

Surgical Management of Cranioschisis Associated with Presumptive Cranial Meningocele in a Korean Native Calf: A Case Report

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Abstract:

Cranial meningocele is a rare congenital neural tube defect characterized by protrusion of the meninges and cerebrospinal fluid through a defect in the cranial vault. A 3-day-old, 30-kg male Korean native calf was presented with a large congenital fluctuant swelling over the frontal region of the head. The calf remained in lateral recumbency and was unable to stand or ambulate independently, although the suckling reflex was preserved. Radiography revealed a large extracranial soft-tissue swelling, and ultrasonography demonstrated predominantly hypoechoic to anechoic fluid contents without definitive evidence of neural tissue. Based on the clinical and imaging findings, a presumptive diagnosis of cranial meningocele was made. Surgical treatment consisted of gradual drainage of hemorrhagic fluid, careful dissection and resection of the protruding extracranial sac and redundant tissues, followed by primary dural and soft-tissue closure. During surgical exploration, tissue grossly suspected to represent neural tissue was identified near the cranial defect, raising the possibility of meningoencephalocele; however, this could not be confirmed because computed tomography and histopathological examination were not performed. On the first postoperative day, the calf developed nystagmus and failed to resume voluntary feeding despite the absence of major local wound complications. The calf died on the second postoperative day. The severe neurological abnormalities present before surgery and the unfavorable postoperative outcome suggest that concurrent intracranial or developmental abnormalities may have been present. This case highlights the importance of thorough preoperative neurological assessment and, when feasible, cross-sectional imaging for accurate characterization, surgical planning, and prognostic evaluation of congenital cranial meningeal defects in calves.

Key Word: Calf; Cranial meningocele; Cranioschisis; Congenital anomaly; Meningoencephalocele; Neurological dysfunction; Surgery.

Date of Submission: 16-09-2026

Date of Acceptance: 29-09-2026

I. Introduction

Congenital defects in cattle are uncommon and may result from genetic, infectious, nutritional, toxic, or multifactorial influences during fetal development. Congenital defects in cattle may result from genetic, infectious, nutritional, toxic, or multifactorial influences during fetal development. Neurological congenital abnormalities, including meningocele and hydrocephalus, have been reported infrequently in cattle.(1, 2)

Cranial meningocele is a congenital neural tube defect characterized by herniation of the meninges and cerebrospinal fluid through a defect in the cranial vault. The condition is thought to originate from focal failure of neural tube closure during embryonic development, followed by incomplete formation of the surrounding cranial bones. Cranial defects have been reported most commonly in the frontal and occipital regions in calves and may present clinically as a fluctuant, skin-covered swelling of variable size.(2)

Cranial meningocele should be differentiated from meningoencephalocele, in which neural tissue is additionally contained within the extracranial sac. This distinction is clinically important because involvement of brain tissue may influence surgical planning and prognosis. Although radiography and ultrasonography can identify a cranial defect and characterize the fluid-filled swelling, computed tomography provides more precise evaluation of the osseous defect and intracranial or extracranial neural tissue involvement.(3, 4)

Surgical correction of cranial meningocele and related congenital cranial abnormalities has been described in calves, with outcomes ranging from uneventful recovery to postoperative neurological complications. Nevertheless, detailed reports describing the surgical management and postoperative outcome of large cranial meningoceles in calves remain limited.(4-7) Therefore, this report describes the clinical presentation, surgical management, and postoperative outcome of a 3-day-old Korean native calf with a large congenital frontal cranial defect associated with a presumptive meningocele.

II. Case Presentation

A 3-day-old, 30-kg male Korean native calf was presented with a large congenital swelling over the frontal region of the head. According to the owner, the swelling had been present since birth. At presentation, the calf remained in lateral recumbency and was unable to attain or maintain a standing position or ambulate independently, although the suckling reflex was preserved. However, the suckling reflex was present.

Physical examination revealed a large, skin-covered cystic swelling over the frontal region of the cranium. The swelling was soft and fluctuant on palpation, suggesting the presence of fluid within the sac. No other gross congenital abnormalities were identified during physical examination.

Radiographic examination of the skull demonstrated a large soft-tissue swelling over the frontal region without identifiable osseous structures within the mass. A distinct cranial defect could not be clearly delineated on radiographs. Ultrasonographic examination revealed predominantly hypoechoic to anechoic contents within the swelling, consistent with a fluid-filled cystic structure. No definitive neural tissue was identified within the sac on ultrasonography. Complete blood count revealed no clinically significant abnormalities.

