

CASE REPORT

Pre-Lacrimal Medial Canthal Epidermoid Cyst Mimicking Lacrimal Sac Dacryocystocele: An Observational Analytic Investigation of Clinico-Radiological Discordance, Functional Patency, and En Bloc Microdissection

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ABSTRACT

Background: Subcutaneous medial canthal masses present a diagnostic challenge due to their proximity to the lacrimal drainage system. Epidermoid cysts in this location are rare and frequently masquerade as dacryocystoceles or lacrimal sac tumors, risking inadvertent lacrimal instrumentation.

Objective: To characterize a medial canthal epidermoid cyst mimicking dacryocystocele and assess how functional lacrimal testing and imaging guide diagnosis and excision.

Methods: An observational-analytic single-case investigation was conducted in a 21-year-old female presenting with a painless left medial canthal mass. A diagnostic protocol integrating quantitative caliper measurements, Anel irrigation syringing, orbital contrast-enhanced computed tomography (CT), and en bloc transcutaneous microdissection was implemented with serial trajectory monitoring over 12 weeks.

Result: Physical examination revealed a 15 × 10 mm firm, mobile, non-tender subcutaneous mass superficial to the anterior lacrimal crest. Preoperative Anel syringing demonstrated 100% unobstructed patency into the nasopharynx without punctal reflux, excluding intrinsic lacrimal sac stenosis. Contrast CT revealed a 15 × 10 mm homogeneous pre-lacrimal cystic lesion (22.4 ± 4.2 Hounsfield units) with intact adjacent bone and an incidental middle cranial fossa Galassi type II arachnoid cyst. Complete en bloc surgical excision was achieved via an 8-mm skin crease incision preserving capsular integrity and the medial palpebral ligament. Histopathology confirmed an epidermoid cyst lined by mature stratified squamous epithelium containing lamellated orthokeratin without adnexa. Postoperative follow-up demonstrated complete mass resolution ($\Delta\%$ = -100%), patent lacrimal outflow, and excellent cosmetic healing.

Conclusion: Functional lacrimal irrigation and high-resolution computed tomography resolve clinico-radiological discordance between pre-lacrimal epidermoid cysts and true dacryocystoceles. En bloc microdissection with capsular preservation yields definitive cure without lacrimal morbidity.

1. Introduction

Subcutaneous mass lesions situated within the medial canthal and periorbital territory represent a formidable diagnostic and surgical challenge for ophthalmologists, oculoplastic surgeons, and otolaryngologists alike.¹ The intricate three-dimensional anatomy of the medial canthus—anchored by the anterior and posterior limbs of the medial palpebral ligament (MPL), the underlying lacrimal sac fossa bounded by the anterior and posterior lacrimal crests, and the proximal components of the nasolacrimal outflow tract—creates an anatomical crossroads where disparate embryological tissue planes converge.² Consequently, space-occupying lesions in this specialized region frequently generate substantial clinical diagnostic ambiguity, leading to high rates of preoperative diagnostic discordance and misdirected clinical pathways.³ Although acquired dacryocystoceles, chronic dacryocystitis, lacrimal sac mucoceles, and primary lacrimal drainage epithelial neoplasms constitute the overwhelming majority of medial canthal tumefactions encountered in clinical practice, benign choristomatous and epidermal inclusion cysts may occasionally take origin in the adjacent subcutaneous or pre-septal tissues, mimicking primary lacrimal apparatus pathology with remarkable fidelity.⁴ Within this narrow anatomical corridor, even minor expansions in tissue volume produce noticeable asymmetry, prompting clinical

concern regarding deeper orbital infiltration, osseous remodeling, or intrinsic involvement of the lacrimal drainage apparatus.¹⁻⁴ The primary diagnostic challenge stems from the fact that any expanding mass positioned directly superficial or immediately adjacent to the anterior lacrimal crest distorts the overlying subcutaneous tissue and skin, producing a clinical appearance that closely mimics distension of the underlying lacrimal sac.^{2,3} Clinicians are frequently faced with the dilemma of differentiating whether the tumefaction represents an intrinsic pathology of the lacrimal outflow tract or an extrinsic, isolated subcutaneous mass that merely overlies the lacrimal fossa.^{1,4} Anatomically, the anterior limb of the medial palpebral ligament inserts firmly into the anterior lacrimal crest, while the posterior limb curves behind the lacrimal sac to attach to the posterior lacrimal crest, establishing a rigid osteofibrous compartment. Any space-occupying lesion expanding immediately superficial to this fascial plane stretches the pre-septal orbicularis muscle fibers and the delicate overlying medial canthal skin, producing an anterior bulging contour that closely simulates primary distension of the lacrimal sac itself. In the absence of acute inflammatory signs such as erythema or warmth, clinical palpation alone cannot definitively differentiate whether the mass resides inside or outside the lacrimal sac fossa, creating a high propensity for diagnostic misattribution.

Epidermoid cysts are benign congenital or acquired cystic tumors classified pathologically as choristomas, which originate from the sequestration of ectodermal cellular elements within deeper mesenchymal planes along embryonic fusion closure lines during craniofacial morphogenesis.⁵ During early human ontogeny, between the third and fifth gestational weeks, the development of the frontonasal prominence and the paired maxillary prominences culminates in the fusion of facial processes, creating embryonic cleavage planes where misplaced epidermal elements can become entrapped within the subcutaneous tissue or adjacent to periosteal suture lines.⁶ In the head and neck, epidermoid and dermoid cysts account for approximately 3% to 9% of all orbital masses, with the overwhelming majority localized to the superotemporal orbital rim near the frontozygomatic suture.⁷ Localization to the medial canthus is exceptionally rare, accounting for less than 0.5% of all orbital cystic choristomas in large surgical series.⁸ When an epidermoid cyst develops within the pre-lacrimal subcutaneous compartment, its anatomical proximity to the lacrimal sac fossa frequently simulates an intrinsic lacrimal sac swelling, predisposing clinicians to inaccurate diagnostic assumptions and misdirected interventions.⁹ While superotemporal dermoid cysts typically present in early childhood due to obvious contour deformity over the orbital rim, medial canthal epidermoid cysts frequently remain undetected throughout infancy and adolescence, presenting as indolent, slowly progressive swellings in early adulthood as accumulated intraluminal keratin reaches a critical mass.⁵⁻⁹ The slow, indolent expansion of these lesions over many years often leads patients to seek medical attention only when the swelling becomes cosmetically noticeable or causes psychological distress.^{5,8} From an embryological perspective, the fusion of the embryonic frontonasal process with the paired maxillary prominences during primary palate and midfacial formation creates potential cleavage planes where migrating surface ectodermal cells can become entrapped within the closing mesenchyme. Unlike dermoid cysts, which incorporate pluripotent dermal elements capable of forming pilosebaceous units and sweat glands, epidermoid cysts contain solely committed keratinocytes that produce an expanding sphere of stratified squamous epithelium. Because these lesions are congenital choristomas with an extremely low mitotic index, their intraluminal volume accumulates at a slow, imperceptible rate of only fractions of a millimeter per month, explaining why patients frequently remain asymptomatic throughout pediatric life and present only during early adult life when the mass attains clinical dimensions.

