HOMEMADE GASTRO-INTESTINAL CANNULAE

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The lack of suitable gastro-intestinal cannulae is often a factor limiting the preparation of animals with fistulae for basic nutritional research. This is especially so in developing countries. Two types of rumen cannulae and one intestinal cannula are described in this paper. They have been constructed from PVC tubing and rubber at low cost and without any requirement for sophisticated equipment. These cannulae have been used in eight bulls for a period of one year without breakage or apparent tissue reaction.

Key Words: Cannulae, gastro-intestinal

Cannulation of various compartments of the gastrointestinal tract and of the intestine has become a common method used in the study of digestive function. In most cases, the cannulae have been made either by injecting a rubber or plastic solution into a mould and then setting the mixture by heat or chemical treatment, or else by machining pre-formed materials (ea. stainless steel, hardened rubber or plastic) to the shape required for the cannulae. Many research institutions and universities are able to afford to manufacture these types of cannulae for their own research since there is access to the necessary raw materials and the technical expertise. This is not always the case in developing countries, and the availability of cannulae in these situations has often been one of the main limiting factors to the use of cannulated animals for basic nutritional research under the local conditions.

In this paper, two types of rumen cannula and a T-piece cannula for intestinal fistulation are described. These cannulae have been made from rubber and PVC tubing, which are materials available in all developing countries at low cost, and have all been tested in cattle for a period of at least one year without any difficulties being encountered.

Materials and Methods

Materials: There are different physical properties required for various components and types of cannulae, and it is useful to summarize first some of the characteristics of the materials used in the construction of the cannulae described here.

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PVC Tubing:
- available in diameters from 13 to 300 mm and over this range the thickness of the material varies from 1 to 5 mm,
- extremely light in relation to its structural strength, and although rigid, it is not brittle,
- easily shaped with a hacksaw, hand file or grindstone,
- easily moulded at relatively low temperatures (eg. using a bunsen burner) and sets quickly at room temperature without becoming brittle,
- fittings (eg. T-joints and end caps) are available for all sizes of tubing, and
- can be rapidly and permanently bonded to itself using PVC cement.

Rubber Tubing:
- available commercially in a range of diameters, in the form of car radiator tubing, and from distributors of irrigation equipment,
- although it does not stick to itself, it does not tear easily, and a permanent junction may be formed with stitching (ea. using nylon string).

Rubber Sheet:
- the protective band for the inner tube of a truck tyre (3 to 10 mm) provides suitable rigidity for the retaining flanges of cannulae.

Wood:
- soft wood is easily formed into stoppers for cannulae and may provide a fairly light yet solid material for this purpose if large corks are not available.

Rumen Fistulation: The method of fistulation used has been described by Hecker (1974). Briefly, it involves the following steps:

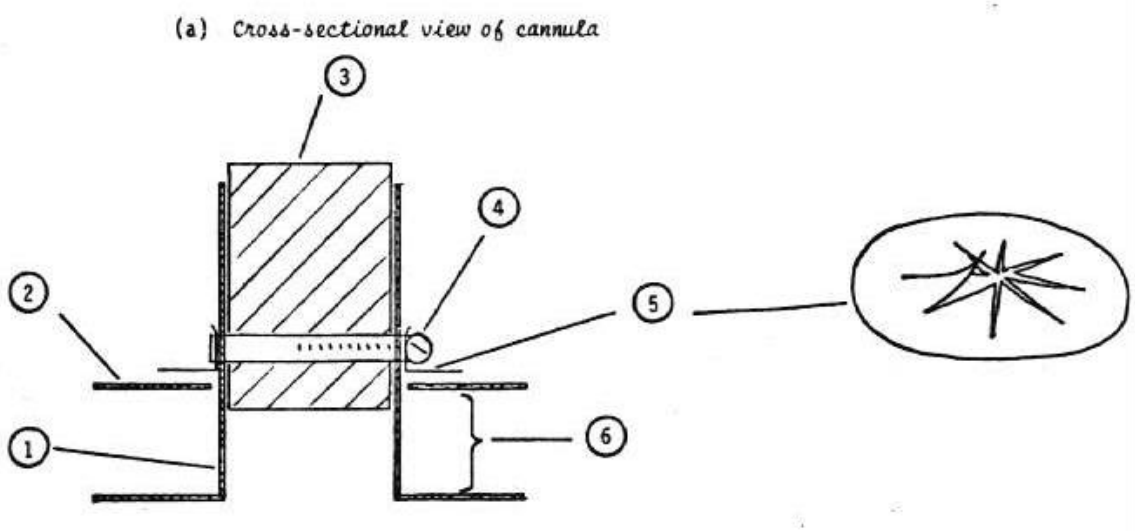
(i) A single skin incision (6 to 10 cm long, depending on the size of the cannula) is made with its centre about 5 to 10 cm ventral of the transverse processes and approximately the same distance posterior to the last rib.
(ii) The body wall and peritoneum may be penetrated by blunt disection.
(iii) A portion of the rumen wall is then exteriorized using two pairs of Alis forceps, and clamped tightly between two metal bars.
(iv) One or two mattress sutures through the skin, body wall and the rumen wall (below the clamp) hold the wound closed.
(v) During the following 5 to 8 days, the rumen and body walls grow together where they have been in contact, necrosis of the clamped portion of the rumen occurs and this falls off, leaving an oval shaped fistula into the rumen.

