CRANIOPLASTY FOR REPAIR OF CRANIOSCHISIS ASSOCIATED WITH MENINGOCELE IN A JERSEY CALF

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ABSTRACT

Cranioschisis with meningocele at the parietal region was diagnosed in a 2-day-old calf. At presentation the animal was standing, attentive and had normal suckling reflex. However, an ovoid, soft, slightly lateral, bladder-like mass was observed extending from the intercornual protuberance to the insertion of the nuchal ligament. Physical examination and radiographs evidenced a deformity of the parietal bone and cranioplasty using a cartilage homograft was performed in an attempt to correct the bone defect. The calf did well postoperatively until day nine. However apathy and seizures were present from day 13 leading to death on day 15.

Keywords: skull defects, cattle, skull repair, cranioschisis, *Cranium bifidum*, cartilage homograft.

CRANIOPLASTIA PARA O TRATAMENTO DE CRANIOSQUISE ASSOCIADA À MENINGOCELE EM UMA BEZERRA DA RAÇA JERSEY

RESUMO

Foi diagnosticado craniosquise com meningocele na região parietal de uma bezerra de dois dias de idade. Na abordagem clínica inicial o animal estava em estação, atento e mamando normalmente. Porém, foi detectada à palpação uma massa ovoide, macia e levemente lateral, estendendo-se desde a protuberância intercornual até a inserção do ligamento da nuca. O exame físico e as radiografias evidenciaram um defeito do osso parietal pelo que foi realizada cranioplastia utilizando um enxerto homólogo de cartilagem na tentativa de corrigir a falha óssea. O animal teve evolução pós-operatória favorável até o dia nove. Entretanto, apresentou apatia e convulsões a partir do dia 13, o que o levou a óbito no dia 15 após a cirurgia.

Palavras-chave: defeitos do crânio, gado, reparação do crânio, *Cranium bifidum*, enxerto homólogo de cartilagem.

CRANEOPLASTIA PARA EL TRATAMIENTO DE CRANEOSQUISIS ASOCIADA A MENINGOCELE EN UNA BECERRA DE LA RAZA JERSEY

RESUMEN

Fue diagnosticada craneosquisis con meningocele en la región parietal de una becerra de dos días de edad. Durante el abordaje clínico el animal se encontraba en cuadripedestación, atento

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y mamando normalmente. Sin embargo, se detectó una masa ovalada, de consistencia suave y lateralizada, que se extendía desde la protuberancia intercornual hasta la inserción del ligamento nucal. El examen físico y las radiografías permitieron la identificación de una falla en el hueso parietal por lo que fue realizada la craneoplastía utilizando un injerto homólogo de cartílago con la finalidad de corregir el defecto. El animal evolucionó favorablemente hasta el noveno día. Sin embargo, a partir del día 13 presentó apatía y convulsiones lo que provocó su muerte 15 días después de la cirugía.

Palabras clave: defectos craneanos, ganado, reparación del cráneo, *Cranium bifidum*, injerto homólogo de cartílago.

INTRODUCTION

Congenital anomalies of the central nervous system are common in cattle (1). Meningocele has been described as the third most frequent bovine inherited defect (2) and is characterized by imperfect closing of the neural tube with meningeal protrusion through a defect in the cranium (cranioschisis or otherwise *cranium bifidum*), forming a skin-covered hernial sac full of cerebral spinal fluid (3).

Cranioplasty using homografts has been performed in large skull defects in humans (4) and animals (5, 6). Different graft types are available for cranioplasty, including cartilage (7-9), bone (6), muscle fascia (10), acrylic (11), and metals (4, 5, 12). Cartilage grafts have been used to efficiently repair skull defects in mice (8) and humans (7, 9).

