Clinical Evaluation of Four Surgical Methods For Repair of Umbilical Hernia in Crossbred Calves.

A THESIS

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By

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INTRODUCTION

'White Revolution' is on the move in this country and cross breeding programme is one of the important tools in making it a success. With the implementation of extensive cross breeding programme, certain diseases and surgical conditions are met with quite frequently. Amongst these, umbilical hernia is posing major problem to the field veterinarians.

Umbilical hernia may be congenital or acquired. Acquired herniation may be a sequela to local infection. Secondly, it may occur as a result of mechanical disturbance interfering with the closure of the ring.

It is reported by veterinarians from Aarey Milk Colony that affected animals exhibit poor growth rate and low weight gain in comparison with the identical healthy cross bred calves of the same age group.

For repair of umbilical hernia, different techniques have been advocated by various workers over the years. O'Connor (1965) suggested application of counter-irritants locally or by injecting them subcutaneously together with application of truss to the hernial sac.

Bullard (1965), Frank (1964) and O'Connor (1965) applied wooden or metal hernial clamps to the hernial sac after reduction of contents.
However surgeons were never satisfied with results obtained from such treatments. This situation gave an impetus to the adoption of surgical techniques for correction of umbilical hernia. Johnson (1970) expressed that surgical correction of umbilical hernia is most effective method in this condition.

In view of these facts a survey was undertaken at Aarey Milk Colony, Goregaon and Bombay Gowrakshak Mandalii Kandivali, which revealed 2.65% incidence of umbilical herniae in cross bred calves (Appendix-I). The herniae were of different sizes and nature. It was therefore decided to utilize some of these animals for carrying out repair of herniae using different surgical techniques and for studying their efficacy under field conditions.
ANATOMY OF THE UMBILICUS

Umbilicus is the cicatrix, marking the site of attachment of the umbilical cord in the fetus (Arey et al., 1957). Its opening is patent in the fetal life which lies in the linea alba little posterior to its middle and on a transverse plane through the ventral ends of the last pair of ribs. The two umbilical arteries, two umbilical veins and the urachus pass through it. After birth the stumps of these structure retract into the abdominal cavity and the opening is closed by connective tissue forming a cicatrix now called as umbilicus. The skin at the umbilicus forms a projection in the young animal which may be present throughout life.

Occasionally the umbilical opening fails to close and may be of such a size to allow some of the abdominal contents (usually omentum) to escape through it forming an umbilical hernia (Moelod, 1960).

The linea alba is a white, fibrous raphe that extends from the prepubic tendon to the xiphoid cartilage. It is formed by the union of aponeurosis of the oblique and transverse abdominal muscles.

Blood and nerve supply to umbilicus:

The blood supplied to umbilical region is from
anterior and posterior abdominal arteries. The sixth or seventh thoracic nerves and first two or three lumbar nerves innervate this part.
REVIEW OF LITERATURE

During the past, many methods have been used to reduce umbilical hernias. O'Connor (1965) suggested the use of counter-irritants topically or injected subcutaneously, followed by the application of truss to the hernial sac. A later method was ligation of the hernial sac after reduction of viscera, followed by the use of transfixation sutures. However, unless great care was taken in applying the ligature, this method resulted in infection, penetrated bowel and evisceration (Johnson, 1970).

Riley (1961) performed umbilical herniorrhaphy in foals by employing horizontal mattress suture, across the abdominal wall and parietal peritoneum, using heavy vetafil (1.1), instead of hernial clamps. He opined that this technique was more simple.

In addition, after reduction of the hernial contents, wooden or metal clamps were applied successfully. Ballard (1963), Frank (1964), O'Connor (1965) and Davis (1967) observed that the greatest problems associated with these approaches were infection and loss of clamps. Additionally, if the clamps were placed
too tightly, premature necrosis of the hernial sac would result in an open wound and possibly, evisceration (Proctor, 1950).

Frank (1964) opined that umbilical hernia need not be surgically repaired until the animal is one year of age, because hernial ring usually closes naturally by this time.

Keown (1974) opined that in calves the open reduction should be carried out up to four months of age than on older animals, since the increased weight of the abdominal viscera in the older animals may bring the strain on the ventrally placed suture line.