Based on the congenital onset, frontal location, physical characteristics of the swelling, and diagnostic imaging findings consistent with a fluid-filled extracranial sac, a presumptive diagnosis of cranial meningocele was made. Surgical exploration with resection of the protruding extracranial sac and subsequent primary closure was elected.

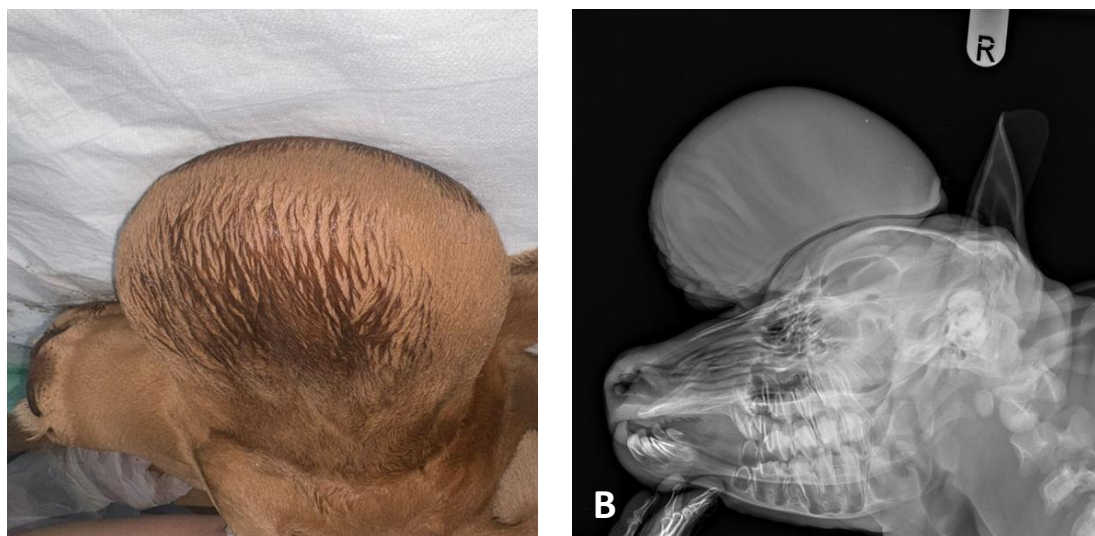


Figure 1. Preoperative gross and radiographic appearance of the congenital cranial lesion in a 3-day-old Korean native calf.

(A) Gross appearance showing a large, skin-covered, fluctuant swelling over the frontal region of the cranium. (B) Right lateral radiograph of the skull demonstrating a large, well-defined soft-tissue swelling overlying the frontal region. No identifiable osseous structures were observed within the swelling, and the underlying cranial defect could not be clearly delineated radiographically.

Anesthesia and surgical procedure

The calf was premedicated with xylazine (0.1 mg/kg, intramuscular), and prophylactic cefazolin (20 mg/kg, intravenous) was administered prior to surgery. Anesthesia was induced with ketamine (4 mg/kg, intravenous) and maintained with sevoflurane in oxygen under pressure-controlled ventilation. Physiological parameters, including heart rate, respiratory rate, oxygen saturation, and end-tidal carbon dioxide concentration, were monitored throughout anesthesia.

The calf was positioned in sternal recumbency, and the frontal region of the head was widely clipped and aseptically prepared with povidone-iodine. A large cystic swelling overlying the frontal region was identified, and the base of the sac and the underlying cranial defect were assessed by palpation. An elliptical skin incision was planned slightly peripheral to the base of the swelling, preserving sufficient normal skin for subsequent primary closure.

Following incision of the skin and subcutaneous tissues, hemorrhagic fluid within the extracranial sac was encountered and gradually drained to reduce tension within the cystic structure. The protruding sac and

redundant soft tissues were then carefully dissected from the surrounding tissues. During exploration of the sac and cranial defect, tissue grossly suspected to represent neural tissue was identified within the protruded region. Care was taken to avoid injury to the suspected neural tissue while the externally protruding sac wall and redundant skin and soft tissues were resected.

