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Surgical management of congenital bilateral flexed contracted tendons via Z-tenoplasty in a neonatal Punganur calf

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ABSTRACT

Congenital flexural limb deformities (contracted flexor tendons) represent a debilitating musculoskeletal pathology in neonatal bovines, manifesting as persistent hyperflexion of distal appendicular joints and inability to bear physiological weight. A five-day-old female Punganur calf weighing 11.8 kg was admitted with severe bilateral contracted flexor tendons involving both metacarpo-phalangeal (fetlock) joints, causing the animal to knuckle forward and ambulate painfully on the dorsal aspect of the pasterns. Radiographic imaging in antero-posterior and latero-medial projections confirmed acute fetlock flexion without osseous dysplasia or articular ankylosis. Following complete hematological workup, surgical correction via bilateral Z-tenoplasty (Z-tenotomy) of both superficial digital flexor tendons (SDFT) and deep digital flexor tendons (DDFT) was performed under Diazepam sedation and local analgesia. Rigid coaptation using custom posterior bamboo splints was maintained postoperatively in combination with systemic antimicrobial and *anti-inflammatory* therapy. The calf showed remarkable recovery, initiating weight-bearing by Day 5, achieving stable ambulation by Day 10, and running with anatomical limb alignment by Day 17. This case illustrates that timely surgical intervention employing Z-tenoplasty provides optimal tendon elongation while preserving structural continuity, leading to complete functional rehabilitation.

Keywords: Punganur miniature cattle, Contracted flexor tendon, Fetlock hyperflexion, Z-tenoplasty, SDFT, DDFT, Rigid splint coaptation

Introduction

Congenital flexural deformities, commonly referred to as contracted flexor tendons, are among the most frequently observed musculoskeletal anomalies in newborn livestock, especially calves and foals. The condition is characterized by an anatomical shortening of the musculotendinous units of the limbs, resulting in the inability of the affected animal to extend the distal limb joints into normal alignment during weight-bearing. In bovines, the distal forelimbs are disproportionately affected, with the metacarpo-phalangeal (fetlock) and proximal interphalangeal joints being the principal sites of contracture.

The etiology of congenital contracted tendons is multifactorial, encompassing intra-uterine malpositioning, genetic predispositions, maternal nutritional deficiencies, toxic plant ingestion (such as lupines or hemlock during gestation), and neuromuscular imbalances. In severe cases, the affected neonate is unable to stand and nurse, predisposing the calf to failure of passive colostral immunoglobulins transfer, decubital ulcers, septicemia, septic arthritis, and high mortality rates. While mild postural deformities may resolve spontaneously or respond to conservative therapy (including manual stretching, physical therapy, oxytetracycline administration, and external coaptation), moderate-to-severe fixed contractures invariably mandate surgical intervention.

Traditional surgical approaches have utilized transverse tenotomy; however, complete transection risks overextension ('dropped soles'), rupture of neurovascular structures, and excessive scar tissue formation. In contrast, Z-tenoplasty (Z-lengthening tenotomy) provides a controlled, precise elongation of the contracted tendon while maintaining structural continuity, anatomical gliding function, and immediate tensile load stability. The Punganur cattle breed, indigenous to Andhra Pradesh and revered for its miniature stature and resilience, is an invaluable indigenous germplasm. This report documents the diagnostic presentation, operative Z-tenoplasty technique, and comprehensive postoperative rehabilitation of severe bilateral congenital fetlock contracture in a neonatal Punganur calf.

2. Patient history and clinical findings

A five-day-old female Punganur calf was presented with history of knuckling since birth

2.1 Baseline patient demographics & anamnesis

- **Species:** Bovine (*Bos indicus*)
- **Breed:** Punganur (Miniature Indigenous Cattle)
- **Sex:** Female
- **Age:** 5 Days (Date of Birth: 10/04/2025)
- **Body Weight:** 11.8 kg
- **Chief Complaint:** Inability to bear normal weight on both forelimbs since birth; severe knuckling-over at the fetlocks and struggling to walk.

2.2 Physical and clinical examination

Upon initial presentation, the calf was alert, active, and exhibited normal mental status ('demented/agitated' during restrictive restraint). Physical inspection of the appendicular skeleton revealed marked bilateral flexural deformity localized to the metacarpo-phalangeal (fetlock) joints. The joints were rigidly locked in acute flexion, preventing normal hoof-ground contact. The calf attempted locomotion by bearing weight directly upon the dorsal surfaces of the fetlock and pastern joints, causing acute contusions and risking full-thickness cutaneous erosion. Manual manipulation under physical restraint demonstrated marked resistance to passive extension, confirming se-

vere contracture of both the superficial and deep digital flexor apparatus.



Figure 1A: Frontal view showing bilateral fetlock flexion deformity and abnormal knuckle-standing.