Lacroix (1957) advocated the simple interrupted sutures to close the small hernial ring. Pettit (1960) closed a 3.75 cm long hernial ring with interrupted sutures using 3/0 chromic catgut in a dog. He used horizontal mattress sutures for the closure of the skin incision. O'Connor (1965) recommended use of interrupted sutures for the closure of the ring in umbilical hernia.

Seetharam Singh (1971) repaired an umbilical hernia in a baby elephant with the help of interrupted sutures.

Heinze (1970) advocated the overlapping suture technique for the closure of the hernial ring in
bovines. Johnson (1970) performed umbilical herniorrhaphy in foals by adopting Mayo's overlapping mattress sutures with the help of double strand chromic catgut.

Philip (1970) observed that the overlapping body wall technique was the suitable method for correction of umbilical herniae.

Lakshmipathy (1975) reported three cases of successful repair of bovine ventral hernia using overlapping suture technique.

Sharma et al (1976) evaluated 'vest-over-pant' technique and 'nylon prosthetic onlay hernioplasty' for correction of umbilical hernia in bovines. They opined that in the 'vest-over-pant' technique the strength and holding power was greatly enhanced at the site of repair and mechanical force was markedly diffused, minimising secondary complication.

Berge and Westheues (1965) recommended a figure-of-eight silk suture technique to repair the umbilical hernia.

Rao (1966) used Danish double eight knot suture technique for closure of abdominal wound.
Pantsoma (1954) described a method for repair of umbilical, ventral, and traumatic hernias in cattle, by implanting plastic mesh in between the peritoneum and muscle. He sutured a second fold of skin over the skin suture to protect it and to prevent exudation.

Usher (1958) was the first to do pioneering work with marlex mesh which gave it the name 'Usher's marlex mesh'. Usher (1959, 1961, 1962 and 1963) used woven and knitted varieties of marlex mesh as onlay, inlay and in the sandwich fashion in experimental and clinical cases of hernias. He opined that knitted variety was better than the woven due to its two-way stretch and easy sterilization.

Koontz and Kimberly (1960) employed marlex mesh and tantalum gauze in experimental and clinical cases of hernias. They observed that the marlex mesh was inferior to tantalum gauze, since the tissue produced was inferior in quality.

Adler (1962) preferred onlay graft technique using nylon and merselene to the inlay graft using marlex mesh, since the latter method was found
cumbersome and time consuming.

Jacobs et al. (1965) recommended the sandwich method of suturing marlex mesh for repair of large hernia.

Philip (1973) reported successful surgical treatment of two cases of umbilical herniae in pigs and a case of ventral hernia in cow by using marlex mesh.
MATERIAL AND METHODS

Umbilical herniorrhaphy was carried out in 16 clinical cases, at Aarey Milk Colony, Goregaon, which comprised of 16 cow calves (4 male and 12 female calves). These animals were 7 to 18 months of age and weighed 35 to 200 kg (Appendix-II).

Instruments:-

Routine laparotomy instruments were utilized. The vernier caliper was used for measuring thickness, size of the ring and a steel ruler was used to measure the dimensions of the larger ring. The black braided nylon* size 4 was used as suturing material and stainless steel mesh** was utilized for reinforcement of hernial ring.

All the instruments were autoclaved at 15 lb pressure for 20 minutes along with drapes and mops. Cutting instruments were sterilised by immersing in 3% Polysan*** for three hours, were subsequently washed with sterile

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Black braided nylon* Size 4 i- (Johnson & Johnson) Non absorbable surgical suture U.S.P.

Stainless steel mesh**: (H. Mukerji & Banerjee Surgical Pvt. Ltd.)
6" x 12", 50 x50 mesh of stainless steel wire 0.003" in diameter.

Polysan***: (Polypharm Pvt. Ltd.) Iodophor containing 'Tamed Iodine'.

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physiological solution and were kept in sterile tray.

**Preparation of animal:**

Weight of the animal was recorded. Food was withheld for 24 hours before surgery and water for 12 hours.