CASE PRESENTATION

A 2-day-old female Jersey calf weighing 34 kg was admitted due to a fluid-filled swelling at the mid-parietal region with no other physical or behavioral abnormalities. Pedigree analysis of the patient revealed no inbreeding within four generations. The ***herd was seronegative for brucella and*** vaccinated ***on a regular basis*** against ***infectious bovine rhinotracheitis, bovine viral diarrhea virus, leptospirosis and brucellosis.***

At admission the calf was standing, attentive, and suckling normally. Signs of pain, distress, or neurological abnormalities were not detected on physical examination and physiological parameters were within normal limits. Inspection of the head evidenced a soft, slightly lateral, bladder-like mass 13 x 10 x 6 cm, extending from the intercornual protuberance to the insertion of the nuchal ligament (Figure 1) emerging from a defect in the parietal bone which was evident on palpation.

Figure 1. (A) 2-day-old calf diagnosed with cranioschisis. (B) Skull swelling.

Survey and contrast radiographs revealed parietal and supraoccipital bone dysplasia, absence of the interparietal bones, and liquid in the mass (Figure 2). Cranioschisis associated with meningocele was diagnosed and cranioplasty using a cartilage homograft from an auricular pinna was chosen for treatment. The graft was in stock at the hospital and was prepared with modifications using a previous technique (13). Briefly, ears were harvested from adult cattle at the slaughterhouse and rinsed with running water. Then, skin was removed using a No. 24 surgical blade and the pinna (mean thickness 0.5 cm) cut (approximately 10 x 10 cm) using sterile surgical instruments followed by drying with sterile cotton compresses. Then, flaps were placed into sealed sterile plates containing 98% sterile glycerin (Vetec Química Fina Ltda, Duque de Caxias, RJ, Brazil) at room temperature and stocked for a period of 30 to 250 days and not exceeding. Twenty-four hours before surgery, a flap was placed in povidone-iodine (Marcodine®, Innovatec Cristália, Itapira, SP, Brazil) diluted into 0.9% saline (Laboratório Sanobiol Ltda, Pouso Alegre, MG, Brazil) (1:50) (14).