Figure 1B: Anterolateral view illustrating severe knuckling-over of the distal forelimb digits.

2.3 Vital signs & physiological status

Clinical Parameter	Observed Value	Reference Interpretation
Rectal Temperature	102.5 °F	100.5 – 102.5 °F (Normal limits)
Heart Rate	142 beats/min	100 – 140 beats/min (Mild neonate tachycardia)
Respiratory Rate	64 breaths/min	30 – 60 breaths/min (Slight polypnea due to stress)
Pulse Rate & Rhythm	140 /min, Regular	Strong, synchronous arterial pulse
Mucous Membranes	Pinkish, Moist	Capillary refill time < 2 seconds
Muzzle & Nostrils	Moist muzzle, no discharge	Clear bilateral airflow
Thoracic Auscultation	Clear lung fields, normal heart sounds	No murmurs, wheezes, or rales
Gastrointestinal / Abdominal	Normal rumen palpation, feces normal	Active suckling reflex preserved

3. Diagnostic investigations

3.1 Radiographic imaging

To differentiate isolated soft-tissue flexor tendon contracture from underlying osseous or articular dysplasias (such as arthrogryposis, physal fractures, epiphyseal dysgenesis, or degenerative joint malformations), standard orthogonal radiographic views of both distal forelimbs were obtained

Antero-Posterior (AP) View: Revealed straight, symmetric metacarpal bones (Mc III+IV) and aligned proximal/middle phalanges without angular rotational deformity, metacarpal deviation, or cortical pathology.

- **Latero-Medial (LM) View:** Demonstrated acute hyperflexion at the metacarpo-phalangeal joint. The articular joint spaces between the distal condyles of the metacarpus, proximal phalanx (P1), and proximal sesamoid bones were completely intact without joint effusion, osteolysis, subluxation, or ankylosis. This confirmed that the contracture was purely of tendinous origin.



Figure 2A: Antero-Posterior (AP) radiographic view displaying normal distal metacarpal osseous alignment.



Figure 2B: Latero-Medial (LM) view showing marked fetlock joint flexion with pristine articular margins.

3.2 Hematological profile (Automated CBC)

Venous blood was collected into EDTA vials and analyzed using an automated veterinary hematology analyzer (ID: 8595 0187, dated 25-Apr-2025). All vital hematological parameters were within physiological neonatal bovine reference intervals, indicating adequate bone

marrow function, absence of acute systemic bacteremia or leukopenia, and excellent suitability for elective surgical intervention.

Parameter	Observed	Bovine Ref.	Units	Clinical Remarks
White Blood Cell Count (WBC)	11.3	4.0 – 12.0	$10^3 / \mu\text{L}$	Normal physiological range
Red Blood Cell Count (RBC)	6.90	5.0 – 10.0	$10^6 / \mu\text{L}$	Adequate neonatal erythrocyte mass
Hemoglobin (HGB)	9.3	8.0 – 15.0	g / dL	Normal oxygen-carrying capacity
Hematocrit (HCT)	29.4	24.0 – 46.0	%	Euvolemic, no dehydration or anemia
Mean Corpuscular Volume (MCV)	42.6	40.0 – 60.0	fL	Normocytic
Mean Corpuscular Hemoglobin (MCH)	13.5	11.0 – 19.0	pg	Normochromic
Mean Corpuscular Hgb Conc. (MCHC)	31.6	30.0 – 36.0	g / dL	Adequate cellular hemoglobin saturation
Platelet Count (PLT)	400	100 – 800	$10^3 / \mu\text{L}$	Normal primary hemostatic competence
Lymphocyte Fraction (LY)	5.2 (46.1%)	40.0 – 75.0	%	Appropriate neonate leukogram
Eosinophils (EO)	5.7	0.5 – 4.0	%	Mild neonatal eosinophilia (parasite-free)
Granulocytes (GR)	0.4	1.5 – 6.0	$10^3 / \mu\text{L}$	No neutrophilic left-shift
Red Cell Distribution Width (RDWCV)	18.7	15.0 – 20.0	%	Uniform red cell distribution

4. Surgical intervention (Z-tenoplasty)

4.1 Anesthetic protocol and patient preparation

Following fasting for 4 hours, the calf was weighed precisely at 11.8 kg. A multi-modal preanesthetic and analgesia regimen was executed. Antimicrobial prophylaxis was initiated prior to incision with Inj. Cefotaxime (10 mg/kg B. Wt., 500 mg reconstituted in sterile wa-

ter, IM). Analgesia and pre-emptive *anti-inflammatory* control were instituted with Inj. Meloxicam (0.5 mg/kg B. Wt., 0.6 mL IM). Neuroleptanalgesia and muscular relaxation were achieved using Inj. Diazepam administered intravenously at 0.4 mg/kg (initial bolus of 0.6 mL IV). Intraoperative sedation maintenance was supplemented with two boluses of Diazepam: 0.3 mL at 11:10 AM and 0.5 mL at 12:00 PM.