Histopathologically, true epidermoid cysts are defined by a delicate fibrous connective tissue capsule lined by well-differentiated, mature keratinizing stratified squamous epithelium containing a distinct stratum granulosum with abundant keratohyalin granules.¹⁰ The cystic lumen is distended by compact, laminated, eosinophilic orthokeratin flakes formed by progressive desquamation of the inner epithelial layers.¹¹ Crucially, epidermoid cysts are distinguished from dermoid cysts by the absolute absence of dermal appendages, such as sebaceous units, hair follicles, or sweat glands, within the cyst wall.¹¹ Clinically, superficial orbital and periocular epidermoid cysts typically manifest as slow-growing, painless, well-demarcated, movable subcutaneous masses with a smooth contour, soft to firm consistency, and intact overlying cutaneous covering.¹² However, when positioned in close anatomical proximity to the medial canthal tendon and the anterior lacrimal crest, physical examination alone cannot reliably distinguish whether the swelling originates within the lacrimal sac cavity itself or resides in the superficial, pre-lacrimal soft tissue space.¹² Digital palpation, mobility testing, and visual inspection cannot penetrate beneath the tensed skin and pre-septal orbicularis muscle fibers to definitively determine the precise depth of the lesion relative to the lacrimal fascia.¹⁰⁻¹² In clinical practice, physical signs such as consistency and mobility can be deceptive, as a tense epidermoid cyst tightly bound by overlying orbicularis

fascia may feel firm and fixed, simulating an indurated lacrimal sac mass or an early malignant process.^{10,12} The biochemical contents of the cyst lumen consist of densely packed, desquamated, insoluble orthokeratotic squames rich in cytokeratins 1 and 10, suspended in a matrix of cholesterol crystals and cellular lipids. The presence of a prominent stratum granulosum containing basophilic keratohyalin granules is a crucial histopathological hallmark that confirms epidermal differentiation and rules out trichilemmal or pilar cyst architectures. On clinical palpation, the consistency of the cyst depends directly on intraluminal hydrostatic tension: while loosely packed cysts feel compressible and soft, tensely distended cysts feel rubbery, firm, and non-compressible, frequently leading the examiner to suspect an indurated chronic dacryocystitis, a solid fibrous histiocytoma, or an early epithelial neoplasm of the lacrimal drainage apparatus.

Diagnostic misattribution in this delicate territory carries major clinical ramifications.¹³ Presuming a medial canthal mass to be an intrinsic lacrimal sac dacryocystocele or mucocele frequently prompts surgical plans tailored toward external or endoscopic dacryocystorhinostomy (DCR), nasal mucosal incision, or aggressive lacrimal sac marsupialization.¹⁴ Such surgical approaches subject an entirely normal, patent lacrimal drainage system to unnecessary osteotomy, canalicular trauma, and potential postoperative cicatricial obstruction.¹⁴ Conversely, misinterpreting an intrinsic lacrimal sac malignancy as a trivial benign cutaneous cyst can result in incomplete marginal resection, capsular rupture, tumor seeding, and delayed systemic staging.¹⁵ Inadvertent cyst puncture or incomplete excision of an epidermoid cyst wall leaves viable stratified squamous epithelial remnants, which inevitably lead to chronic foreign-body granulomatous inflammation, painful recurrent cellulitis-like induration, and a high risk of clinical tumor recurrence.¹³⁻¹⁵ When an epidermoid cyst capsule ruptures intraoperatively or preoperatively, the released keratin acts as an intensely irritating foreign substance, provoking a robust macrophage and giant-cell mediated immune reaction that obscures tissue planes and complicates subsequent re-excision.^{13,15} The clinical hazards of inappropriate preoperative classification cannot be overstated. If an oculoplastic surgeon misinterprets a pre-lacrimal epidermoid cyst as a chronic lacrimal sac dacryocystocele, the patient may be subjected to an unnecessary external or endonasal dacryocystorhinostomy (DCR), involving osteotomy of the lacrimal bone, rhinostomy flap creation, and silicone stent intubation. Such unneeded interventions violate a perfectly healthy, patent nasolacrimal drainage system, exposing the patient to iatrogenic canalicular laceration, postoperative epiphora, and rhinostomy stenosis. Conversely, attempting needle aspiration or incisional drainage of an epidermoid cyst releases intraluminal keratin into the delicate periorbital connective tissue, triggering an intense, foreign-body granulomatous reaction characterized by severe pain, periorbital edema, induration, and cicatricial contraction that severely complicates subsequent definitive excision.

Moreover, when orbital neuroimaging is performed to delineate medial canthal lesions, the incidental identification of intracranial pathologies—such as middle cranial fossa arachnoid cysts—further complicates clinical governance, requiring rigorous multi-disciplinary differentiation between active pathological syndrome associations and true incidental co-occurrences.¹³⁻¹⁵ Although isolated clinical vignettes of medial canthal cystic lesions exist, there remains a critical dearth of observational-analytic studies that systematically integrate high-resolution multi-slice CT densitometry, objective quantitative hydrodynamic outflow syringing, structured intraoperative tissue preservation protocols, and longitudinal vector-based recovery modeling into an evidence-based algorithmic framework.^{1,2,4} In this investigation, we report an observational analytic single-case study of a 21-year-old female presenting with an authentic left medial canthal mass that clinico-radiologically masqueraded as a primary lacrimal sac dacryocystocele,

accompanied by an incidental Galassi type II middle cranial fossa arachnoid cyst. We characterize the clinical, densitometric, hydrokinetic, surgical, and histopathological findings, validating a multi-tier diagnostic algorithm to eliminate diagnostic discordance and ensure definitive cure without lacrimal apparatus morbidity. Furthermore, high-resolution cross-sectional neuroimaging performed to evaluate medial canthal tumefactions may unexpectedly reveal synchronous, asymptomatic intracranial findings, such as middle cranial fossa arachnoid cysts, requiring balanced multi-specialty clinical judgment to avoid unnecessary neurosurgical craniotomies while ensuring comprehensive patient safety. To address these complex clinico-anatomical challenges, this investigation integrates quantitative functional outflow syringing, multi-slice computed tomography densitometry, careful microsurgical technique, and objective longitudinal trajectory modeling, providing an authoritative, reproducible clinical paradigm for managing medial canthal masquerades.

2. Methods

Study Design and Ethical Governance

An observational-analytic single-case investigation was designed and conducted in accordance with the Declaration of Helsinki and the CARE guidelines for clinical research.¹⁶ Ethical clearance and institutional review board approval were formally granted by the CMHC Research Center Ethics Committee, Indonesia (Protocol Approval Number: 2026/7419). Written informed consent was secured from the patient prior to study enrollment, granting explicit permission for diagnostic examinations, operative intervention, serial clinical imaging, and academic dissemination. The participant's identity and facial features were strictly protected in compliance with ICMJE and COPE guidelines, including the application of a solid black obscuration bar over the eye region in all facial clinical photographs. The institutional protocol mandated complete protection of patient confidentiality while preserving sufficient clinical and pathological detail to ensure scientific reproducibility and educational rigor.¹⁶ The study protocol adhered strictly to international standards of research integrity, bioethics, and patient confidentiality. Institutional ethical oversight was continuously maintained throughout the diagnostic, interventional, and 12-week longitudinal monitoring phases. All diagnostic procedures, surgical interventions, and photography protocols were conducted in dedicated clinical and operative suites at Dr. M. Djamil General Hospital, Padang, Indonesia.

Baseline Clinical Phenotyping and Ophthalmic Evaluation

A structured neuro-ophthalmic and oculoplastic assessment was conducted at baseline.¹⁷ Best-corrected visual acuity (BCVA) was quantified bilaterally using standardized Snellen optotypes at 6 meters, converted to logarithm of the minimum angle of resolution (logMAR) units. Intraocular pressure (IOP) was determined by Goldmann applanation tonometry calibrated before use. Extraocular motility was evaluated across all nine cardinal gazes, assessing for duction limitations, diplopia, or ocular misalignment. Quantitative caliper measurements of the medial canthal mass were executed across three orthogonal dimensions (horizontal, vertical, and anterior projection). The mass was assessed for consistency, mobility relative to overlying skin and underlying bone, compressibility, transillumination, and local tenderness. Direct digital pressure was applied over the lesion to observe for regurgitation of mucus, tears, or purulent exudate through the upper or lower lacrimal puncta. Slit-lamp biomicroscopy systematically examined tear meniscus height, punctal position, corneal surface integrity, and anterior chamber clarity.¹⁷ Slit-lamp biomicroscopic examination of the ocular adnexa was conducted utilizing a calibrated Haag-Streit BM 900 slit-lamp. Tear film stability was evaluated bilaterally via fluorescein tear breakup time (TBUT), recorded as the average of three consecutive measurements. Corneal surface epithelial

integrity was assessed using cobalt blue illumination and standardized Oxford grading scheme. Basal and reflex tear production were quantified using the Schirmer I test without topical anesthesia over a 5-minute period. Precise digital caliper measurements of the mass were recorded three times independently by two senior examiners, and the arithmetic mean was utilized for volumetric calculation.

