similar to Aveling's, except that the spindle (a) had two valves open after the recipient's vessel; other modifications are insignificant.

Mancoq [Moncoq] replaced the spindle (a) with a clysopompe with two valves (v. B.), Schliep with a syringe that is modelled on the one on the so-called gastric pumps. (4) Albini also switches on a syringe machine.

Finally I have to remember the complicated apparatus for the direct transfer from vein to vein of Roussel. (5) To avoid inserting a cannula into the blood donor's vein, Roussel sucks a cupping head onto the donor's vein, which has swollen after a bloodletting bandage has been applied. Due to a special device that is difficult to understand without a drawing, there is a lancet inside the cupping head that can nevertheless be guided from the outside. The transfer head leads from the cupping head, similar to that constructed in Roussel's simple apparatus. The handling of the apparatus also means that the air is completely blocked by sodium hydroxide solution and the latter is also displaced by the bloodletting blood.

The whole set up is extremely clever. As for the usage, I just want to retell a story that Heyfelder shared with us.

Roussel had received an invitation from the Russian Ministry to give a guest role in Petersburg with his “Transfuseur direct”. Everyone is assembled and looks expectantly at the surgeon and his instrument: the blood donor and recipient are ready, but the apparatus did not work, the valves were not tight; after a pause of the greatest and most embarrassing embarrassment, a new apparatus had to be fetched from Roussel's hotel. It would surely be a blatant injustice if I did not want to mention that in a great many cases the valves really held tight and the story went smoothly.

A later profound researcher will certainly succeed in constructing an even more complex apparatus with the application of all ingenuity: considerations would, for example, be the installation of a device that directly measures the quantity and speed of the blood passed over, the switching on of a thermometer, or, better still, the production of a heating device for the blood flowing through, possibly self-regulating by an electrical device, and the installation of a clockwork that controls the entire device set in motion, and God knows what else.

I don't know whether I have to mention that every producer is ready to take an oath that his apparatus is the very best. I finally have to apologize a thousand times if I have ignored one or the other of the fathers entirely, or if I only sketched them too briefly.

With regard to instruments and surgical methods, the following generally applies: "the simplest is necessarily the best."

References (as printed)

1. Boston medical and surgical journal 1874.
2. New-York medical record 1874
3. Vgl. Eulenburg und Landois, Die Transfusion des Blutes. Berlin 1866. Goldschmidt in Berlin verkauft unseren Apparat, Spritze, Luftfänger und Canülen zu 45 Mark (siehe dessen illustr. Catalog).
4. Berl. klin. Wochenschrift 1874. Nr. 3 mit Abbildung.
5. Beschreibung und Abbildung in Wiener medic. Presse 1873. Nr. 50.