Pharmacological Agent	Therapeutic Class	Dose Rate	Dose Given	Timing & Purpose
Inj. Cefotaxime	Third-generation Cephalosporin	10 mg / kg B. Wt.	500 mg (IM)	Single pre-op prophylactic bolus
Inj. Meloxicam	Selective COX-2 Inhibitor NSAID	0.5 mg / kg B. Wt.	0.6 mL (IM)	Pre-emptive analgesia
Inj. Diazepam (Induction)	Benzodiazepine GABAA agonist	0.4 mg / kg B. Wt.	0.6 mL (IV)	Muscular relaxation & smooth sedation
Inj. Diazepam (Maint. I)	Sedative supplement	--	0.3 mL (IV)	Administered at 11:10 AM
Inj. Diazepam (Maint. II)	Sedative supplement	--	0.5 mL (IV)	Administered at 12:00 PM

The calf was placed in right lateral recumbency on a padded operating table. Both distal forelimbs were circumferentially shaved from the carpus down to the coronary band. The surgical fields were scrubbed aseptically using 7.5% povidone-iodine surgical scrub, degreased with surgical alcohol, and painted with 10% povidone-iodine solution. The limbs were isolated using sterile four-corner draping. Local infiltration analgesia was achieved using 2% Lignocaine Hydrochloride along the planned incision site.

4.2 Step-by-step operative technique

- **Step 1: Surgical Approach & Exposure.** A 6 cm longitudinal cutaneous incision was created on the posterior/plantar aspect of the mid-metacarpal region, approximately midway between the carpus and fetlock. The incision was placed directly over the flexor tendon bundle, strictly avoiding medial and lateral digital neurovascular packets.
- **Step 2: Peritenon Dissection & Tendon Isolation.** Subcutaneous loose connective tissue and deep metacarpal fascia were meticulously dissected with Metzenbaum scissors. The carpal canal peritenon was incised to expose the superficial digital flexor tendon (SDFT) and deep digital flexor tendon (DDFT). Curved mosquito and Kelly hemostats were introduced beneath the tendons to isolate them cleanly from the underlying suspensory ligament (interosseus muscle).

- **Step 3: Execution of Z-Tenoplasty (SDFT & DDFT).** To achieve elongation while preserving structural and mechanical continuity, Z-tenoplasty was performed on the SDFT first: A central longitudinal sagittal incision (approx. 2.5–3.0 cm in length) was made through the mid-substance of the tendon. At the proximal end of the sagittal cut, a transverse hemisection was executed towards one edge (medial). At the distal end, an opposing transverse hemisection was made towards the contralateral edge (lateral), forming a complete 'Z' configuration. Because passive fetlock extension was still restricted due to concomitant involvement of the DDFT, an identical Z-tenotomy was systematically executed on the DDFT.
- **Step 4: Joint Realignment & Tendon Suture.** With both tendons incised in a Z-configuration, manual traction was applied to the digits, gently extending the fetlock joint to the 180° physiological plane. The longitudinal halves of the Z-cuts slid smoothly past each other, lengthening each tendon unit by approximately 1.5 to 2.0 cm. The overlapping distal and proximal tendon slips were sutured in the lengthened configuration using synthetic absorbable suture in a locking-loop / horizontal mattress pattern to maintain stability.
- **Step 5: Layered Anatomical Closure.** Complete surgical hemostasis was verified. Subcutaneous fascia and adjacent soft tissues were closed in a simple interrupted pattern using synthetic absorbable suture. The skin edges were carefully apposed using non-absorbable monofilament suture in a horizontal mattress pattern to minimize tension and prevent dehiscence under limb movement. The identical operative procedure was sequentially completed on the contralateral forelimb. Total operative duration was 1 hour and 25 minutes.

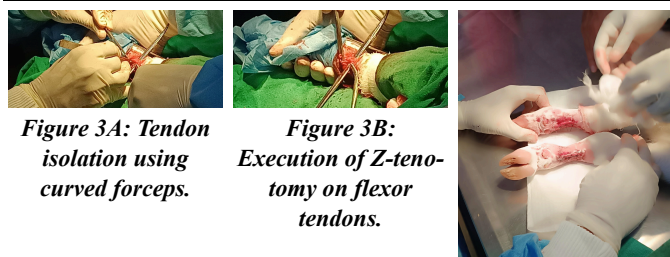


Figure 3A: Tendon isolation using curved forceps.

Figure 3B: Execution of Z-tenotomy on flexor tendons.

Figure 3C: Completed skin apposition with mattress sutures.