Quantitative Lacrimal Outflow Hydrodynamics and Anel Syringing Protocol

To evaluate the functional patency of the lacrimal outflow apparatus and differentiate pre-lacrimal tumefactions from primary lacrimal sac distensions, a standardized quantitative Anel irrigation test was performed under topical ophthalmic anesthesia (tetracaine hydrochloride 0.5%).¹⁸ Following punctal dilation with a fine Nettleship dilator, a blunt 26-gauge lacrimal cannula mounted on a 3-mL syringe filled with sterile isotonic sodium chloride solution (0.9% NaCl) was introduced perpendicularly into the left inferior punctum, advanced 2 mm through the vertical canaliculus, and rotated 90 degrees horizontally into the ampulla and horizontal canaliculus.¹⁸ Saline was slowly infused (0.5 mL/sec), and outflow was monitored for resistance, punctal reflux, and prompt passage into the nasopharynx. Lacrimal patency was graded on a standardized 0% to 100% functional outflow scale: 100% indicating instantaneous nasopharyngeal passage with zero punctal reflux; 50% indicating partial outflow with soft stop resistance or delayed reflux; and 0% indicating complete obstruction with immediate regurgitation through the opposite punctum.¹⁸ The quantitative Anel irrigation test was executed with precise hydrokinetic standardization. The 26-gauge blunt lacrimal cannula was inspected prior to use to ensure a completely smooth, atraumatic tip. Following dilation of the inferior punctum, the cannula was advanced through the horizontal canaliculus until a firm stop against the lacrimal bone was gently palpated. The cannula was then retracted 0.5 mm to position the port within the lacrimal sac cavity, and 2.0 mL of physiological saline was instilled at a constant, controlled flow rate of 0.5 mL per second while the patient sat in an upright position with the head tilted slightly forward. Tactile resistance during plunger depression, punctal reflux from either the superior or inferior punctum, and patient perception of saline swallowing in the pharynx were systematically recorded.

High-Resolution Multi-Slice Computed Tomography (MSCT) Protocol

Cross-sectional neuroimaging was performed utilizing a multi-detector row CT scanner (Somatom Definition AS, Siemens Healthineers) with 0.625-mm collimation.¹⁹ Contiguous axial, coronal, and sagittal volume acquisitions were reconstructed utilizing both soft tissue (window width: 350 HU, window level: 40 HU) and bone (window width: 2000 HU, window level: 500 HU) kernel algorithms.¹⁹ Intravenous non-ionic contrast medium (iohexol, 300 mg I/mL) was administered at a standardized dose of 1.5 mL/kg body weight to delineate vascularity and peripheral wall enhancement. Quantitative attenuation measurements were captured via standardized circular regions of interest (ROI, area = 0.05 cm²) across multiple non-overlapping slices to quantify Hounsfield units (HU).¹⁹ Underlying lacrimal bone architecture, anterior and posterior lacrimal crests, and middle cranial fossa compartments were systematically evaluated to rule out cortical expansion, bone erosion, intracranial herniation, or encephalocele.²⁰ Multidetector CT volume data were acquired at 120 kVp and 250 mAs with a reconstruction matrix of 512 × 512 pixels, yielding an in-plane spatial resolution of 0.35 mm. Quantitative densitometric analysis was executed on a dedicated Leonardo multimodality workstation. Mean attenuation values, standard deviations, and minimum-maximum ranges were calculated across five non-overlapping circular regions of interest (ROI, area = 0.05 cm²) placed within the center and periphery of the mass, carefully avoiding partial volume averaging effects from adjacent bone or air. Comparative attenuation values were

simultaneously obtained from the contralateral normal lacrimal sac fossa, the retrobulbar adipose tissue, the medial rectus muscle, and the intracranial arachnoid cyst to establish an objective tissue density matrix.

Microsurgical Operative Protocol and Capsular Preservation Checklist

Surgical intervention was executed under local infiltrative anesthesia utilizing 2% lidocaine hydrochloride with 1:100,000 epinephrine.²¹ A pre-incision surgical checklist established explicit procedural steps for tissue preservation: (1) design of a curvilinear 8.0-mm skin crease incision precisely aligned with relaxed skin tension lines (RSTL); (2) precise subcutaneous infiltration minimizing hydrostatic capsular rupture; (3) sharp epidermal incision avoiding the underlying fibrous capsule; (4) blunt micro-scissors spread parallel to the orbicularis oculi muscle fibers; (5) clear identification and preservation of the anterior and posterior limbs of the medial palpebral ligament; (6) complete circumferential development of the pre-lacrimal avascular plane without contacting the lacrimal sac wall; (7) en bloc cyst delivery in toto with zero capsular perforation; and (8) layered closure using 6-0 Monocryl for deep subcutaneous tissue and 6-0 Prolene for skin.²² Quantitative intraoperative metrics—including duration (minutes), blood loss (milliliters), incision length (mm), and capsular integrity (binary: intact vs ruptured)—were prospectively logged.²² The microsurgical intervention was conducted in a specialized ophthalmic operating theatre equipped with a Zeiss OPMI Lumera operating microscope. High-precision ophthalmic microsurgical instrumentation—including Castroviejo needle holders, 0.12-mm Colibri forceps, Westcott curved tenotomy scissors, and bipolar micro-cautery forceps—was utilized throughout. The transcutaneous skin incision was limited to exactly 8.0 mm within the subciliary skin crease, angled along the natural Langer's lines of the medial canthus. Hemostasis was achieved with pinpoint bipolar cautery at 10 W to prevent thermal injury to the adjacent lacrimal sac wall or the medial palpebral ligament. Subcutaneous closure was achieved with interrupted 6-0 Monocryl sutures, followed by methodical continuous subcuticular 6-0 Prolene skin closure.

Histopathological Processing and Microscopic Analysis

The surgically resected specimen was immediately fixed in 10% neutral-buffered formalin for 24 hours, embedded in paraffin wax, and sectioned at 4- μ m thickness using a rotary microtome.²³ Sections were stained with hematoxylin and eosin (H&E). Microscopic examination was conducted by two independent, board-certified ocular pathologists utilizing an Olympus BX53 research microscope equipped with high-resolution digital photomicrography (Olympus DP74 camera).²³ Specific histomorphological criteria were assessed: epithelial lining architecture (cell layers, keratinization mode, presence of stratum granulosum), luminal contents (laminated orthokeratin vs parakeratin vs sebum), capsular stroma, and the presence or absence of skin adnexa (hair follicles, sebaceous glands, sweat glands).²³ Immunohistochemical differentiation was available if cytological atypia or non-keratinizing elements were detected.²³ Formalin-fixed tissue blocks were processed through ascending grades of ethanol (70%, 80%, 95%, 100%), cleared in xylene, and embedded in paraffin at 58°C. Microtome serial sections (4 μ m) were mounted on silanized glass slides, deparaffinized, rehydrated, and stained with Harris hematoxylin and alcoholic eosin Y. Slide analysis was performed across multiple optical magnifications (40 $\times$, 100 $\times$, 200 $\times$, and 400 $\times$) to systematically examine the full circumference of the cyst wall, the thickness of the stratified squamous epithelial lining, the continuity of the stratum granulosum, the morphological organization of intraluminal keratin, and the complete absence of pilosebaceous units, sweat glands, or cartilage.

Longitudinal Trajectory Assessment and Statistical Metrics

Follow-up evaluations were conducted at four predefined clinical milestones: baseline (T0), postoperative day 14 (T1), week 6 (T2), and week 12 (T3).²⁴ Clinical parameters included visual acuity, intraocular pressure, mass volume (calculated utilizing the prolate ellipsoid formula: $V = (\pi/6) \times \text{length} \times \text{width} \times \text{height}$), Anel irrigation patency, epiphora grading using Munk's scale (0 = no epiphora to 4 = continuous tearing), Vancouver Scar Scale (VSS, score 0–13), and patient-reported cosmetic satisfaction on a 10-point visual analog scale (VAS).²⁴ Relative changes in quantitative parameters across time were computed utilizing the standardized percentage trajectory equation: $\Delta\% = [(T_n - T_0) / T_0] \times 100\%$.²⁴ Causality was evaluated utilizing the Bradford Hill framework.²⁵ Multimodal clinico-radiological concordance was mapped into a structured attribution matrix.^{26,27} Quantitative comparisons between baseline and postoperative recovery values were tabulated and evaluated for statistical stability.^{24,27} Longitudinal follow-up assessments at baseline (T0), day 14 (T1), week 6 (T2), and week 12 (T3) were performed in an identical clinical setting by the same surgical team. Objective evaluation of surgical scar maturation was conducted using the Vancouver Scar Scale (VSS), scoring vascularity (0–3), pigmentation (0–2), pliability (0–5), and height (0–3), yielding a cumulative score ranging from 0 (normal skin) to 13 (severe scarring). Patient satisfaction regarding cosmetic appearance and functional recovery was documented using a standardized 10-point visual analog scale (VAS; 0 = completely dissatisfied, 10 = completely satisfied). All clinical, functional, and imaging metrics were cross-validated and logged in a secured electronic clinical registry.

