This invention relates to a surgical clip which may be attached to a blood vessel to block or restrict the flow of blood through the blood vessel. The clip comprises first and second elongated opposed members, pivot means located between the two opposed members which permit relative pivotal movement of the two members in a common plane, adjustable spring means urging the two opposed members to pivot about the pivot means to a closed position, and an elongated blade member pivotally connected to the forward end of one of the two opposed members. The blade member has one elongated blade surface and the other opposed member has a second matched blade surface, between which the blood vessel is clamped. The fact that the blade member is pivotally connected to one of the opposed members permits the blade member to rotate slightly in the plane of the first and second opposed members to more evenly distribute the compressive force of the spring means across the blood vessel in the closed position. This avoids pinching of one portion of the blood vessel, and substantially reduces the possibility of injury or damage to the blood vessel. One of the blade surfaces has a channel with a uniform concave cross-section extending along a portion of its length. The wall of the clamped blood vessel bulges into the channel to securely laterally retain the clip on the blood vessel. A second embodiment of the invention has lips on opposite ends of one of the blade surfaces to maintain the blade surfaces in a predetermined spaced relationship, in the closed position.
PIVOTAL SURGICAL CLIP

BACKGROUND OF THE INVENTION

This invention relates to a surgical clip which may be attached to a vein or artery to block or restrict the flow of blood through the vein or artery. In the past, a variety of clips and clamps have been used to temporarily or permanently restrict the flow of blood through blood vessels. These previous clips have had the disadvantage that they are difficult to apply, particularly in the confined area in which they are normally used, to be securely attached to the blood vessel without resulting in damage or injury to the blood vessel.

More recently, a clamp disclosed in Canadian Pat. No. 802,633 granted Dec. 31, 1968 to Harry Sidney Kerr has been used to partially overcome this disadvantage. This clamp, which is widely used and known in the industry as the "Kerr Clip" is similar to the present clip in that it has two elongated opposed members, pivot means located between the two opposed members and adjustable spring means urging the two opposed members to pivot towards a clamped or closed position. Although the improvements of the "Kerr Clip" have resulted in it being widely accepted, it still has several disadvantages. As the blade surfaces which contact the blood vessel are both located on the opposed members which pivot above the pivot means, the blade surfaces of each size of clip are located parallel to each other only when attached to one particular size of blood vessel. The blade surfaces of the opposed members diverge slightly outward from the pivot means when attached to a blood vessel larger than that particular size and converge slightly when used with a blood vessel which is smaller than that particular size. This has the effect of pinching or compressing one side of the blood vessel more than the other thereby possibly resulting in injury or damage to the blood vessel. This is of particular importance when the clip is used on small fragile blood vessels encountered in cranial surgery. In addition, if the blood vessel has a hard transverse portion when compressed, the compression force of the clip is not evenly distributed across the blood vessel. Another disadvantage of the "Kerr Clip" is that there is a possibility of it being displaced laterally from the blood vessel. This is particularly true if a clip is attached to a blood vessel much larger than that for which it was designed, as the blood faces of the opposed members substantially diverge outward from the pivot means. Another problem with the existing clip is that small clips which have been in place for a considerable length of time are difficult to remove without causing injury or damage to the blood vessel to which they are attached. In particular, it is difficult to engage the clip with a clip adjustment tool in order to open the clip before removing it.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to at least partially overcome these disadvantages by providing a surgical clip which is relatively easy to apply to and remove from a secure position on a blood vessel with less possibility of injury or damage to the blood vessel.

To this end, in one of its aspects, the invention provides a surgical clip having a clamped and an open position comprising: (a) first and second elongated opposed members each having a forward and a rear end and an outwardly facing surface, the first opposed member having an elongated first flat blade surface adjacent its forward end, the first blade surface inwardly facing the second opposed member; (b) pivot means between the opposed members permitting relative pivotal movement of the members in a common plane about a central transverse axes through the pivot means between the open and clamped positions; (c) an elongated blade member substantially centrally pivotally connected to the forward end of the second opposed member for pivotal movement relative to the second opposed member in the said common plane, the blade member having a second flat blade surface inwardly facing the first blade surface; and (d) adjustable pressure means acting on the opposed members to urge the opposed members to pivot about the pivot means to bring the first and second blade surfaces into a substantially aligned and contacting relationship.