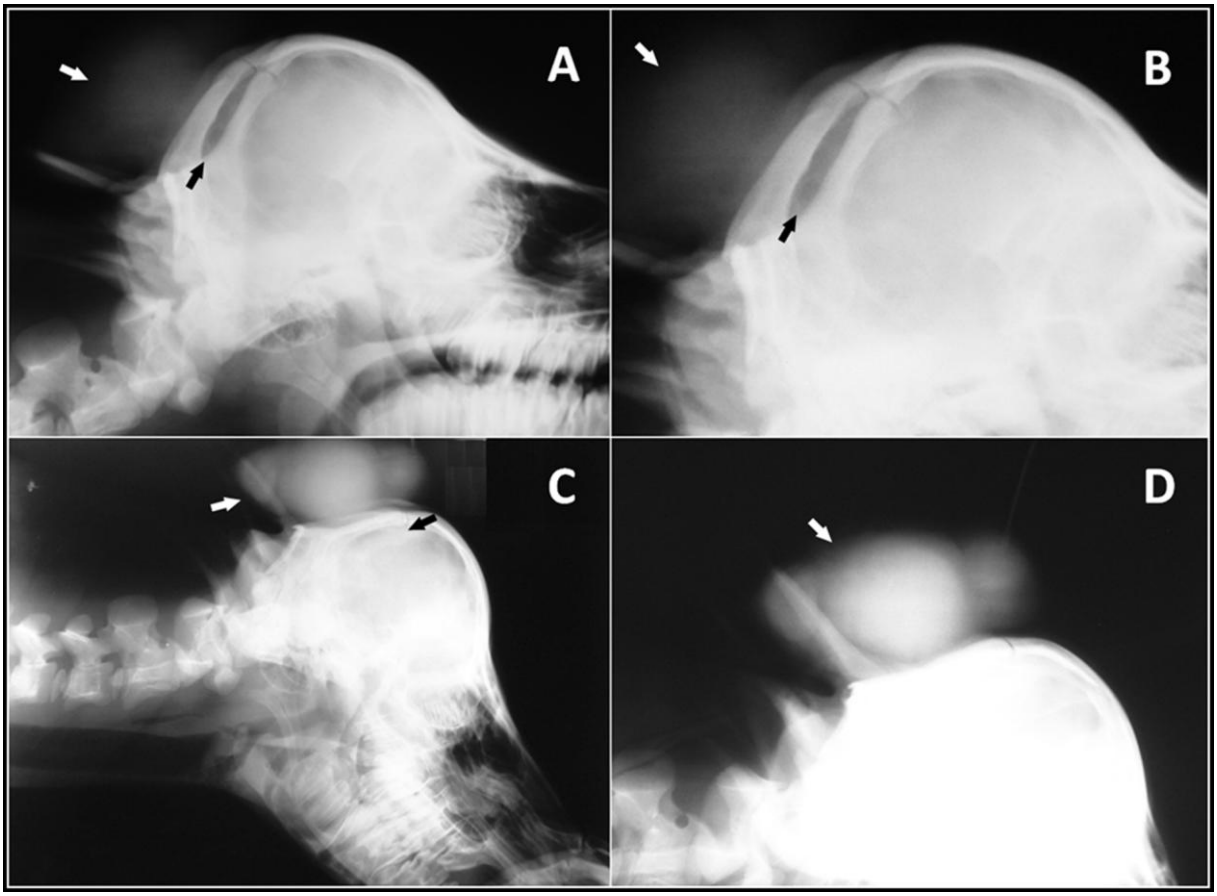

Figure 2. Survey (A and B) and contrast (C and D) radiographs, showing the cranial defect (black arrows) and the hernial sac (white arrows).

The calf was sedated with ***xylazine*** hydrochloride (0.05 mg/kg IV; Rompun®, Bayer, São Paulo, SP, Brazil) and positioned in sternal recumbency with the head lying on a support. Then, intravenous propophol (3.0 mg/kg IV; PropoFlo™, Abbott, Libertyville, IL, USA) was used for intubation, followed by inhalatory anesthesia with halothane and oxygen. The skin was thoroughly clipped and antiseptically prepared. The subarachnoid space was exposed through a rostrocaudal incision of skin and *dura mater*, and approximately 200 mL of cerebral spinal fluid (confirmed through laboratorial analysis) were drained out, evidencing a bone gap of five centimeter in diameter at the interparietal region. The cerebral hemispheres and cerebellum were also visible but no macroscopic morphological changes were observed on

these structures (Figure 3). The *dura mater* was sutured using chromated catgut (Shalon Fios Cirúrgicos, São Luis de Montes Belos, GO, Brazil), and the cartilage homograft (7 cm length and 0.5 cm thick) was juxtaposed to the bone defect followed by skin suture with 2-0 nylon (Shalon Fios Cirúrgicos, São Luis de Montes Belos, GO, Brazil) (Figure 3). Post-surgical therapy included ceftiofur (2.2 mg/kg IV once daily for 9 days; Topcef®, Eurofarma, São Paulo, SP, Brazil), dexametasone (0.2 mg/kg IV once daily for 3 days; Azium®, Shering-Plough, Cotia, SP, Brazil), flunixin meglumine (1.1 mg/kg IV twice daily for 3 days; Banamine® Shering-Plough, Cotia, SP, Brazil) and daily wound care. The animal nursed well postoperatively and its physiological parameters were within normal limits. However, by the owner's request, the calf was discharged on day nine. Further antibiotic therapy and daily wound care were advised for five more days along with housing in an individual pen until radiographic reassessment (i.e., four weeks after surgery). Unfortunately, six days after discharge the owner informed death of the calf. Necropsy was performed by one of the authors within two hours from demise. Although the homograft was almost intact, encephalitis and intracranial purulent discharge were observed. Owner's interview disclosed several handling anomalies including placing the calf together with other calves immediately after arrival to the farm and antibiotic administration in a random schedule. Apathy and seizures were the primary clinical signs after discharge and seemed to be present from day 13 after surgery until death on day 15.