Hemorrhage encountered during dissection was controlled using electrocautery. Following resection, the surgical field and cranial defect were carefully inspected for active bleeding and persistent fluid leakage. The margins of the dural defect were apposed using 2-0 polydioxanone in a simple continuous pattern. No gross fluid leakage was observed following dural closure. The subcutaneous tissues were subsequently closed to minimize dead space, followed by primary skin closure with nylon in a simple interrupted pattern. After closure, the surgical site was examined for residual dead space, excessive skin tension, hemorrhage, and fluid leakage, with no remarkable abnormalities identified. The incision was disinfected with povidone-iodine and covered with a sterile dressing.

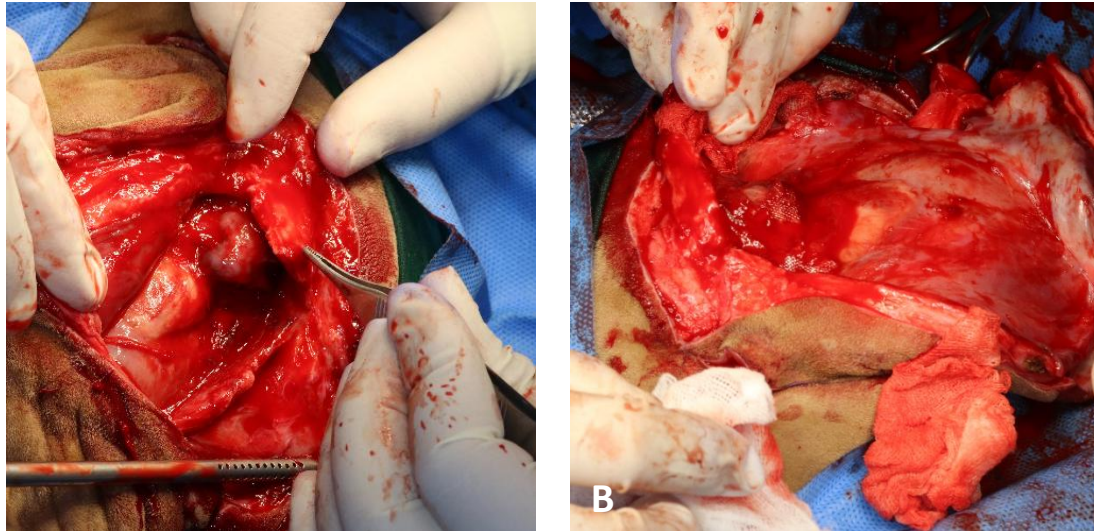


Figure 2. Intraoperative appearance of the congenital cranial defect.

(A) Intraoperative view following incision and dissection at the base of the cranial mass, demonstrating a large osseous defect with absence of normal calvarial bone over the lesion. **(B)** Appearance immediately before wound closure after resection of the protruding sac and redundant soft tissues. The extensive cranial defect and absence of osseous coverage remained clearly visible.

Postoperative care and outcome

On the first postoperative day, nystagmus was observed, and the calf did not resume voluntary feeding. Minimal exudate was observed from the surgical site, and the incision remained grossly clean without evidence of marked discharge. The surgical wound was dressed twice daily. Despite the absence of notable local wound complications, the calf died on the second postoperative day.