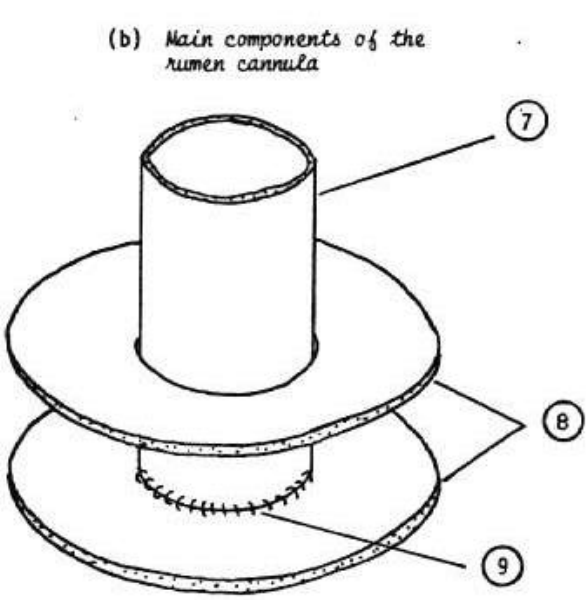
Using this technique, the operation may be performed very rapidly and the risk of infection occurring is small. The limitation on its use has been the difficulty in obtaining suitable cannulae.

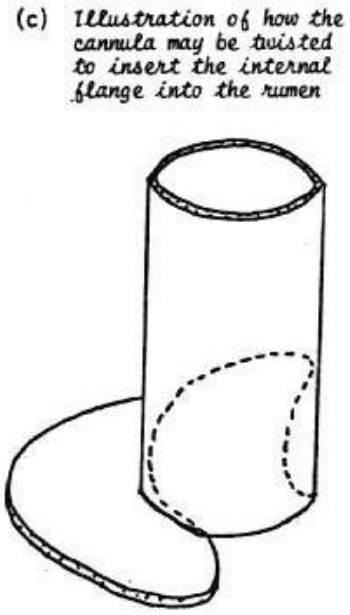
Construction of a Rubber Cannula

The method described above leaves an oval fistula, and a flexible rubber cannula has generally been preferred in the first instance (Figure 1). The basic component of this cannula may be constructed from a section of radiator hose and a circular rubber disc (approximately 5 mm thick) cut from the tube protector of a truck tyre. These two

Figure 1:
Diagrammatic description of a rumen cannula for cattle made from pre-formed rubber components



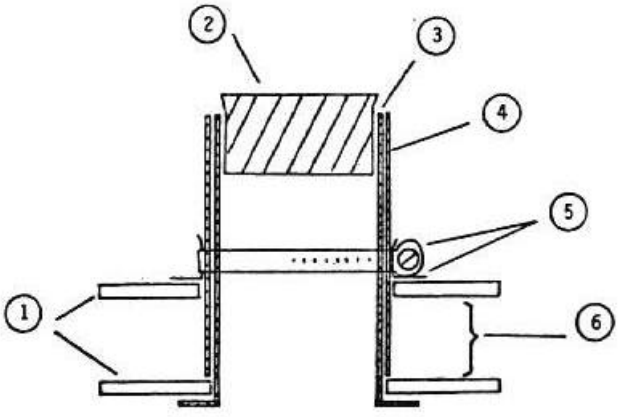




1 Main body of cannula, tube and internal flange
2 External flange
3 Wood plug
4 Hose clamp
5 Clamped retainer flange made from inner tube
6 Rumen wall, muscle and skin
7 Tube of cannula - radiator hose
8 Two flanges - inner tube protector from truck tyre assembly
9 Continuous stitching with nylon string

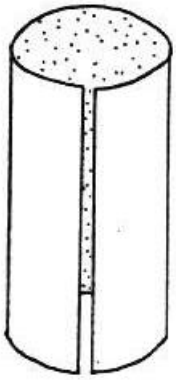
parts may be sewn together with nylon string. The insertion of this cannula is facilitated by twisting a section of the disc into the tube (Figure lc) and then when the cannula is in position, the disc may be pushed out of the tube to resume its normal shape in the rumen. The cannula is held in position with a rubber disc, of the same type as that sewn to the cannula, and this is clamped in position using a retaining flange made from an inner tube (inset in Figure la) and a radiator hose clamp. The stopper (of wood) must extend far enough into the tube to provide a rigid support for the clamp.