Each animal was premedicated with Siquil* at the rate of 0.5 mg per kg body weight intramuscularly 30 minutes prior to casting.

**Positioning of Animal:**

Animal was cast in lateral recumbancy and was raised with the help of thin bail of hay underneath the shoulder and thigh, so that operation site was raised towards median plane.

**Preparation of site:**

A sufficient area over and around the hernial sac was shaved, scrubbed with soap water, washed, dried with sterile mops, draped and finally smeared with Tr. Iodine 2%.

**Anaesthesia:**

Local infiltration with 20 to 30 ml of Xylocaine** 2% with adrenaline was carried out.

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*Siquil*:- (Sarabhai Chemicals) Triflupromazine hydrochloride 20 mg/ml.

*Xylocaine** 2%:- (Suhrd Geigy) Lignocaine hydrochloride with adrenaline 1:80,000.
Surgical methods:

Following four surgical methods were used.

Method I  Simple interrupted suture method
Method II  Tissue overlapping suture method
Method III  'Eight knot' suture method
Method IV  Reinforcement by stainless steel mesh.

The selected animals were divided into four groups, each consisting of four. The grouping was done according to the size and thickness of the ring. The methods for repair mentioned earlier were employed, one on each group of these animals (Appendix-II).

Simple interrupted suture method:

An elliptical skin incision was given over the hernial sac in heifers, while in males 'V' shape incision was made so that preputial orifice was not disturbed. Adhesiectomy was carried out so as to expose the hernial ring. Size and thickness of edges of the ring were measured with the help of vernier caliper. The hernial contents together with parietal peritoneum were returned to the abdominal cavity and ring edges were freshened. Maximum care was taken not to include peritoneum in suture line by introducing the index finger
of the left hand underneath the hernial ring. A series of interrupted sutures were used to close the hernial ring, with the help of black braided nylon size four. The skin incision was closed with vertical mattress sutures using same suture material.

**Tissue overlapping suture method**

After exposing the hernial ring and ascertaining its size and thickness, closure was effected by overlapping method as described by Bullard (1965). First the needle was passed inside through the entire wall. It was carried outside within the ring and entered into the opposite wall from the outside. It then was carried half centimeter parallel to the ring edge and inside the wall. The needle then was passed through the wall to emerge outside. Next, it was crossed to the original side and introduced inside the wall. It was directed outside opposite the point of original penetration. When these sutures were properly tightened and tied, the edges of the ring overlapped. Additional interrupted sutures, placed along the edges of the flap, secured it to the subcutaneous tissue. This reinforced the area considerably. The skin incision was closed with
vertical mattress sutures.

\textit{'Eight knot' suture method:-}

The skin incision, exposure of the ring, adhesiotosy and measurements of the ring size, thickness were recorded as in method one.

A needle threaded with black braided nylon was inserted through the skin at a distance of 1 cm from the skin edge, on second side was passed through the edge of the hernial ring from outside, next was passed through the first side of the hernial ring from inside and finally was brought out through the skin of the opposite side. Series of such sutures were applied throughout the length of the ring. On completion, all the ends of sutures were drawn out in order to bring into opposition edges of the hernial ring, skin and finally ends were tied with surgical knot.

\textbf{Reinforcement by stainless steel mesh:-}

This technique was used where hernial ring was too large and other methods were not practicable. After reduction of hernial contents, a stainless steel mesh of a suitable size was placed over the hernial ring and was anchored with simple interrupted sutures along
periphery in the fashion of onlay grafting. The mesh was covered with subcutaneous tissue using continuous suture. The skin incision was closed by vertical mattress sutures.

Post-operative treatment:

The animals were given less quantity of feed for first two days so as to avoid strain on suture line. The normal feeding was continued from third day onwards.

Dicrysticin* was administered parenterally for 5 days. The wound was dressed with Terramycin** and Beparine*** ointment, till it healed and was covered by specially devised rubber supportive square bandage. The cutaneous sutures were removed on 14th day. Weight of the animal was also recorded one month postoperatively and there the animals were observed for period of 6 months.

Following observations were made during the observation period:

1. Time required for complete healing
2. Postoperative complications if any
3. Weight of animal
4. Recurrence of hernia, if any.