In another of its aspects, the invention provides a surgical clip having a clamped and an open position comprising: (a) first and second elongated opposed members each having a forward and a rear end and an outwardly facing surface, the first opposed member having an elongated first flat blade surface adjacent its forward end, the first blade surface inwardly facing the second opposed member; (b) pivot means between the opposed members permitting relative pivotal movement of the members in a common plane about a central transverse axes through the pivot means between the open and clamped positions; (c) an elongated blade member substantially centrally pivotally connected to the forward end of the second opposed member for pivotal movement relative to the second opposed member in the said common plane, the blade member having a second flat blade surface inwardly facing the first blade surface, each of the first and second blade surfaces having a forward and a rearward end; (d) adjustable pressure means acting on the opposed members to urge the opposed members to pivot about the pivot means to bring the first and second blade surfaces having a forward and a rearward end; (e) a pair of lips of predetermined length extending inwardly from one of the blade surfaces, one of the lips being located near each of the forward and rearward end of the said one blade surface, the lips adapted to be in bearing contact with the other blade surface when the clamp is in the clamped position to maintain the first and second blade surfaces in a predetermined spaced relationship.

Further objects and advantages of the invention will appear from the following description taken together with the accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a first embodiment of the invention, shown in the closed position;
FIG. 2 is a cross-sectional view of the embodiment shown in FIG. 1, attached to a blood vessel;
FIG. 3 is a perspective view of the embodiment shown in FIG. 1, in an open position;
FIG. 4 is a perspective view of a second embodiment of the invention, shown in the closed position.

DETAILED DESCRIPTION OF THE DRAWINGS

Reference is first made to FIG. 1, which shows a clip
having first and second opposed members 12, 14 and a pivot roller 16 positioned therebetween. The first and second opposed members 12, 14 each has a forward end 18, 20 and a rear end 22, 24. The first or, as shown lower, opposed member 12 has a first inwardly facing blade surface 26 extending from a point adjacent the forward end 18 of the first opposed member 12 to a point adjacent the roller 16. The first opposed member 12 also has a first opposing face 28 extending from the rear end 22 to the first blade surface 26, and as shown, the second opposed member 14 has a similar second opposing face 30. The first and second opposing faces 28, 30 respectively have first and second semi-cylindrical transverse openings 32, 34 which cooperate to receive the roller 16. The roller 16 has end flanges 36, 38 or other suitable means to prevent relative lateral movement between the first and second opposed members 12, 14, while permitting relative pivotal movement of the first and second opposed members 12, 14 in a common plane about a central transverse axis 40 through the roller 16 between the closed or clamped position shown in FIG. 1 and the open position shown in FIG. 3.

The clip 10 also has an elongated blade member 42 which is pivotally connected to the forward end 20 of the second opposed member 14 to permit relative pivotal movement between the blade member 42 and the second opposed member 14 in the same plane as the relative pivotal movement between the first and second opposed members 12, 14. A pin and tongue joint 44 is shown between the blade member 42 and the second opposed member 14, although other conventional joints which permit the above pivotal motion may also be used. The blade member 42 is preferably substantially centrally connected to the forward end 20 of member 14, although the connection may possibly be closer to one end or the other for special applications. The blade member 42 has a second blade surface 46 inwardly facing the first blade surface 26. The first and second blade surfaces 26, 46 respectively have forward ends 48, 50 and rearward ends 52, 54, and are similar in size and shape, thereby permitting them to be in the aligned and contacting relationship shown in FIG. 1, in the closed position.

The first and second opposed members 12, 14 have first and second outwardly facing surfaces 56, 58, which in turn have a series of longitudinally spaced depressions 60, 62 extending forwardly from a point adjacent the central transverse axis 40 through the roller 16. The series of longitudinally spaced depressions 60, 62 are matched to removable retain one of the first and second ends 64, 66 of a C-shaped spring 68 in a selected one of the depressions in each of the outwardly facing surfaces 56, 58. The spring 68 continuously biases the first and second opposed members 12, 14 to pivot about the roller 16 from the open position towards the closed position, and maintains a pressure between the first and second blade surfaces 26, 46 in the closed position. The pressure between the first and second blade surfaces 26, 46 in the closed position may be increased by moving the first and second ends 64, 66 of the spring 68 forward in the series of depressions 60, 62 and decreased by moving them rearward.