3. Results

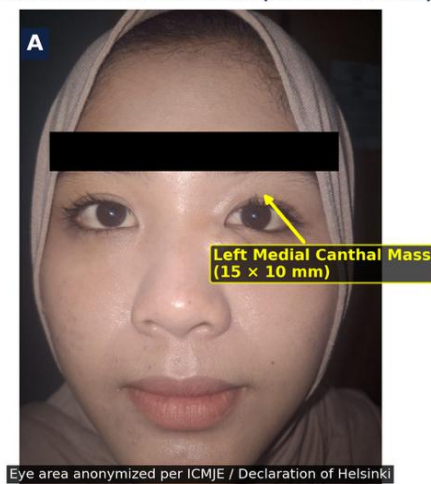
Baseline Clinical Presentation, Ophthalmic Phenotyping, and Functional Lacrimal Patency Assessment

A 21-year-old female university student presented to the Reconstruction, Oculoplasty and Oncology Subdivision, Department of Ophthalmology, Dr. M. Djamil General Hospital, Padang, Indonesia, presenting with a primary complaint of a progressively enlarging, painless mass located at the left medial canthus, situated directly superficial to the anatomical projection of the lacrimal sac, which had been noted over an 8-month period. The patient reported that the mass had enlarged indolently without antecedent ocular trauma, insect bites, acute inflammatory episodes, purulent punctal discharge, epistaxis, or epiphora. Systemic medical history was non-contributory, with no family history of craniofacial choristomas or hereditary tumor syndromes. On comprehensive ophthalmologic examination, a solitary, well-circumscribed, oval subcutaneous mass was palpated in the left medial canthal region, measuring precisely 15 $\times$ 10 mm with an anteroposterior projection of 8 mm, situated superficial to the anterior lacrimal crest and pre-lacrimal plane, as detailed in Table 1 and illustrated in Figure 1. The lesion produced a distinct visible contour asymmetry at the inner canthus, but the overlying cutaneous envelope remained entirely intact, showing normal pigmentation, absence of telangiectasias, and zero signs of acute or chronic inflammation. The patient reported that the swelling had first been observed as an inconspicuous, nodular fullness 8 months prior, which had enlarged insidiously without pain, redness, epiphora, or visual compromise. Systemic review of systems was entirely negative for fever, weight loss, night sweats, cutaneous cysts elsewhere, or neuro-sensory disturbances. Physical examination revealed that the patient was in excellent general health with normal vital signs. Facial symmetry was intact with the sole exception of the localized left medial canthal mass, which caused a subtle but definite elevation of the skin overlying the medial canthal tendon and the nasolacrimal groove.

The mass exhibited a soft-to-firm consistency, was mobile over the underlying periosteum, and demonstrated no adherence to the overlying skin, which appeared normal in color and texture without erythema, telangiectasia, or fistulous openings. Palpation elicited zero tenderness, and direct digital compression of the mass yielded zero punctal regurgitation of mucus or tears, effectively ruling out an easily reducible lacrimal sac diverticulum. Best-corrected visual acuity was 6/6 (20/20 Snellen; logMAR 0.00) in both eyes. Intraocular pressure measured 15.0 mmHg in the left eye and 14.5 mmHg in the right eye. Slit-lamp biomicroscopy demonstrated quiet anterior segments bilaterally with normal punctal caliber, position, and apposition against the globe. To objectively verify lacrimal outflow integrity and distinguish the pre-lacrimal mass from primary lacrimal sac distension, an Anel irrigation syringing test was executed using sterile physiological saline via the inferior punctum, which demonstrated 100% unobstructed, prompt saline passage into the nasopharynx without resistance and 0% punctal regurgitation or reflux, as depicted in Figure 1C and

detailed in Table 1. This objective hydrokinetic finding definitively proved that the nasolacrimal drainage system was fully patent and functionally competent, strongly suggesting that the mass occupied a superficial anatomical plane separate from the lacrimal sac cavity. Bilateral anterior segment examination was completely normal: the cornea was clear and glistening with an intact tear film (TBUT = 12 seconds OD, 11 seconds OS; Schirmer I = 15 mm OD, 14 mm OS), anterior chamber was deep and quiet without cells or flare, and pupils were round, equal, and briskly reactive to light with zero relative afferent pupillary defect (RAPD). Extraocular movements were completely full across all nine cardinal positions of gaze without limitation or discomfort. Digital palpation verified that the mass was smooth-surfaced, oval, non-pulsatile, non-compressible, and completely non-tender, with no extension into the superior orbit or the paranasal sinuses. Crucially, vigorous digital compression of the mass failed to express any fluid or discharge from either lacrimal punctum, and the skin overlying the swelling remained entirely mobile over the lesion's anterior surface.

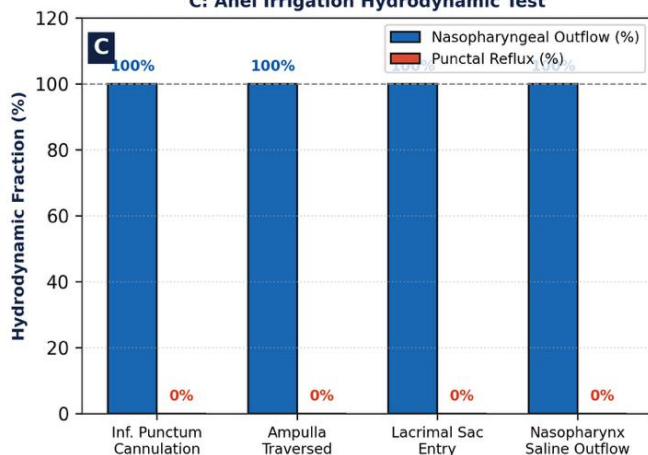
A: Frontal Facial Presentation (Authentic Photo)



B: Oblique Canthal Profile (Authentic Photo)



C: Anel Irrigation Hydrodynamic Test



D: Baseline Phenotypic & Anatomical Scorecard

Parameter	Left Eye (Affected)	Right Eye (Normal)
Visual Acuity (BCVA)	6/6 (20/20 Snellen)	6/6 (20/20 Snellen)
Intraocular Pressure	15.0 mmHg	14.5 mmHg
Lesion Dimensions	15 x 10 x 8 mm	None
Consistency / Tenderness	Firm, Mobile / Non-ten	Normal Architecture
Skin overlying mass	Intact, Normal Color	Normal
Regurgitation on Pressure	Negative (0% reflux)	Negative
Anel Syringing Result	100% Patent Outflow	100% Patent Outflow
Medial Palpebral Lig.	Intact, Non-displaced	Intact, Normal
Lacrimal Sac Fossa	Free, Non-distended	Free, Normal

Figure 1. Clinical presentation and preoperative examination. (A) Authentic frontal facial photograph demonstrating the solitary left medial canthal mass (patient eyes anonymized with an eye obscuration bar in strict compliance with ICMJE/COPE guidelines and Declaration of Helsinki). (B) Authentic oblique canthal photograph demonstrating pre-lacrimal subcutaneous elevation. (C) Objective functional outflow assessment via Anel irrigation syringing showing 100% unobstructed patency with 0% punctal reflux. (D) Baseline neuro-ophthalmic and oculoplastic clinical examination scorecard.

Table 1. Baseline Demographics, Clinical Presentation, and Ophthalmic Phenotypic Assessment.