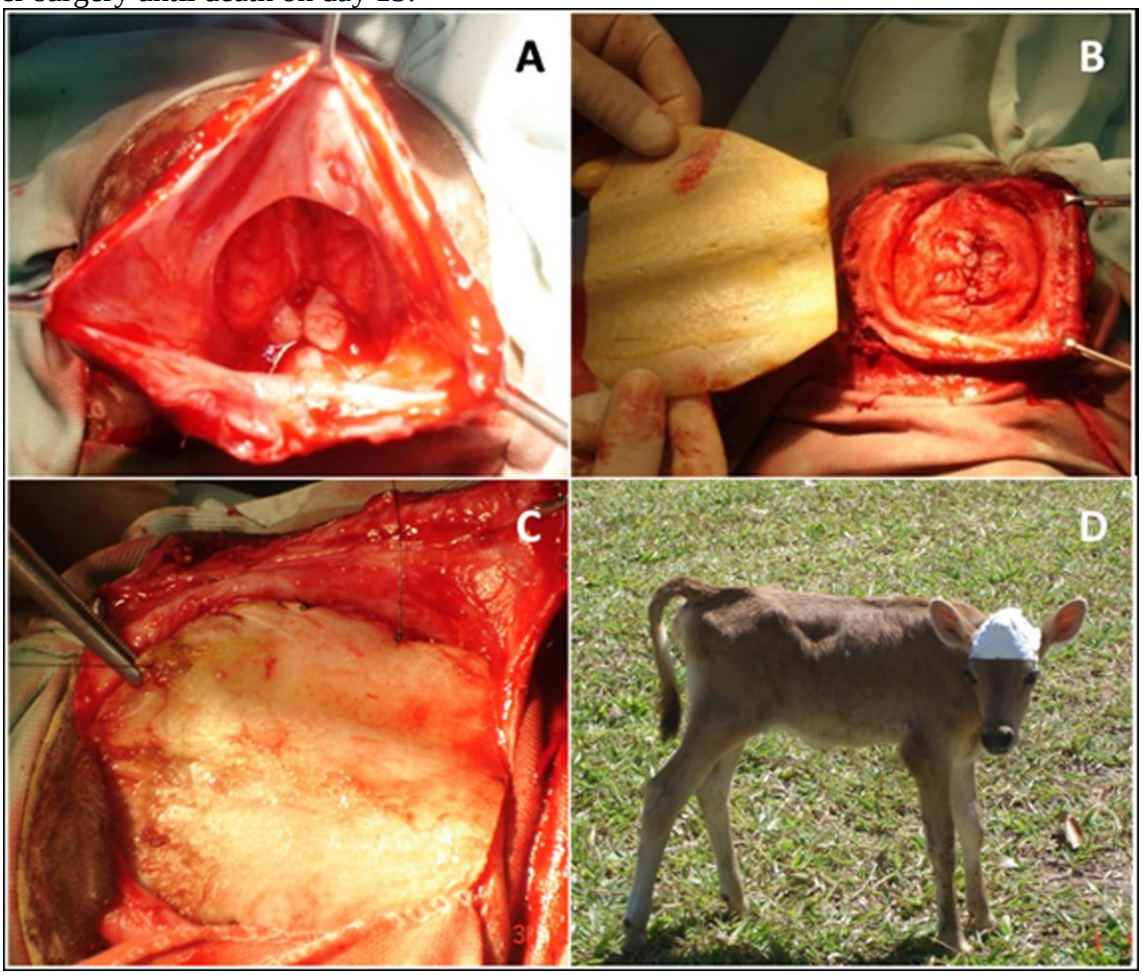

Figure 3. (A) Cranioschisis at the cranial interparietal region showing cerebral hemispheres and cerebellum without morphological changes. Cartilage homograft harvested from the auricular pinna before (B) and after (C) juxtaposition on the defect. (D) Animal standing 6 hours after surgery.