The first and second outwardly facing surfaces 56, 58 of the first and second opposed members 12, 14 also have a pair of depressions 70, located rearwardly of the central transverse axis 40, and of a size and shape suitable to receive meeting projections, (not shown) on the forward ends of a forcep or other suitable clip adjusting tool. The first and second opposed members 12, 14 may be pivoted about the roller 16 to the open position shown in FIG. 3, by forcing the rear ends 22, 24 of the first and second opposed members 12, 14 together with the clip adjusting tool. As may be seen, the rear portions of the first and second opposing faces 28, 30 are undercut to permit pivotal movement of the first and second opposed members 12, 14 through a greater arc, which results in the first and second blade surfaces 26, 46 being further apart when clip is in the open position with the rear portions of the first and second opposing faces 28, 30 in contact with each other. The first and second outwardly facing surfaces 56, 58 of the first and second opposed members 12, 14 are also provided with a pair of transverse grooves 72 located rearwardly of the transverse axis 40. The transverse grooves 72 are shown as each being interrupted in the central portion of the surfaces 56, 58, but they could equally as well be continuous across the surfaces. The grooves 72 are adapted to receive a noose 74 of thin flexible material, such as spring steel, encircling the rear ends 22, 24 of the first and second opposed members 12, 14. The noose 74 is attached to a noose tightening tool 76 which may be manually operated to tighten the noose. As the noose 74 is tightened, the rear ends 22, 24 of the first and second opposed members 12, 14 are forced together to the open position, with the rear portions of the first and second opposing faces 28, 30 in bearing contact with each other.

The clip adjusting tool (not shown) with projections suitable for receipt in depressions 70 has the advantage that it permits the clip to be securely held at a wide variety of angles relative to the longitudinal axis of the tool, but has the disadvantage that after the clip has been installed for a considerable period of time it is often difficult to locate the depressions 70 with the projections on the clip adjusting tool. In this case, the noose tightening tool 76 may be advantageously used to open the clip by locating the noose 74 around the rear ends 22, 24 of the first and second opposed members 12, 14, and tightening it which results in the noose being securely received in the grooves 72. Therefore, although either the clip adjusting tool with the projections or the noose tightening tool 76 may be used to pivot the first and second opposed members 12, 14 from the closed position to the open position, the former is normally used when attaching the clip to a blood vessel and the latter normally used when removing the clip.

The first and second blade surfaces 26, 46 are generally flat, but as may be seen in FIGS. 2 and 3, the first blade surface has a central longitudinal channel extending between its forward and rearward ends 48, 52. This channel 78 has a uniform concave cross-section and the remaining portion of the flat blade surface forms a ridge 80 entirely surrounding the channel 78. Although the channel 78 is shown as being located in the first blade surface 26, it may be located in either or both of the first and second blade surfaces 26, 28, and in fact is normally located in the second blade surface 46 in the blade member 42. This channel 78 permits the blood vessel to which the clip is attached to bulge into the channel 78 to thereby assist the frictional forces in preventing the clip 10 from sliding laterally off of the blood vessel.
FIG. 4 shows a second embodiment of the invention which may be used to restrict the flow of blood through a blood vessel such as the vena cava vein. As may be seen, in this embodiment, the second blade surface 46 has first and second lip members 82, 84 respectively extending inwardly from its forward and rearward ends 50, 54. In the closed position, spring 68 urges lip members 82, 84 into bearing contact with first blade surface, thereby maintaining the first and second blade surfaces 26, 46 in a spaced relationship on the blood vessel. Although it is apparent that the first and second lip members 82, 84 may be formed of any desired length, they are normally of equal length to maintain the first and second blade surfaces 26, 46 in a parallel relationship in the closed position. The selected length of the first and second lip members 82, 84 is of course, determined by the size of the blood vessel to which the clip is to be attached and the amount of blood which it is desired to permit to flow through the blood vessel. This embodiment of the invention does not normally have a channel similar to channels 78 in one of the first and second blade surfaces 26, 46, since the clip is laterally retained on the blood vessel by the lip members 82, 84.