Figure 2:
Diagrammatic description of a rumen cannula made from PVC tubes and rubber flanges

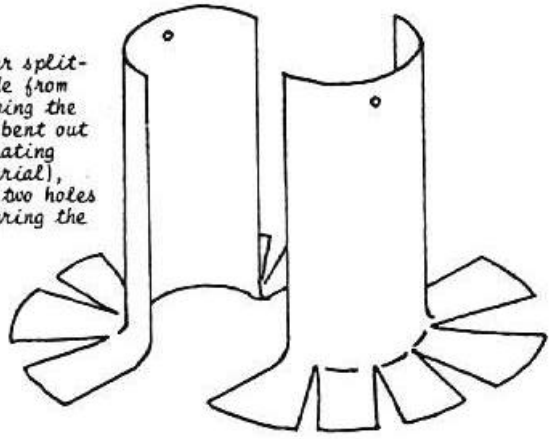


(a) *Cross-sectional view of cannula in situ*

(c) *The outer split-tube made form PVC tube of the same diameter as the internal tube.*



(b) *The inner split-tube made from PVC showing the flange (bent out after heating the material), and the two holes for securing the string.*



1 Internal and external flanges (see component 2 of Figure 1)
2 Rubber stopper
3 Inner split-tube of cannula (see Figure 2(b))
4 Outer split-tube of cannula (see Figure 2(c))
5 Clamping assembly (see Figure 1)
6 Rumen wall, muscle and skin

A PVC Cannula for the Rumen

When a more circular fistula has formed into the rumen after the rubber cannula has been in position for some time, it may be advantageous to insert a PVC cannula. This type of cannula is lighter than the rubber cannula, and in addition, a tube size can be selected to fit the fistula exactly. The design of the cannula is shown in Figure 2. The main component is a PVC tube. This may be prepared with a flange by making cuts of 1 to 2 cm length at intervals of approximately 2 cm along the circumference of the tube and then heating this strip evenly in an open flame. When the material becomes pliable, the sections may be bent outwards at right angles to the main tube and set in this position by holding the tube down on a flat surface until the material hardens (approximately one minute). To facilitate placing the cannula in the fistula, it is then cut in half, longitudinally, and a small hole made in each half at the opposite end to the flange (Figure 2b) for the attachment of a length of string. The retaining flanges and clamping arrangement may be prepared in the same way as for the rubber cannula. In order to hold the two halves of this inner split-tube together, an outer split-tube is prepared from the same diameter PVC tube but with only a single split (Figure 2c). The cannula is inserted by first putting the two halves of the inner tube (attached to a length of string) into the rumen. The internal retaining flange is then passed around the string and into the rumen before pulling the two halves through the flange and positioning them in the fistula. The surface of the tube must be thoroughly dried before applying PVC cement and placing the outer split-tube in position. When the cement has dried, the external flange may be slipped on and clamped in position. A rubber stopper or a piece of wood may be used to seal the cannula.

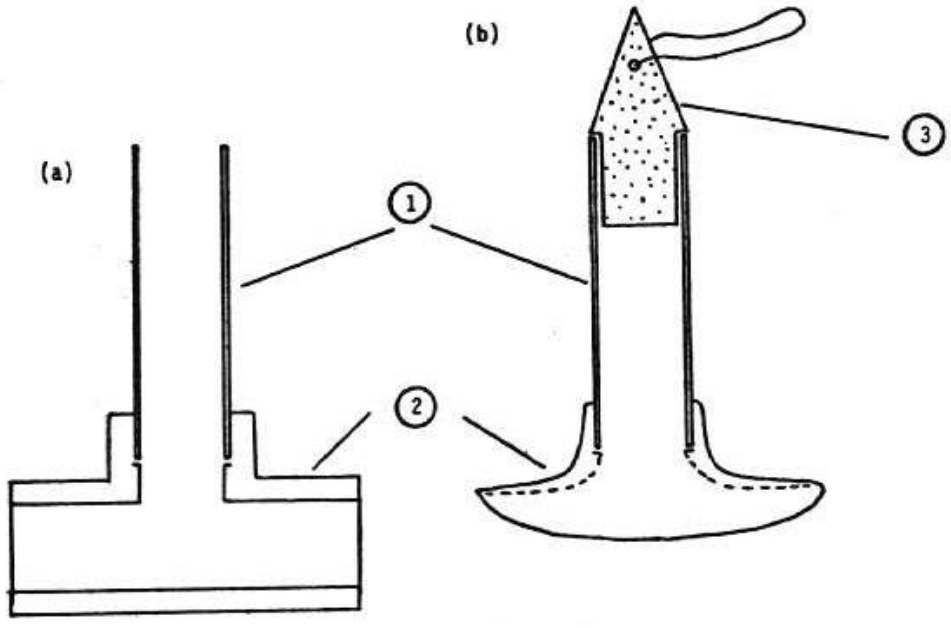
A PVC Intestinal Cannula

The techniques commonly used for the intestinal cannulation of ruminants have been reviewed by MacRae (1975). The single T-cannula has been chosen in preference to re-entrant cannulation at this institute because of the easier management of animals prepared in this way, and also in the belief that the marker Cr_2O_3 may be used to provide an accurate estimate of the flow of digesta.