DISCUSSION AND CONCLUSIONS

The defect in the calf described herein was classified as an occipital meningocele based on a categorization system used for humans (15). A small number of reports on the surgical treatment of cranioschisis in cattle have been published (2, 16-19). Nevertheless, no grafts were used in those calves. Two of those cases (2, 16) reported small bone defects (i.e., $\leq$ 1.5 cm in diameter). Whilst the gaps' sizes were not informed in two of the previous cases, the surgical technique used allowed repairing those defects by either routine suturing the adjacent tissues (17) or suturing the bone edges and fascia (18). A previous case reported a slightly larger defect than in our patient (i.e., 6 cm in diameter) and surgery was performed by suturing the skin without complications and therefore obtaining good results (19). Even though, we decided to use a cartilage graft in an attempt of creating a new bone matrix. Our decision was justified by the previous observation of bone regeneration in both, palate cleft in dogs (14) and skull defects in mice (8) using a cartilage homologous-graft from auricular pinna conserved in 98% glycerin and cultured cartilage, respectively.

Although bone grafts are considered the gold standard to repair osseous defects, this kind of tissue exhibits shortcomings and complications such as limited bone retrieving sites and donor morbidity, algesia, and infection (20). Previous studies demonstrated that cartilage efficiently repairs bone defects in humans (7, 9) and mice, and is a suitable alternative material to substitute bone grafts (8). In addition, cartilage grafts were ready to be used at patient's admission in this case.

The presence of a single or, otherwise, multiple congenital defects has been associated with genetic and/or environmental factors (e.g., infection, toxic agents, fertilization techniques and management) (21, 22). Similar to other reports, it was not possible to determine the etiology of the abnormality in this case (21, 23, 24). However, involvement of infectious or toxic agents often considered as teratogenic (e.g., ***bovine viral diarrhea virus***, toxic plants, etc.) seemed very unlikely. Additionally, the absence of inbreeding within four generations in our case did not rule out a genetic defect as the underlying cause of the deformity. It is known that inbreeding has been traced in cases of multiple congenital defects in cattle arising dating back to seven generations (22).

Whilst congenital anomalies are in general easily recognized based on a comprehensive clinical approach (23), the use of imaging techniques, e.g., radiography, ultrasound, and computed tomography, may be essential for definitive diagnosis (10). Computed tomography is extremely useful to imaging skull defects in cattle (19); however, the use of this imaging technique on animal production is not common. As previously described (22, 23), survey and contrast radiographs were enough to diagnose both *cranium bifidum* and meningocele.

Cranioschisis may be life-threatening or cause only an aesthetic defect (25). Although surgery rate of success is highly variable from patient to patient (19, 23), repair of meningocele or meningoencephalocele must be considered in order to minimize complications along animal's life (10). A variety of techniques have been described to correct meningocele in cattle (16-19). We decided to attempt surgical correction to overcome the cranial defect. The cartilage homograft from the auricular pinna was chosen because it was large enough to cover the bony defect, easy to obtain, and readily available at the patient's presentation.

The patient was standing, attentive, and suckling after surgery. Although the recommended postoperative management included hospitalization until next radiographic evaluation (i.e., four weeks after surgery), the owner requested discharge at day nine due to cost-benefit considerations. For the same reason, we were disallowed to perform histopathological examination after necropsy, and so we could not search for any evidence of healing at the graft site. Surgical mismanagement seems unlikely to be the cause of bacterial

meningitis in this case, because of the animal was discharged suckling, with no signs of neurological distress and all of the physiological parameters within normal limits. Even though we do not have enough data to rule out any complication arising from both (1) post-discharge management and (2) graft rejection, the unfavorable outcome was presumably highly influenced by the lack of veterinary care at the farm and the above mentioned random schedule for antibiotic administration. Overall, we infer that the use of cartilage homograft represents an alternative to repair large skull defects in calves, provided that comprehensive care and long lasting follow up are performed.

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