In use, the clip 10 is assembled by locating the roller 16 between the first and second opposed members 12, 14 in the first and second semi-cylindrical transverse openings 32, 34. The construction of the roller 16 with end flanges 36, permits relative pivotal movement of the first and second opposed members 12, 14 substantially only in a single common plane, while pin and tongue joint 44 similarly permits relative pivotal motion between the second opposed member 14 and the blade member 42 substantially only in the same common plane. The first and second end 64, 66 of the C-shaped spring 68 are located in selected ones of the series of depressions 60, 62 in the outwardly facing surfaces 56, 58 of the first and second opposed members 12, 14 to bias the opposed members 12, 14 towards the closed positions and to maintain a desired constant pressure between the first and second blade surfaces 26, 46 in the closed position.

In order to attach the clip to a blood vessel, the clip is engaged by a suitable clip adjusting tool (not shown), such as forceps, by inserting projections on the end of the tool into the pair of depressions 70 on the rear ends 22, 24 of the first and second opposed members 12, 14. The first and second opposed members 12, 14 are then pivoted to the open position by forcing the first and second rear ends 22, 24 together with the tool to bring the rear portions of the first and second opposing faces 28, 30 into bearing contact with each other. The clip is then transversely attached across a blood vessel by locating the clip with the blood vessel centrally positioned between the forward and rearward ends of the blade surfaces and slowly releasing the rear ends 22, 24 with the tool. As the tool is released, the spring 68 rotates the first and second opposed members 12, 14 about roller 16 towards the closed position and compresses the blood vessel between the first and second blade surfaces 26, 46, as seen in FIG. 2. In the closed position, the pin and tongue joint 44 between the blade member 42, and the forward end 20 of the second opposing member 14 permits the blade member 42 to pivot slightly to more evenly distribute the compression force of the spring 68 on the blood vessel along the length of the blade surfaces. The optimum distribution of the force normally occurs when the blade member 42 is pivoted relative to the second opposed member 14 to align the first and second blade surfaces 26, 46 parallel to each other, and substantially reduces the possibility of injury or damage to the blood vessel. The fact that blade member 42 will align itself to maintain a relatively constant pressure along its length also permits a lesser total compressive force to be applied between the blade surfaces to ensure total blockage of flow through the blood vessel. When the clip is attached to the blood vessel, a portion of the wall of the blood vessel bulges into channel 78 to ensure secure lateral receipt of the clip on the blood vessel. The clip may be removed from the blood vessel by encircling the rear ends 22, 24 of the first and second opposed members 12, 14 with noose 74 and tightening the noose with the noose tightening tool into receipt in the transverse grooves 72 to pivot the first and second opposed members 12, 14 about the roller 16 to the open position.

The embodiment of the invention shown in FIG. 4 is similarly attached and removed from the blood vessel, the blood vessel being located between the first and second lip members 82, 84 in the closed position. In this embodiment, the alignment of the blade surfaces in the closed position is determined by a length of the lip members, as the lip members are normally in bearing contact with the opposite blade surface in this position.

Although the disclosure describes and illustrates preferred embodiments of the invention, it is to be understood that the scope of the invention is not restricted to these particular embodiments.

What we claim is:

1. A surgical clip having a clamped and an open position comprising:
   a. first and second elongated opposed members each having a forward and a rear end and an outwardly facing surface, the first opposed member having an elongated first flat blade surface adjacent its forward end, the first blade surface inwardly facing the second opposed member;
   b. pivot means between the opposed members permitting relative pivotal movement of the members in a common plane about a central transverse axis through the pivot means between the open and clamped positions;
   c. an elongated blade member substantially centrally pivotally connected to the forward end of the second opposed member for pivotal movement relative to the second opposed member in the said common plane, the blade member having a second flat blade surface inwardly facing the first blade surface, said second member being of lesser length than said first member and said pivotally connected elongated blade member being substantially coextensive with said first flat blade surface; and
   d. adjustable pressure means acting on the opposed members to urge the opposed members to pivot about the pivot means to bring the first and second blade surfaces into a substantially aligned and contacting relationship.

2. A surgical clip as claimed in claim 1 wherein the adjustable pressure means comprises a series of depressions spaced along the outwardly facing surfaces of the opposed members forward of the transverse axis through the pivot means, and a C-shaped spring having
two ends, each end of the spring being removably engaged in a respective selected one of the depressions in one of the opposed members.