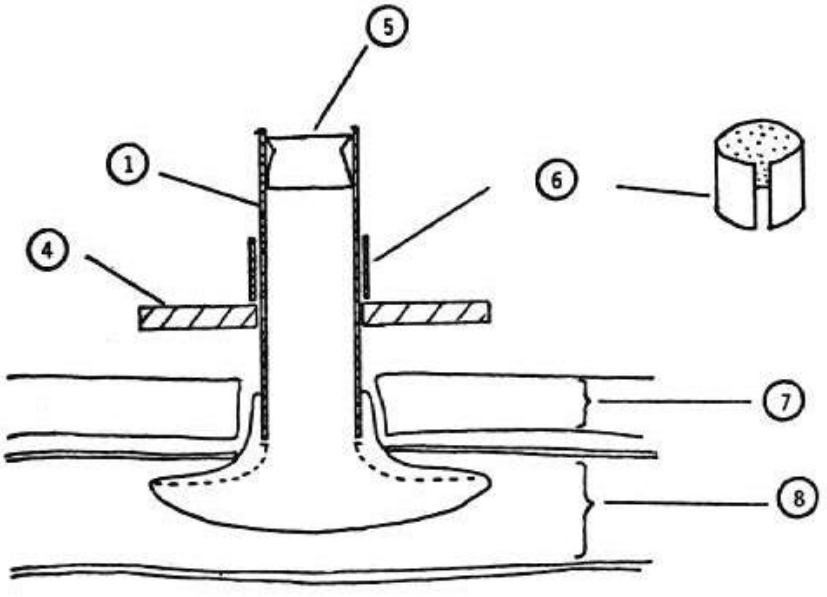
The type of cannula made at this institute is shown in Figure 3. This type of cannula may be made in about 10 minutes and at very low cost. The basic components are a length of PVC tube normally of 13 mm diameter and about 10 cm long, a PVC T-piece junction and some PVC cement. When the tube has been cemented in place (Figure 3a), the shaping of the T-piece may be easily done using an electric grindstone or, if this is not available, with a hand file. The final shape is shown in Figure 3b, with the broken line indicating that the thickness of the T-piece may be substantially reduced during the shaping. This reduces the weight of the cannula and minimises the obstruction to the flow of digesta , without having an appreciable effect on its structural strength. A smooth finish may be produced using fine sandpaper.

A "spearhead" may be made from wood to insert in the cannula during surgery, and to facilitate exteriorizing the cannula once it has been sutured into the intestine. When the cannula has been exteriorized, it may be held in position by sliding a tightly fitting rubber flange (about 6 cm external diameter) over the tube of the cannula and then fixing it there by cementing a ring (1 cm wide) of PVC tube directly above it

Figure 3:
An intestinal cannula made from PVC tubing and a T-joint. Figure 3(a) shows a cross-section of the original T-joint and tubing before shaping, and 3(b) shows the same material after shaping.



(c) *Cross-sectional view of the cannula in situ*



1	PVC tube (13 mm diameter)	5	Rubber stopper
2	T-piece of PVC tubing	6	Clamping ring to retain the external flange in position
3	"Spearhead" for exteriorization of cannula	7	Muscle and skin
4	External rubber flange	8	Intestine

(Figure 3c). At this stage, the "spearhead" may be removed and replaced with a rubber stopper. A rubber tip from the plunger of a 20 ml syringe is most suitable for this as it is light and can be pushed in flush with the end of the tube which protects it from becoming dislodged if the animal licks the cannula.

Conclusions

Cannulae of the types described above have been used in eight crossbred bulls (Zebu x Holstein) and during a year of experimentation with these animals, there has been no tissue reaction to the PVC and no breakage of any cannula.

The low cost of these cannulae, their durability and the ease with which they may be prepared suggests that their usefulness may not be restricted to the developing country situation.

The contribution of Dr G Ravelo, who introduced the use of PVC tubing for the manufacture of cannulae at this institute, is gratefully acknowledged,

References

Becker J F 1974 Experimental Surgery on Small Ruminants Butterworths & Co London

MacRae J C 1975 In Digestion and Metabolism in the Ruminant (et I W McDonald 6 A C I Warner) The University of New England Publishing Unit Armidale Australia p261

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