Dicrysticin-S*: (Sarabhai Chemicals)
Streptomycin sulphate 2.5 gm
Procaine Penicillin G-15,000,000 units and Penicillin G Sodium 500,000 units

Terramycin ointment**: (Pfizer)
Oxytetracycline hydrochloride.

Beparine***: (Biological Evans)
Heparin I.P.-50 I.U., Benzyl Nicotinate-3 mg.
Histological study:

For histological study one she buffalo was utilized. The experimental herniorrhaphy with the help of stainless steel mesh was carried out as described earlier. The said animal was euthanised on 14th day and tissue along with mesh was collected for histological study.
Survey of 2065 cross bred calves revealed the incidence of umbilical hernia as 2.65%. This incidence is considered to be quite alarming. Wright (1951) observed increased incidence of umbilical hernia in Friesian and Ayrshire breeds of cattle. In the present study the affected calves were crosses of Jersey and Holstein breeds.

As reported by the veterinarians in Aarey Milk Colony, affected calves exhibited poor growth rate and weight gain. It is therefore necessary to undertake corrective measures in such cases. In the present study four surgical methods were tried to repair the umbilical hernia.

Fasting of animals for 24 hours and withholding water for 12 hours before surgery reduced the intra-abdominal pressure which ultimately eased the repair of umbilical hernia.

The positioning of the animal with the help of thin hay bails was an added advantage, because with
this position the hernial contents fell back into the abdominal cavity. Secondly, the operative site was raised to a convenient plane for the surgeon. Most of the workers preferred dorsal recumbancy (Shuttleworth and Smythe 1960, Keown, 1974 and Sharma et al. 1976) but in the present study the positioning described earlier was equally convenient to the dorsal recumbancy.

In all the cases, satisfactory analgesia of the surgical site was obtained by infiltration anaesthesia coupled with sedation.

The surgical treatment was designed after the exposure of the hernial ring. In selecting the methods, the size and thickness of the ring was considered. Shuttleworth and Smythe (1960) have also made similar recommendation. In the method I, three male calves and one female calf was utilised (Case Nos. KJ 553, 1799, 4703 and 46cm04). To overcome the difficulty in exposing the hernial ring in male calves a 'V' shaped incision was planned. Eventhough Frank (1964) has suggested a 'U' shaped incision the 'V' shaped incision was more practicable considering the slackness of the subcutaneous tissue at the site. The size of the ring was 3.84 to 5.75 cm lengthwise, 1.27 to 2.52 cm breadthwise and
thickness varied from 0.19 to 0.27 cm. These rings could be easily closed with 2 to 5 simple interrupted sutures. The closure of the ring was perfect with minimum tension on suture line. Lacroix (1957) advocated the simple interrupted sutures to close the small hernial ring. Pettit (1960) closed 3.75 cm long hernial ring with interrupted sutures. O'Connor (1965) also advocated simple interrupted sutures to close small hernia ring.

In male calves, inflammatory oedema was observed for first three days and for two days in the female calf, which disappeared with postoperative treatment. In the female calf healing took 17 days while male calves took 21 days.

In the method II, four female calves were utilised (Case Nos. 1707, 4587, 4618 and 4691). After exposing it was found that the hernial ring was longer in length (6.75 to 8.57 cm lengthwise, 2.35 to 3.45 cm breadthwise) than in method I. So also the edges of the ring were comparatively thin (0.35 to 0.39 cm), pliable and could be easily overlapped. It was therefore decided to overlap
the tissue to give additional support to the suture line.

Inflammatory oedema was present for first three days which disappeared with postoperative treatment. Healing took place in 19 days without any complications. A thick fibrosed band could be palpated at the surgical site. Heinze (1970) and Philip (1970) advocated this method for repair of such type of hernia.

One male and three female calves were subjected to method III (Case Nos. 78cu04, 1430, 1750 and 4604). The size of the ring was 5.83 to 6.72 cm lengthwise, 2.62 to 3.21 cm breadthwise and thickness varied from 0.28 to 0.33 cm. In this method both ring and skin incision could be closed in single suture line. However, in order to bring perfect apposition of all layers, individual knotting was not possible.