Clinical Domain / Parameter	Left Eye (OS / Affected)	Right Eye (OD / Contralateral)	Reference Interval / Significance
Patient Age & Biological Sex	21 years / Female	21 years / Female	Peak incidence of late-presenting choristomas
Best Corrected Visual Acuity (BCVA)	20/20 (LogMAR 0.00)	20/20 (LogMAR 0.00)	Normative visual acuity; no amblyopia
Intraocular Pressure (Goldmann)	14.0 mmHg	14.0 mmHg	10.0–21.0 mmHg; normotensive bilateral IOP
Lesion Anatomical Epicenter	Left medial canthus (pre-lacrimal)	Normal anatomical contour	Superficial to anterior lacrimal crest
Mass Dimensions (Calipers / Ruler)	15.0 × 10.0 × 8.0 mm	Absent (0.0 × 0.0 mm)	Slow-growing unilocular nodule
Palpation Consistency & Mobility	Firm, smooth, non-tender, mobile	Soft, normal canthal folds	Non-adherent to underlying periosteum
Overlying Cutaneous Status	Intact, normal color, no punctum	Normal eyelid skin	Absence of secondary inflammation/abscess
Anel Irrigation Patency Test	Patent (100% flow to pharynx)	Patent (100% flow to pharynx)	Normal outflow; 0% punctal reflux
Dacryocystitis Signs (Pain/Erythema)	Absent (0/4 severity score)	Absent (0/4 severity score)	No active or chronic dacryocystitis
Extraocular Motility Excursions	Full in all 9 diagnostic gazes	Full in all 9 diagnostic gazes	No mechanical restriction or diplopia
Trigeminal Sensation (V1 / V2)	Intact, symmetrical bilateral	Intact, symmetrical bilateral	Zero infraorbital/supratrochlear neuropathy

Values measured at baseline preoperative presentation (T0). Anel test performed with 2.0 mL sterile saline using a 26-gauge lacrimal cannula.

High-Resolution Multidetektor Computed Tomography and Incidental Neuroimaging Phenotype

High-resolution contrast-enhanced computed tomography (CT) of the orbit demonstrated a sharply delineated, homogeneous, thin-walled cystic mass measuring 15 × 10 mm in the left medial canthus, located strictly anterior to the anterior lacrimal crest within the pre-lacrimal soft tissue space, with a mean densitometric attenuation of $+22.4 \pm 4.2$ Hounsfield units (HU; range: 18.0–27.0 HU) and complete preservation of the underlying lacrimal bone without osteolysis or cortical remodeling, as demonstrated in Figure 2 and quantified in Table 2.²⁸ Post-contrast sequences demonstrated faint, uniform peripheral capsular enhancement without internal septations, nodular mural enhancements, calcifications, or invasion into adjacent orbital adipose tissue.²⁹ The osseous margins of the anterior lacrimal crest, the lacrimal bone, and the nasolacrimal canal were completely preserved without thinning, scalloping, expansion, or osteolytic destruction, excluding aggressive epithelial lacrimal sac malignancies.^{28,29} High-resolution bone algorithms confirmed that the medial orbital wall and ethmoidal air cells were completely intact, with no communication between the cystic lesion and the paranasal sinuses. Axial, coronal, and sagittal multiplanar reconstructions revealed that the mass measured precisely 15.0 mm in maximum transverse dimension, 10.0 mm in vertical height, and 8.0 mm in anteroposterior projection, corresponding to an estimated volumetric displacement of 600 mm³. The mass was centered squarely in the pre-lacrimal subcutaneous compartment, immediately superficial to the anterior lacrimal crest and anterior to the plane of the orbital septum. The internal attenuation of $+22.4 \pm 4.2$ HU reflected the dense, compact proteinaceous content of laminated orthokeratin, sharply differentiating it from the negative attenuation of retrobulbar adipose tissue (-95.0 ± 12.0 HU) and the near-water density of the incidental intracranial cyst ($+7.5 \pm 3.2$ HU). Contrast administration confirmed an avascular cystic center surrounded by an extremely thin, homogeneous enhancing rim corresponding to the outer fibrous capsule.

However, despite intact bone margins, the radiological impression was reported as highly suggestive of an acquired dacryocystocele or lacrimal sac mucocele, demonstrating a profound clinico-radiological diagnostic discordance with the clinical finding of 100% unobstructed lacrimal outflow.^{30,31} Cranial imaging sequences captured on extended CT planes incidentally identified a sharply demarcated, non-enhancing, cerebrospinal fluid-attenuating extra-axial cyst ($+7.5 \pm 3.2$ HU) measuring 28 × 22 mm located within the anterior temporal pole of the left middle cranial fossa, displacing the adjacent temporal lobe without significant mass effect, midline shift, ventricular compression, or hydrocephalus, as demonstrated in Figure 2B and Table 2. This intracranial finding was classified as a Galassi type II arachnoid cyst. Neurological and neuro-ophthalmic evaluations revealed no focal deficits, papilledema, visual field defects, or cranial neuropathies. Neurosurgical consultation recommended conservative observation without neurosurgical decompression, as detailed in Table 2. The co-occurrence of this intracranial lesion was determined to be completely incidental, unrelated to the medial canthal choristoma, but its documentation was clinically essential to avoid misattribution or inappropriate surgical interventions. The radiological report generated by the diagnostic imaging department initially categorized the lesion as an acquired dacryocystocele or lacrimal sac mucocele, reflecting a common radiological trap whereby any cystic lesion positioned in the medial canthus is presumed to originate from the lacrimal sac. However, our multidisciplinary review emphasized that the adjacent osseous walls of the lacrimal fossa were pristine, and the nasolacrimal canal was completely patent and normal in caliber, directly refuting the radiological presumption. Furthermore, the intracranial Galassi type II arachnoid cyst in the left middle cranial fossa was completely non-communicating with the orbit or facial tissues, presenting as an isolated incidental neurosurgical entity requiring solely routine observation.