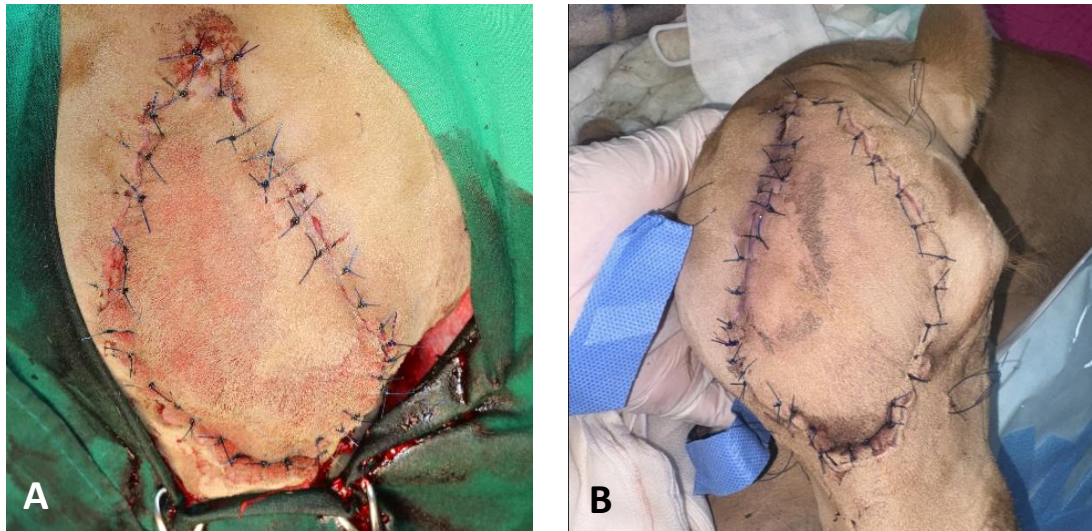


Figure 3. Postoperative appearance of the surgical site following resection of the congenital cranial lesion. (A) Immediate postoperative appearance following resection of the protruding sac and primary skin closure with simple interrupted sutures. (B) Appearance of the surgical site on the first postoperative day. The incision remained well apposed without marked wound dehiscence or discharge.

III. Discussion

Cranial meningocele is a congenital neural tube defect characterized by protrusion of the meninges and cerebrospinal fluid through a defect in the cranial vault. Cranioschisis, also referred to as cranium bifidum, results from incomplete development of the cranial bones and may permit secondary herniation of the meninges, with or without neural tissue. In cattle, these lesions are most commonly reported in the frontal or parietal regions and generally present shortly after birth as a fluctuant, skin-covered swelling of variable size.(2, 7, 8) Kisipan et al. suggested that the primary developmental abnormality involves focal failure of neural tube closure, followed by defective formation of the surrounding cranial structures.(2) Boscarato et al. similarly described cranioschisis as incomplete closure of the skull that allows protrusion of intracranial tissues through the resulting defect.(8)

The clinical presentation of the present calf was notable for persistent lateral recumbency and inability to stand or ambulate independently, despite preservation of the suckling reflex. A remarkably similar neurological presentation was described by Boscarato et al. in a neonatal calf with frontal cranioschisis and meningocele.(8) That calf remained in permanent lateral recumbency while retaining a sucking reflex and additionally exhibited opisthotonus, thoracic limb spastic paresis, and pelvic limb flaccid paresis. Neurological improvement was not observed after surgical treatment, and the calf was euthanized on the third postoperative day. (8) In contrast, more favorable outcomes have generally been reported in calves without marked preoperative neurological abnormalities. Ohba et al. described a calf without neurological signs that recovered uneventfully after surgical correction and remained neurologically normal during follow-up.(3) Similarly, Kohli and Naddaf reported successful surgical management in three calves, with uneventful healing and no reported recurrence.(9) Taken together, these reports suggest that marked preoperative neurological dysfunction may be associated with a less favorable outcome, potentially reflecting concurrent intracranial or developmental abnormalities that cannot be corrected by extracranial sac resection alone.(3, 8, 9)

Diagnostic imaging is important for characterizing the cranial defect and differentiating meningocele from meningoencephalocele. In the present case, radiography revealed no identifiable osseous structure within the mass, whereas ultrasonography demonstrated predominantly hypoechoic to anechoic contents. However, neither a distinct cranial defect nor definite neural tissue within the sac was identified preoperatively. This represents an important diagnostic limitation because radiography and ultrasonography may not reliably determine whether brain tissue is incorporated into the protruding sac. Ohba et al. reported that ultrasonography suggested the presence of brain-like tissue but could not definitively establish whether it was located within the sac; CT subsequently demonstrated both the cranial defect and herniated encephalic tissue, allowing a diagnosis of meningoencephalocele.(3) Verma et al. likewise emphasized the value of CT for differentiating meningocele from meningoencephalocele and for guiding surgical planning.(4) Therefore, the absence of preoperative cross-sectional imaging in the present case prevented definitive assessment of possible neural tissue involvement.(3, 4)

During surgical exploration in the present case, tissue grossly suspected to represent neural tissue was observed near the cranial defect. Because brain tissue within the herniated sac is the principal feature distinguishing meningoencephalocele from meningocele, this finding raises the possibility that the lesion may have represented a meningoencephalocele rather than a simple meningocele.(3) However, because neither CT nor histopathological examination was performed, neural tissue involvement could not be confirmed. Accordingly, the diagnosis of cranial meningocele should be regarded as presumptive, and meningoencephalocele cannot be completely excluded.(3, 4)