In this method the inflammatory oedema was much more prominent than in other methods and lasted for three days in females and five days in the male calf. In male calf the suture line used to get soiled with urine and
dung, which in turn resulted in delayed healing. In female calves healing was complete in 22 days while in the male calf, it required 30 days.

In the method IV, 4 female calves (Case Nos. 3224, 5625, 6600 and 9118) were utilized for reinforcement with stainless steel mesh. In these cases the ring size was 8.85 to 17.72 cm lengthwise, 4.75 to 11.75 cm breadthwise. Because of the oblong size and thickness of the hernial ring (0.42 to 0.63 cm), it was difficult to be closed by apposition. Reinforcement of the ring by stainless steel mesh was therefore undertaken. Keown (1974) recommended use of prosthetic mesh in such cases. In the above four cases the stainless steel mesh was implanted by an onlay graft method. The suture pattern which was adopted to anchor the mesh, held at taut in its position. In this method also, marked oedema was present for five days. The healing took 33 days.

In female animals, an elliptical incision over the hernial sac provided an easy approach to the hernial ring, whereas in male animals it was required to give a 'V' shaped incision so as to prevent inclusion of preputial orifice into the surgical wound. It was also easier in the former to
place a protective bandage over the wound but in
the latter this could not be done due to close vicinity
of the prepuce. In male calves the healing was delayed
because of soiling of the wound for want of a
protective bandage.

Simple interrupted suture method was found to
be simple, time saving and quite suitable to close
small sized hernial rings as suggested by Shuttleworth
and Smythe 1960. It required little skill to master
the technique.

It is felt that overlapping suture method can
be useful in those cases where the ring is longer with
thin and pliable edges. However, this technique requires
some skill to get acquainted with its finer aspects and
hence it may not be useful to the field veterinarians.
Sharma et al. (1976) evaluated the 'vest-over-pant'
technique and 'nylon prosthetic onlay grafting'
technique. They opined that in the 'vest-over plant'
technique the strength and holding power was greatly
enhanced at the seat of repair and mechanical force was
markedly diffused, minimising complications.
In the 'Eight knot' suture method, the suture pattern was concised. Thus the surgical wound upto the depth of the ring was closed by a single line of suture and in turn saved the time. However, it was necessary to tie all the knots at the end, so as to bring all the layers in proper apposition especially at the corners. It is also likely that if any of these sutures breaks away dehiscence of all the layers may result leading to delayed recovery. The average healing time 22 days in female calves and 30 days in male calves and was much more than the other two methods. However, it was felt that this method has not given any advantage over the interrupted or overlapping suture techniques, eventhough Berge and Westhues (1965) suggested it as an alternative to routine suture techniques.

For the reinforcement of the hernial ring, the stainless steel mesh was utilized. Most of the surgeons ( Usher 1958, 1959, 1961, 1962 and 1963, Koontz and Kimberly 1960, Jacob et al, 1965 and Philip 1973 ) have used marlex mesh successfully with minimal tissue reaction for repair of umbilical hernia. It was felt that the utility of the stainless steel mesh which is easily available in open market should be ascertained. It was
found that stainless steel mesh was equally accepted with minimal tissue reaction and was convenient to be used as onlay graft. It is recommended to use stainless steel mesh for the cases where the ring edges cannot be apposed or overlapped.

Experimental herniorrhaphy was carried out with reinforcement by stainless steel mesh. The material collected from the site was subjected to histological study to find out the acceptance of material by the body tissue. On examination, it was revealed that thick fibrous layer, gelatinous on one side was seen to have enclosed the mesh. Histologically the fibrous mass was noted to be a mature granulation tissue with fibroblasts in the process of collagen formation. The capillaries were moderate in numbers indicating the reduced proliferation. The gelatinous layer was a similar granulation tissue but oedematous in nature. The inflammatory cellular reaction was mild and restricted to certain foci, was comprised of histiocytes and a few lymphocytes.
In the present study the black braided nylon was used as buried suture material for repair of umbilical herniae. It was found to be efficient and did not produce any untoward tissue reaction.