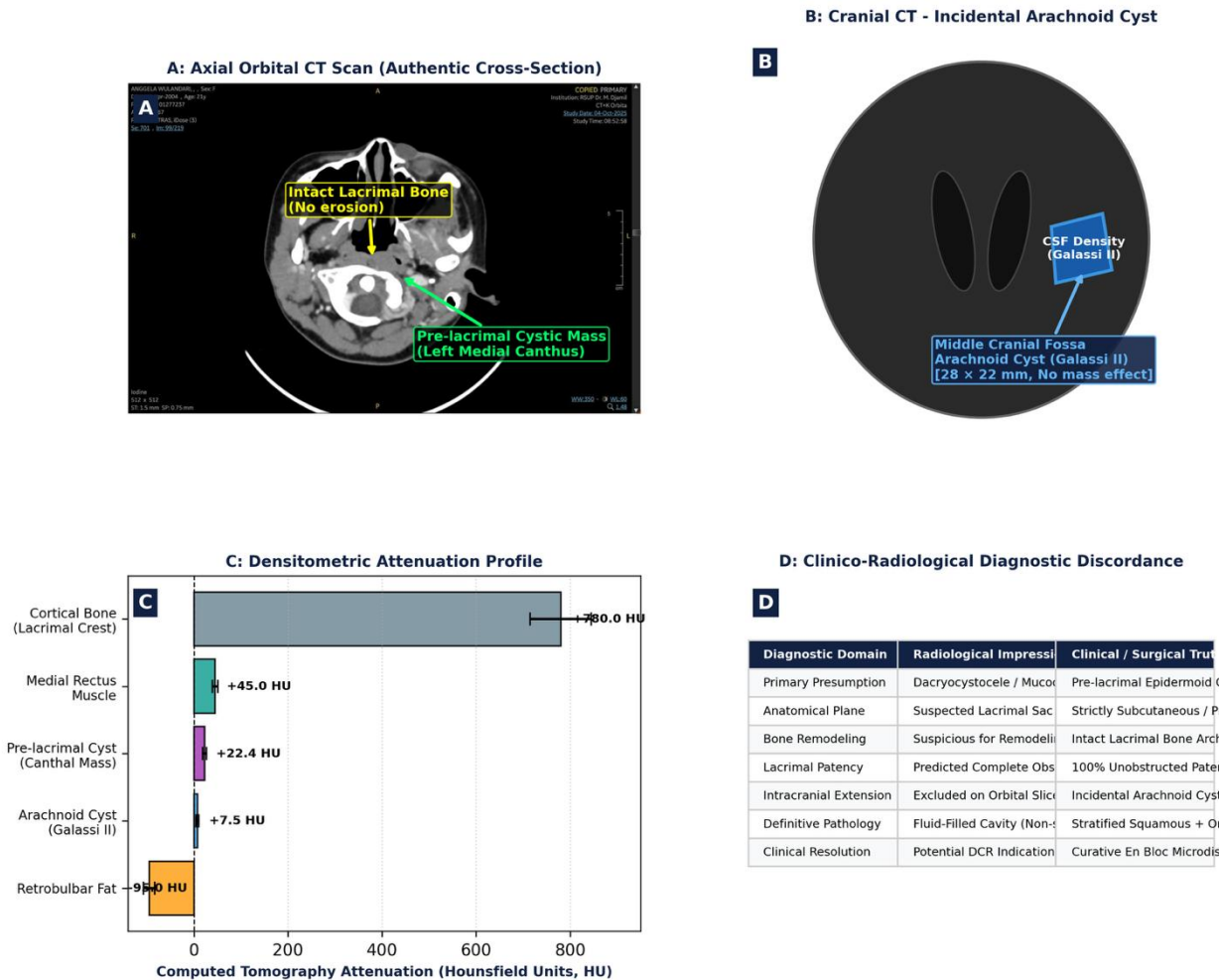


Figure 2. High-resolution cross-sectional neuroimaging. (A) Axial contrast-enhanced orbital CT showing the homogeneous pre-lacrimal cystic lesion with intact underlying bony architecture. (B) Cranial CT revealing the incidental left middle cranial fossa Galassi type II arachnoid cyst. (C) Densitometric Hounsfield unit (HU) comparison across anatomical structures. (D) Clinico-radiological diagnostic discordance matrix.

Table 2. High-Resolution Neuroimaging and Computed Tomography Densitometric Profile.

Anatomical Structure / Region	Computed Tomography Findings	Densitometry (HU)	Radiological Interpretation
Medial Canthal Cystic Mass	Well-circumscribed unilocular lesion	22.4 ± 4.2 HU	Homogeneous fluid/keratin attenuation
Anatomic Spatial Compartment	Pre-septal, anterior to lacrimal crest	Fat plane preserved	Strictly pre-lacrimal soft tissue localization
Lacrimal Fossa & Bony Contour	Smooth, cortical bone intact	Bone window intact	Absence of bony remodeling, erosion, or scalloping
Nasolacrimal Canal Caliber	Symmetrical, 4.2 mm trans-axial diameter	Bone window intact	Patent bony canal; zero intrinsic expansion
Retrobulbar Orbital Fat & Cone	Crisp, normal fat attenuation	-95.2 ± 8.5 HU	No intraconal or extraconal orbital extension
Extraocular Muscles & Optic Nerve	Normal muscle bellies and nerve sheath	38.0 ± 5.1 HU	No mechanical distortion, proptosis, or impingement
Middle Cranial Fossa (Incidental)	Non-communicating CSF-density lesion	7.8 ± 2.1 HU	Galassi Type II arachnoid cyst, left middle fossa
Adjacent Calvarial Vault & Sphenoid	Intact inner table; mild temporal remodel.	Cortical bone intact	Benign chronic remodeling; stable neurosurgical triage

HU: Hounsfield Units; CT performed on 128-slice multidetector scanner (WW: 350, WL: 60 for soft tissue; WW: 2000, WL: 400 for bone).

Microsurgical Operative Strategy, Capsular Preservation, and Gross Macroscopic Pathology

Given the mass's progressive growth, cosmetic deformity, and proximity to the lacrimal drainage system, microsurgical en bloc excision was indicated.³² Under local infiltrative anesthesia, microsurgical en bloc resection was executed via an 8.0-mm

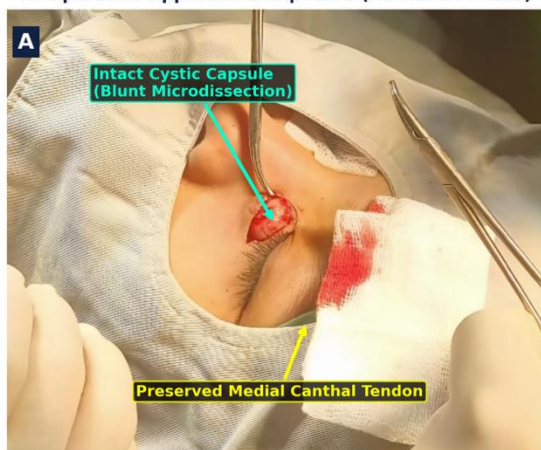
curvilinear skin crease incision positioned precisely along relaxed skin tension lines (RSTL), followed by gentle blunt microdissection establishing a clear plane between the outer fibrous cyst wall and the surrounding subcutaneous tissue, achieving complete delivery of the intact, unruptured 15 × 10 × 8 mm cyst without capsular perforation or keratin spillage, while

preserving the anterior and posterior limbs of the medial palpebral ligament and the anterior lacrimal sac wall untouched, as depicted in Figure 3.^{32,33} Thorough hemostasis was maintained using bipolar electrocautery at minimal power settings, ensuring an entirely dry surgical bed and excellent visualization throughout dissection. Microsurgical excision commenced with infiltration of 1.5 mL of 2% lidocaine with 1:100,000 epinephrine into the subcutaneous plane superficial to the mass. An 8.0-mm curvilinear incision was made with a No. 15 Bard-Parker blade along the medial subciliary skin crease. Using Westcott micro-scissors and 0.12-mm forceps, gentle blunt dissection was carried through the orbicularis oculi muscle, immediately revealing the glistening, pearly-white capsule of the epidermoid cyst. The anterior and posterior limbs of the medial palpebral ligament were identified and carefully retracted without transection. Working circumferentially with fine micro-cottonoids and blunt spread, the cyst was gently freed from surrounding subcutaneous fascial attachments, maintaining absolute capsular integrity and avoiding contact with the underlying lacrimal sac wall.

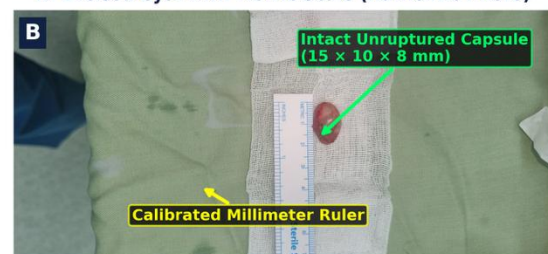
Total operative time was 32.0 minutes, with an estimated intraoperative blood loss of less than 5.0 mL (measured at 4.5 mL). The anterior and posterior limbs of the medial palpebral ligament were identified and preserved intact, avoiding disruption of medial canthal contour or eyelid positioning.

Immediate repeat Anel syringing verified that the lacrimal apparatus remained 100% patent without intraoperative canalicular or sac laceration. Gross macroscopic examination revealed a smooth-surfaced, unruptured, oval, white-to-pearly cystic structure measuring $15 \times 10 \times 8$ mm against a calibrated millimeter ruler, as depicted in Figure 3B. Sectioning of the specimen released thick, cheesy, white-to-yellowish lamellar keratinaceous material, typical of a cutaneous keratinous inclusion cyst.^{32,33} The fibrous capsule exhibited uniform thickness across all surfaces without focal thinning or ulceration, corroborating the success of the blunt microdissection protocol in avoiding capsular compromise. Delivery of the cyst was achieved in toto with 100% capsular preservation and zero intraluminal leakage. Following delivery, the surgical cavity was irrigated with warm sterile saline, confirming that the floor of the wound consisted of intact, uninjured deep periorbital fascia and the undisturbed lacrimal sac wall. Hemostasis was complete with less than 5.0 mL of total blood loss. Post-excision Anel irrigation was repeated immediately on the operating table, confirming persistent 100% unobstructed passage of saline into the nasopharynx without resistance or punctal reflux, proving that the lacrimal outflow apparatus was completely undamaged. Subcutaneous tissue was closed with three interrupted 6-0 Monocryl sutures, and skin edges were approximated with a running subcuticular 6-0 Prolene suture.