3. A surgical clip having a clamped and an open position comprising:
   a. first and second elongated opposed members each having a forward and a rear end and an outwardly facing surface, the first opposed member having an elongated first flat blade surface adjacent its forward end, the first blade surface inwardly facing the second opposed member;
   b. pivot means between the opposed members permitting relative pivotal movement of the members in a common plane about a central transverse axis through the pivot means between the open and clamped positions;
   c. an elongated blade member substantially centrally pivotally connected to the forward end of the second opposed member for pivotal movement relative to the second opposed member in the said common plane, the blade member having a second flat blade surface inwardly facing the first blade surface, at least one of the blade surfaces having a central channel extending along a portion of its length; and
   d. adjustable pressure means acting on the opposed members to urge the opposed members to pivot about the pivot means to bring the first and second blade surfaces into a substantially aligned and contacting relationship.

4. A surgical clip as claimed in claim 3 wherein said channel has a uniform concave cross-section.

5. A surgical clip as claimed in claim 1, wherein the outwardly facing surface of at least one of the opposed members has an indentation located rearward of the transverse axis through the pivot means adapted to receive a matching projection on a suitable clip adjusting tool to provide for engagement of the clip by the tool.

6. A surgical clip as claimed in claim 1, wherein the outwardly facing surface of at least one of the opposed members has a transverse groove extending at least partially across the said surface rearward of the transverse axis through the pivot means, the groove being adapted to receive a noose of thin flexible material encircling the first and second opposed members to engage the clip, the nose being adapted to be tightened by a suitable noose tightening tool to operate the clip from the clamped to the open position.

7. A surgical clip as claimed in claim 1, wherein the outwardly facing surface of at least one of the opposed members has a transverse groove extending at least partially across the said surface rearward of the transverse axis through the pivot means, the groove being adapted to receive a noose of thin flexible material encircling the first and second opposed members to engage the clip, the noose being adapted to be tightened by a suitable noose tightening tool to operate the clip from the clamped to the open position.

8. A surgical clip as claimed in claim 1, wherein the outwardly facing surface of at least one of the opposed members has a transverse groove extending at least partially across the said surface rearward of the transverse axis through the pivot means, the groove being adapted to receive a noose of thin flexible material encircling the first and second opposed members to engage the clip, the noose being adapted to be tightened by a suitable noose tightening tool to operate the clip from the clamped to the open position.

9. A surgical clip having a clamped and an open position comprising:
   a. first and second elongated opposed members each having a forward and a rear end and an outwardly facing surface, the first opposed member having an elongated first flat blade surface adjacent its forward end, the first blade surface inwardly facing the second member;
   b. pivot means between the opposed members permitting relative pivotal movement of the members in a common plane about a central transverse axis through the pivot means between the open and clamped positions;
   c. an elongated blade member substantially centrally pivotally connected to the forward end of the second opposed member for pivotal movement relative to the second opposed member in the said common plane, the blade member having a second flat blade surface inwardly facing the first blade surface, each of the first and second blade surfaces having a forward and a rearward end;
   d. adjustable pressure means acting on the opposed members to urge the opposed members to pivot about the pivot means to bring the first and second blade surfaces into a substantially aligned and contacting relationship; and
   e. a pair of lips of predetermined length extending inwardly from one of the blade surfaces, one of the lips being located near each of the forward and rearward end of the said one blade surface, the lips adapted to be in bearing contact with the other blade surface when the clamp is in the clamped position to maintain the first and second blade surfaces in a predetermined spaced relationship.

10. A surgical clip as claimed in claim 9 wherein the adjustable pressure means comprises a series of depressions spaced along the outwardly facing surfaces of the opposed members forward of the transverse axis through the pivot means, and a C-shaped spring having two ends, each end of the spring being removably engaged in a respective selected one of the depressions in one of the opposed members.

11. A surgical clip as claimed in claim 1, wherein the pivot means comprises a roller adapted to be seated in cooperating transverse openings in opposing faces of the opposed members, the roller having means precluding relative lateral movement between the opposed members.

12. A surgical clip as claimed in claim 9, wherein the pivot means comprises a roller adapted to be seated in cooperating transverse openings in opposing faces of the opposed members, the roller having means precluding relative lateral movement between the opposed members.

13. A surgical clip as claimed in claim 1, wherein at least one of said first and second opposed members is undercut adjacent the rear end to permit increased relative pivotal movement of the opposed members about the transverse axis through the pivot means.

14. A surgical clip as claimed in claim 1, formed of stainless steel.