5. Postoperative management & external coaptation

5.1 External rigid coaptation (Splinting)

Following cutaneous closure, primary wound dressings were applied using sterile povidone-iodine ointment and sterile gauze pads. Extensive cotton padding was circumferentially rolled from the proximal metacarpus to the hooves to prevent pressure necrosis and distribute coaptation tension evenly. Rigid immobilization was achieved using custom posterior wooden/bamboo splints measuring 15 cm in length, 4 cm in width, and 1.5 cm in thickness. The splints were contoured, applied strictly to the posterior (caudal) aspect of both forelimbs, and securely wrapped with cohesive elastic bandages. This rigid coaptation held both fetlock joints in complete anatomical extension, neutralizing tensile forces across the healing tendon repair lines.

5.2 Medical protocol

- **Inj. Cefotaxime:** 500 mg (10 mg/kg B. Wt.) IM once daily for 3 consecutive days to prevent surgical site infection.

- **Inj. Meloxicam:** 0.5 mg/kg B. Wt. (0.6 mL) IM once daily for 3 consecutive days for *anti-inflammatory* and analgesic efficacy.
- **Wound & Bandage Care:** Daily physical inspection of distal digits for signs of swelling, hypothermia, bandage slippage, strike-through, or moist dermatitis.

5.3 Chronological clinical follow-up & outcome

The calf recovered smoothly from anesthesia and was bottle-fed colostrum and whole maternal milk. A structured follow-up regimen was observed:

- **Day 5 Post-Operative:** Splints and bandages remained intact. The calf exhibited renewed vigor and made repeated purposeful attempts to stand. With minimal tail and thoracic support, the calf was able to bear weight squarely on both soles.
- **Day 10 Post-Operative:** The calf stood up spontaneously and walked steadily across clean, non-slip flooring without assistive holding. No knuckling-over or recurrent hyperflexion was observed.
- **Day 17 Post-Operative:** External splints were removed. Suture lines had healed by primary intention without drainage or dehiscence. Cutaneous sutures were removed. Dynamic locomotion assessment revealed complete functional recovery: the calf was capable of running, turning sharply, and standing with normal dorsal metacarpal-phalangeal angles.

CLINICAL OUTCOME HIGHLIGHT: *Bilateral Z-tenoplasty of both the SDFT and DDFT, combined with rigid posterior splinting for 14–17 days, completely resolved congenital fetlock contracture in this neonatal calf, achieving full locomotor restoration without residual gait abnormalities.*

6. Discussion

Congenital flexor tendon contracture is a progressive mechanical deformity. When neonates are unable to place the sole on the ground, the physiological extensor reflex is compromised, perpetuating a vicious cycle of persistent muscle contraction, joint stiffness, and secondary periarticular capsular fibrosis. If unaddressed, dorsal weight-bearing produces skin ulceration, chronic cellulitis, and septic tenosynovitis or arthritis, almost invariably necessitating humane euthanasia.

Therapeutic options depend strictly upon the severity of the contracture. Mild deformities where the limb can be passively manipulated into extension often respond favorably to conservative therapy: high-dose oxytetracycline (which chelates calcium and induces muscle relaxation), corrective shoeing with toe extensions, and padded splints. However, when the joint cannot be passively extended beyond a right angle—as observed in this case—conservative management fails, and surgical lengthening becomes mandatory.

Historically, complete transection (transverse tenotomy) of the SDFT alone or combined with the DDFT has been performed. However, complete transection creates a wide gap filled with disorderly fibrous tissue, leading to prolonged healing times, severe hyperextension ('dropped soles'), loss of structural elasticity, and potential rupture during initial weight-bearing. In contrast, the Z-tenoplasty technique used in this study represents the gold standard in functional reconstructive tendon surgery. By dividing the tendon along its longitudinal axis and staggering transverse cuts at opposite poles, the surgeon achieves controlled, calibrated lengthening. Suturing the overlapping slips preserves mechanical continuity and guides collagen fiber alignment along longitudinal lines of tensile stress.

External coaptation is an indispensable adjunct to tenoplasty. Padded posterior rigid splints prevent tensile stress across the newly sutured overlapping tendon ends while maintaining the articular capsule in extension. In neonatal calves, rapid skeletal growth and remarkable tendon remodeling capacity enable robust healing within two to three

weeks, as evidenced by this calf's unassisted running and normal gait by post-operative Day 17.

7. Conclusion

Congenital bilateral flexed contracted tendons involving the fetlock joints in a neonatal Punganur calf were successfully corrected using bilateral Z-tenoplasty of both the superficial and deep digital flexor tendons. The procedure provided precise anatomical elongation while preserving tendon continuity and tensile strength. When coupled with rigid posterior external splinting and appropriate antimicrobial and analgesic coverage, Z-tenoplasty offers rapid functional rehabilitation, eliminating the risk of permanent recumbency or joint deformities. This surgical strategy represents an exemplary therapeutic standard for severe congenital flexural deformities in valuable livestock breeds.

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