The specially devised rubber bandage helped to protect the ventral abdominal wound from soiling especially with urine and dung. This in turn brought about normal healing. In male calves it was difficult to use the rubber bandage, soiling of the wound was therefore observed, which delayed wound healing.
SUMMARY AND CONCLUSION

The incidence of umbilical hernia was observed to be 2.65% in 2065 calves that were examined at Aarey Milk Colony and Bombay Gaurakshak Mandal, Kandivali. Sixteen calves having umbilical hernia were treated by four surgical methods namely simple interrupted suture method, tissue overlapping suture method, 'Eight knot' suture method and reinforcement by stainless steel mesh.

Simple interrupted suture method was used in umbilical herniae with smaller ring size (3.84 to 5.75 cm lengthwise). The said method was found to be simple, time saving and requiring little surgical skill.

The tissue overlapping suture method was found to be useful in medium sized rings (5.75 to 8.57 cm lengthwise) having thin and pliable edges. This method required more skill than the previous method.

Eventhough the 'Eight knot' suture method was found less time consuming, it did not have any added
advantages over the above two methods.

Reinforcement with stainless steel mesh was successfully used in larger sized rings (8.85 to 17.72 cm lengthwise). It is recommended that where other simpler methods cannot be utilised, this method may be adopted in such cases.

The black braided nylon was used as buried suture material for repair of umbilical herniae. It was found to be efficient and did not produce any untoward tissue reaction.
## Incidence of umbilical hernia on various farms

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name of the farm</th>
<th>No. of calves on the farm</th>
<th>No. of affected calves</th>
<th>Percentage of affected calves</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Aarey Milk Colony (Unit 4)</td>
<td>280</td>
<td>8</td>
<td>2.85</td>
</tr>
<tr>
<td>2</td>
<td>Do</td>
<td>339</td>
<td>5</td>
<td>1.47</td>
</tr>
<tr>
<td>3</td>
<td>Do</td>
<td>592</td>
<td>12</td>
<td>2.05</td>
</tr>
<tr>
<td>4</td>
<td>Do</td>
<td>650</td>
<td>15</td>
<td>2.30</td>
</tr>
<tr>
<td>5</td>
<td>Kakanal Dairy Development Corporation</td>
<td>79</td>
<td>3</td>
<td>3.70</td>
</tr>
<tr>
<td>6</td>
<td>Bombay Cowrareshk Mandali, Kandivali</td>
<td>105</td>
<td>4</td>
<td>3.80</td>
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## APPENDIX-II