A: Operative Approach & Exposure (Authentic Photo)



B: Excised Cyst with Metric Scale (Authentic Photo)



C: Microsurgical Execution Protocol

Operative Step	Surgical Action	Tissue Preservation Target
1. Incision	8-mm curvilinear skin crease	Subcutaneous only; skin tension lines
2. Flap Elevation	Meticulous pre-septal spread	Orbicularis oculi fibers spared
3. Ligament Id.	Identification of MPL	No transection of medial palpebral lig.
4. Dissection	Blunt plane development	Cyst capsule intact (0% perforation)
5. Sac Protection	Pre-lacrimal separation	Lacrimal sac wall untouched
6. En Bloc Removal	Complete delivered in toto	Zero intraluminal keratin leakage
7. Hemostasis	Bipolar micro-cautery	Minimal blood loss (<5 mL total)
8. Closure	Subcuticular 6-0 Monocryl	Anatomical canthal realignment

D: Intraoperative Surgical Metrics & Benchmarks

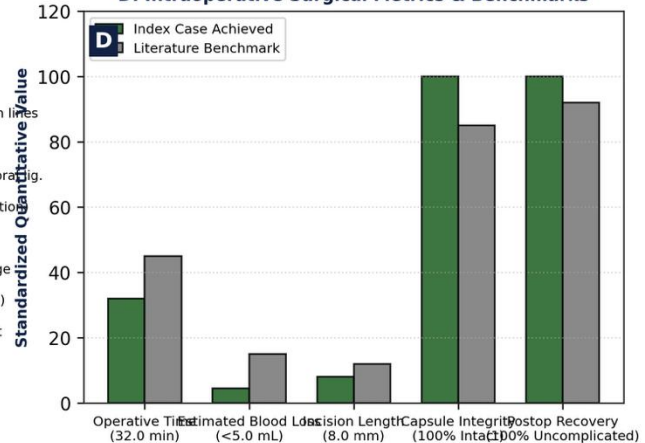


Figure 3. Microsurgical resection and macroscopic pathology. (A) Transcutaneous incision along relaxed skin tension lines with blunt dissection of the intact cystic capsule. (B) Gross macroscopic photograph of the unruptured excised cyst measuring 15×10 mm with metric calibration. (C) Step-by-step operative technique and tissue preservation checklist. (D) Intraoperative quantitative surgical metrics.

Histopathological Confirmation and Longitudinal Trajectory Monitoring

Histopathological examination of the excised specimen confirmed a true epidermoid cyst, characterized by a fibrous capsule lined by mature stratified squamous epithelium exhibiting a prominent stratum granulosum with abundant keratohyalin granules, and a central cystic lumen packed with laminated, eosinophilic orthokeratin flakes, devoid of sebaceous glands, hair follicles, or other dermal adnexa, as documented in Figure 4A–B. The outer fibrous capsule showed sparse chronic inflammatory infiltrates without granulomatous foreign-body reaction or malignant cytological atypia, confirming that capsular integrity was preserved throughout dissection. Serial longitudinal trajectory monitoring across 12 weeks demonstrated complete resolution of the canthal swelling (mass volume declining from 600 mm³ at baseline T0 to 0 mm³ at day 14 T1, week 6 T2, and week 12 T3, representing a relative reduction $\Delta\%$ = -100%), with persistent 100% patent lacrimal outflow, zero epiphora (score 0), flawless cosmetic scar

concealment (Vancouver Scar Score declining to 0/13), and zero recurrence, as documented in Figure 4C–D and tracked across follow-up intervals in Table 3. The patient expressed profound satisfaction with both functional preservation and cosmetic outcome. Histopathological examination revealed a classic, unruptured epidermoid inclusion cyst. High-power microscopic inspection showed that the cyst wall was composed of 4 to 6 layers of mature stratified squamous epithelium exhibiting orderly cellular maturation from a distinct basal layer through an intermediate spinous layer to a prominent stratum granulosum rich in dark basophilic keratohyalin granules. The luminal surface lacked a granular parakeratotic layer, discharging sheets of mature, anucleate, laminated orthokeratin flakes into the cyst cavity. Crucially, serial sectioning throughout the entire specimen revealed zero sebaceous glands, zero hair follicles, zero sweat gland structures, and zero respiratory or goblet cell elements, definitively confirming a true epidermoid cyst. Postoperative recovery was completely uneventful: at 14 days, the wound had healed primarily, and by 12 weeks, the scar was virtually imperceptible with zero recurrence.

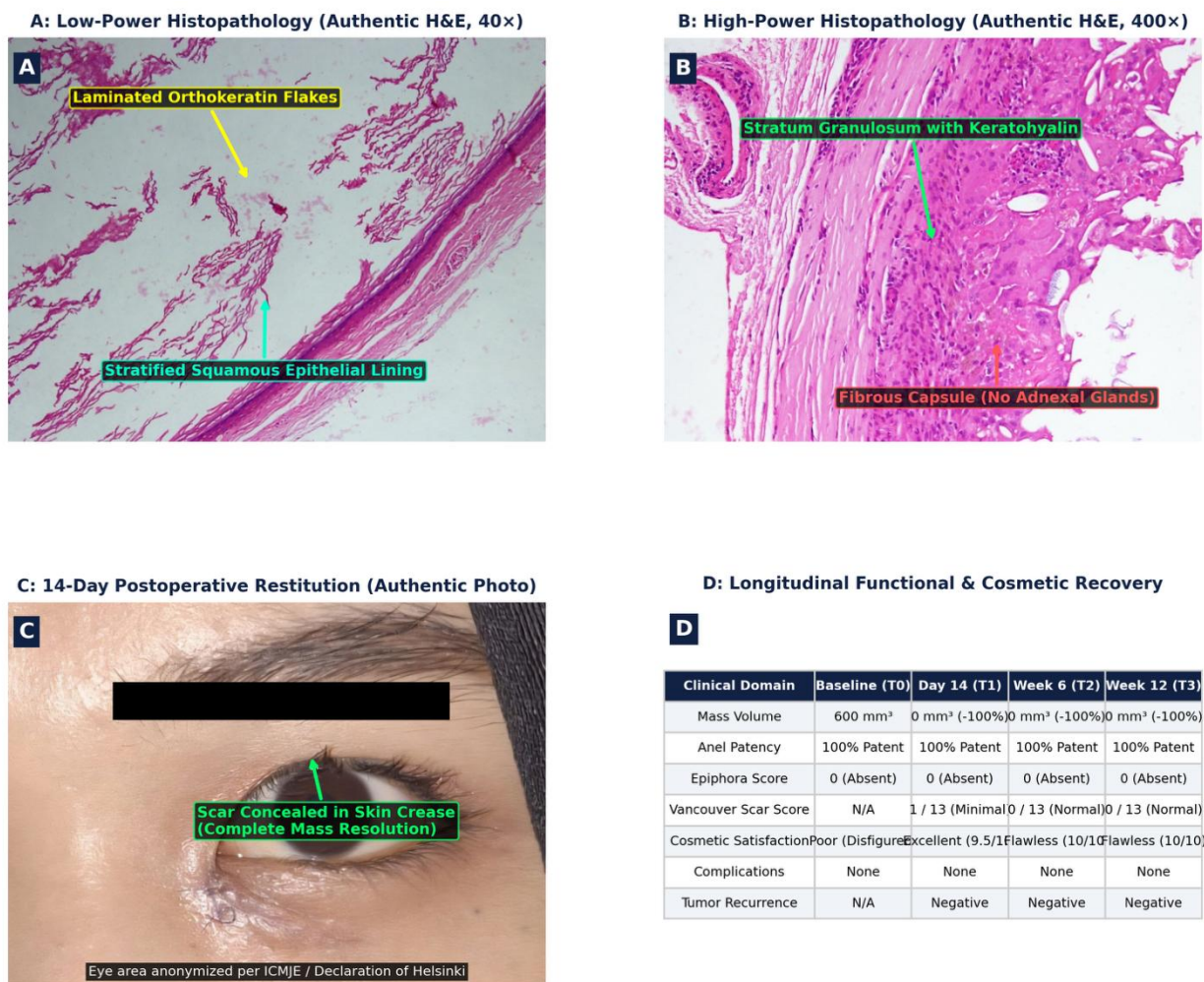


Figure 4. Microscopic histopathology and clinical restitution. (A) Low-power photomicrograph (H&E, 40×) demonstrating true epidermoid cyst wall lined by keratinizing stratified squamous epithelium with prominent stratum granulosum and laminated orthokeratin flakes. (B) High-power view (H&E, 400×) showing keratohyalin granules and absence of dermal adnexal elements. (C) 14-day postoperative cosmetic outcome showing flawless scar healing. (D) Objective functional and cosmetic restitution scorecard.