The surgical technique used in the present case was broadly comparable to previously reported procedures for cranial meningocele in calves. An elliptical skin incision was made around the base of the lesion, hemorrhagic fluid was gradually drained to reduce tension within the sac, and the protruding extracranial sac and redundant soft tissues were carefully resected. The margins of the dural defect were subsequently apposed using 2-0 polydioxanone in a simple continuous pattern before routine closure of the overlying soft tissues. Kohli and Naddaf similarly described elliptical skin incisions, drainage of clear or red-tinged fluid, blunt dissection of the sac, and excision of redundant tissues while preserving sufficient tissue for closure.(9) Boscarato et al. also performed drainage of approximately 1 L of hemorrhagic cerebrospinal fluid followed by excision of the meningeal sac and closure of the meningeal margins.(8) Other reports have described comparable approaches involving drainage of the sac followed by resection of redundant tissue and primary closure.(5, 6)

Various techniques have been proposed for management of the cranial defect itself. In several reported cases, successful outcomes were achieved using soft-tissue or meningeal closure without rigid reconstruction of the skull defect.(8, 9) In contrast, Oliveira Filho et al. performed cranioplasty using a cartilage homograft in a Jersey calf with a 5-cm cranial defect. The graft was positioned over the defect after closure of the dura mater to provide structural coverage of the skull defect.(10) These differences indicate that surgical reconstruction should be individualized according to the size and configuration of the cranial defect, the amount of viable soft tissue available for closure, and the presence or absence of exposed neural structures.(9, 10)

Despite the absence of marked local wound complications, the present calf developed nystagmus and failed to resume voluntary feeding on the first postoperative day and died on the second postoperative day. Neurological abnormalities and unfavorable postoperative outcomes have also been reported in calves undergoing surgical treatment for cranial meningocele. Verma et al. reported postoperative circling and blindness in two surgically treated calves, one of which subsequently died.(4) Oliveira Filho et al. described a calf that initially recovered well following cranioplasty but developed apathy and seizures from postoperative day 13 and died on postoperative day 15; necropsy revealed encephalitis and intracranial purulent exudate.(10) Boscarato et al. reported persistent severe neurological abnormalities after surgery in a calf with marked preoperative neurological dysfunction, resulting in euthanasia on the third postoperative day.(8)

In the present case, severe preoperative recumbency and nystagmus observed on the first postoperative day indicated the presence of neurological abnormalities; however, their underlying cause and relationship to the subsequent death could not be determined. Boscarato et al. reported developmental abnormalities including atrophy of the diencephalon and corpus callosum and absence of the third and fourth ventricles in a calf with preoperative neurological dysfunction.(8) However, the exact cause of death in the present calf remains unknown. In the absence of postoperative imaging and necropsy, intracranial hemorrhage, cerebral edema, infection, congenital structural abnormalities, or other perioperative complications cannot be confirmed or excluded. Consequently, a direct causal relationship between the surgical procedure and postoperative death cannot be established.(4, 8, 10)

Several limitations of this report should therefore be acknowledged. First, CT or MRI was not performed before surgery, preventing precise characterization of the cranial defect and assessment of possible neural tissue herniation.(3) Second, histopathological examination of the resected tissues was not performed, and therefore the exact composition of the protruding sac could not be confirmed. Third, postmortem examination was unavailable, preventing determination of the definitive cause of postoperative death. Nevertheless, this case demonstrates that a large congenital frontal cranial defect associated with a presumptive meningocele may be accompanied by severe neurological dysfunction and an unfavorable outcome despite surgical treatment and satisfactory local wound management. Preoperative neurological status and, when feasible, cross-sectional imaging should therefore be considered important components of diagnostic evaluation and prognostic assessment in calves with congenital cranial meningocele.(3, 4, 8)

IV. Conclusion

This case describes the surgical management of a large congenital frontal cranial defect associated with a presumptive meningocele in a neonatal Korean native calf with severe neurological dysfunction. Although surgical resection and primary dural and soft-tissue closure were successfully performed, nystagmus was

observed and voluntary feeding did not resume on the first postoperative day, and the calf died on the second postoperative day. Intraoperative identification of tissue grossly suspected to represent neural tissue raised the possibility of meningoencephalocele, although neural tissue involvement could not be confirmed. The clinical course suggests that marked preoperative neurological dysfunction and possible intracranial abnormalities may be associated with an unfavorable outcome. Comprehensive neurological assessment and cross-sectional imaging, when feasible, should therefore be considered for diagnostic characterization, surgical planning, and prognostic assessment.

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