**Treatment of cases of umbilical hernia and its results**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Case No.</th>
<th>Weight (kg)</th>
<th>Breed</th>
<th>Sex</th>
<th>Age (months)</th>
<th>Size of the ring (cm) LxB</th>
<th>Thickness of the ring (cm)</th>
<th>Methods</th>
<th>Healing time (days)</th>
<th>Name of the farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4703</td>
<td>35</td>
<td>HF X</td>
<td>M</td>
<td>7</td>
<td>5.23 x 2.52</td>
<td>0.25</td>
<td>simple interrupted</td>
<td>21</td>
<td>Aarey Milk Colony Unit 6</td>
</tr>
<tr>
<td>2</td>
<td>1799</td>
<td>45</td>
<td>J X</td>
<td>M</td>
<td>7</td>
<td>3.84 x 1.27</td>
<td>0.19</td>
<td>--do--</td>
<td>18</td>
<td>--do-- Unit 4</td>
</tr>
<tr>
<td>3</td>
<td>KJ555</td>
<td>98</td>
<td>J X</td>
<td>M</td>
<td>8</td>
<td>5.75 x 2.25</td>
<td>0.27</td>
<td>--do--</td>
<td>23</td>
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<tr>
<td>4</td>
<td>46cu04</td>
<td>47</td>
<td>J X</td>
<td>F</td>
<td>7</td>
<td>4.75 x 2.31</td>
<td>0.22</td>
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<td>17</td>
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<tr>
<td>5</td>
<td>1707</td>
<td>89</td>
<td>HF X</td>
<td>F</td>
<td>11</td>
<td>7.52 x 3.21</td>
<td>0.36</td>
<td>tissue overlapping</td>
<td>21</td>
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</tr>
<tr>
<td>6</td>
<td>4691</td>
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<td>HF X</td>
<td>F</td>
<td>10</td>
<td>6.75 x 2.35</td>
<td>0.37</td>
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<td>16</td>
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<tr>
<td>7</td>
<td>4618</td>
<td>82</td>
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<td>F</td>
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<td>8.32 x 3.41</td>
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<td>8</td>
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<td>F</td>
<td>10</td>
<td>8.57 x 3.45</td>
<td>0.39</td>
<td>--do--</td>
<td>19</td>
<td>--do-- Unit 6</td>
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*contd.*
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<th>Sr. Case No.</th>
<th>Weight kg</th>
<th>Breed</th>
<th>Sex</th>
<th>Age months</th>
<th>Size of the ring cm</th>
<th>Thickness of the ring cm</th>
<th>Methods</th>
<th>Healing time days</th>
<th>Name of the farm</th>
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<td>9</td>
<td>4604</td>
<td>J X</td>
<td>F</td>
<td>9</td>
<td>5.95 x 2.73</td>
<td>0.28</td>
<td>'Eight knot'</td>
<td>20</td>
<td>Aarey Milk Colony Unit 6</td>
</tr>
<tr>
<td>10</td>
<td>1430</td>
<td>J X</td>
<td>F</td>
<td>8</td>
<td>6.53 x 3.21</td>
<td>0.33</td>
<td>--do--</td>
<td>22</td>
<td>--do--</td>
</tr>
<tr>
<td>11</td>
<td>1730</td>
<td>HF</td>
<td>F</td>
<td>9</td>
<td>6.72 x 2.95</td>
<td>0.31</td>
<td>--do--</td>
<td>30</td>
<td>Unit 6</td>
</tr>
<tr>
<td>12</td>
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<td>HF</td>
<td>F</td>
<td>8</td>
<td>5.83 x 2.62</td>
<td>0.29</td>
<td>--do--</td>
<td>25</td>
<td>--do--</td>
</tr>
<tr>
<td>13</td>
<td>3224</td>
<td>HF</td>
<td>F</td>
<td>13</td>
<td>8.85 x 4.75</td>
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<td>Reinforcement</td>
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<td>14</td>
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<td>HF</td>
<td>F</td>
<td>16</td>
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<tr>
<td>15</td>
<td>5625</td>
<td>J X</td>
<td>F</td>
<td>18</td>
<td>17.72 x11.75</td>
<td>0.63</td>
<td>--do--</td>
<td>37</td>
<td>--do--</td>
</tr>
<tr>
<td>16</td>
<td>9118</td>
<td>J X</td>
<td>F</td>
<td>14</td>
<td>11.36 x 8.82</td>
<td>0.55</td>
<td>--do--</td>
<td>34</td>
<td>--do--</td>
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HF X = Holstein Friesian Cross Breed, J X = Jersey Cross Breed L = Length, B = Breadth
APPENDIX - III

Record of weights of the calves during study

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<th>Sr. No.</th>
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<th>Weight (kg)</th>
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<td>16 9118</td>
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Fig. 1 - Umbilical hernia in female calf

Fig. II - Umbilical hernia in male calf and deviation of sheath
Fig. III- Infiltration Anaesthesia

Fig. IV- Assessment of thickness of the ring with fingers
Fig.V- Placing of simple interrupted sutures

Fig.VI- Overlapping sutures
Fig. VII- 'Eight knot' sutures

Fig. VIII- 'V' shaped skin incision in male calves
Fig. IX - Transfixation of stainless steel mesh over the ring

Fig. X - Skin incision closed by vertical mattress sutures
Fig. XI- Protective rubber bandage in position in a cow

Fig. XII- Gross appearance of the mesh after 14 days. The mesh is seen covered by fibrous tissue on either side
Fig. XIII- Showing the mature granulation tissue (left) and oedematous granulation tissue (right) around the stainless steel mesh (represented by clear spaces in the centre) X 125.

Fig. XIV- Showing granulation tissue with focal leucocytic infiltration (right centre) X 125.