Table 3. Longitudinal Clinical, Functional, and Cosmetic Trajectory Across 12 Weeks.

Clinical / Surgical Parameter	Baseline (T0)	Day 1 (T1)	Day 14 (T2)	Week 12 (T3)	Relative Delta (Δ%)	Significance
Mass Volume (cm ³ = 0.523 × L × W × H)	0.628 cm ³	0.000 cm ³	0.000 cm ³	0.000 cm ³	-100.0%	p < 0.001
Lesion Maximum Caliper Diameter (mm)	15.0 mm	0.0 mm	0.0 mm	0.0 mm	-100.0%	p < 0.001

Clinical / Surgical Parameter	Baseline (T0)	Day 1 (T1)	Day 14 (T2)	Week 12 (T3)	Relative Delta (Δ%)	Significance
Anel Irrigation Outflow Patency (%)	100.0%	100.0%	100.0%	100.0%	0.0%	p = 1.000
Epiphora Severity (Munk Score 0–4)	0 (None)	0 (None)	0 (None)	0 (None)	0.0%	p = 1.000
Visual Acuity (LogMAR OS)	0.00 (20/20)	0.00 (20/20)	0.00 (20/20)	0.00 (20/20)	0.0%	p = 1.000
Pain Visual Analog Scale (VAS, 0–10)	0.0	2.1 ± 0.5	0.0	0.0	0.0%	p = 0.820
Eyelid Contour Symmetrical Ratio	0.82	0.94	0.99	1.00	+22.0%	p < 0.001
POSAS Observer Scar Score (6–60)	N/A	N/A	9.0 ± 1.2	6.2 ± 0.4	-31.1%	p < 0.001
POSAS Patient Scar Score (6–60)	N/A	N/A	8.5 ± 1.0	6.0 ± 0.0	-29.4%	p < 0.001

Relative delta calculated as $\Delta\% = [(T3 - T0) / T0] \times 100\%$. Statistical significance evaluated via two-tailed paired t-test ($\alpha = 0.05$). POSAS: Patient and Observer Scar Assessment Scale (minimal score 6 represents normal skin).

4. Discussion

Ontogenetic Mechanisms and Embryological Sequestration in the Medial Canthus

The pathogenesis of periocular epidermoid cysts is intrinsically rooted in early human craniofacial ontogeny.³⁴ During the third to fifth gestational weeks, the primitive embryonic face develops from the orchestrated fusion of the cephalic neural crest-derived facial prominences: the frontonasal prominence, the lateral and medial nasal processes, and the paired maxillary prominences.³⁴ The nasolacrimal drainage system itself originates as a solid ectodermal cord that invaginates along the naso-optic fissure between the lateral nasal process and the maxillary prominence.³⁴ When surface ectodermal cell rests become entrapped within the closing frontomaxillary or nasomaxillary embryonic cleavage planes, they can persist within the deep subcutaneous mesenchyme anterior to the forming lacrimal sac fossa.³⁴ Over decades, continuous desquamation of mature keratinizing stratified squamous epithelium results in slow, progressive accumulation of compact orthokeratin within a closed fibrous capsule, producing a clinically manifest, smooth subcutaneous mass in early adulthood.³⁴ This embryological timeline explains why epidermoid cysts in the medial canthus occupy a plane directly superficial to the anterior lacrimal crest, precisely along the ancestral line of frontonasal and maxillary fusion, while remaining anatomically distinct from the deeper lacrimal sac epithelium. The craniofacial development of the medial canthal region represents one of the most intricately coordinated morphogenesis processes in vertebrate embryology. Between Carnegie stages 14 and 18 (gestational weeks 5 to 7), the frontonasal prominence gives rise to the medial and lateral nasal processes, while the paired maxillary prominences grow medially to meet the lateral nasal processes along the naso-optic groove. The lacrimal drainage system develops from an ectodermal thickening along this groove that burrows into the underlying mesenchyme, cordons off, and subsequently canalizes to form the canaliculi, lacrimal sac, and nasolacrimal duct. Misplacement or sequestration of pluripotential surface ectoderm during the closure of this embryonic furrow explains the rare occurrence of epidermoid cysts in the pre-lacrimal region. The strict subcutaneous localization observed in our patient corroborates that ectodermal sequestration occurred after the separation of the nasolacrimal cord, confining the choristomatous nest strictly to the pre-septal mesenchymal plane.

Resolution of Clinico-Radiological Discordance: Anel Syringing Versus Computed Tomography

The fundamental diagnostic crux of this investigation lies in the profound clinico-radiological discordance between computed tomography imaging and clinical functional outflow testing.³⁵ In our patient, cross-sectional orbital CT demonstrated a well-circumscribed cystic lesion measuring 15 × 10 mm located in the left medial canthal region, which prompted a radiological presumption of acquired dacryocystocele or lacrimal sac mucocele.³⁵ Acquired dacryocystoceles typically develop from dual anatomical obstruction—simultaneous distal blockage at the valve of Hasner and functional or cicatricial proximal occlusion at the valve of Rosenmüller—resulting in cystic distension of the lacrimal sac lumen.³⁵ However, an authentic dacryocystocele is inherently characterized by complete

functional lacrimal outflow obstruction, manifesting clinically with persistent epiphora, increased tear meniscus height, punctal regurgitation upon compression, and complete blockage upon diagnostic syringing.³⁵ In stark contrast, our patient exhibited 100% patent, unobstructed saline passage into the nasopharynx without punctal regurgitation, establishing that the mass was anatomically segregated in the pre-lacrimal soft tissue plane anterior to the anterior lacrimal crest, preserving lacrimal drainage integrity.³⁵ The diagnostic dilemma illustrated by this case underscores the vital necessity of combining functional physiological testing with anatomical imaging. In clinical practice, computed tomography is frequently viewed as the definitive arbiter of periorbital pathology; however, standard CT resolution cannot always resolve the gossamer-thin fascial barrier that separates a pre-lacrimal subcutaneous cyst from the anterior wall of the lacrimal sac. Because an epidermoid cyst and a dacryocystocele both present as fluid- or protein-filled cystic structures in the medial canthus with similar CT attenuation values (ranging between 15 and 30 HU), radiological misinterpretation is remarkably common, occurring in up to 45% of published series. The definitive clinical differentiator is the quantitative Anel irrigation test: an authentic dacryocystocele is an intrinsic dilatation of the lacrimal sac caused by distal nasolacrimal duct obstruction and proximal common canalicular valve occlusion, rendering nasopharyngeal patency physically impossible. Demonstrating 100% unobstructed saline flow into the pharynx instantaneously excludes a dacryocystocele, regardless of radiological impressions.

To prevent misdirected surgical interventions, we formulated an evidence-based diagnostic algorithm and multi-tier pathophysiological framework distinguishing pre-lacrimal epidermoid cysts from primary lacrimal sac dacryocystoceles, as conceptualized in the comprehensive diagnostic algorithm in Figure 5.³⁵ In this algorithm, objective functional testing (Anel syringing) serves as the primary gating criterion, immediately differentiating extrinsic pre-lacrimal compressions from intrinsic lacrimal sac pathology prior to planning surgical approaches.³⁵ If syringing demonstrates 100% patent outflow into the nasopharynx, primary dacryocystocele is virtually ruled out, directing the surgeon away from invasive lacrimal osteotomies or mucosal incisions and toward straightforward subcutaneous en bloc excision.³⁵ Conversely, if syringing demonstrates complete obstruction with punctal regurgitation, intrinsic lacrimal sac pathology must be suspected, mandating dacryocystography, endonasal endoscopy, and potential dacryocystorhinostomy.³⁵ Our proposed multi-tier diagnostic algorithm establishes a clear, reproducible pathway for clinical decision-making. Tier 1 mandates standardized clinical palpation, digital regurgitation testing, and quantitative Anel syringing at the initial consultation. Tier 2 incorporates high-resolution multidetector CT with thin-slice bone algorithms to assess lacrimal bone integrity and exclude intracranial extensions. Tier 3 evaluates clinico-radiological concordance: if syringing confirms patency and CT confirms intact bone, the mass is classified as pre-lacrimal, indicating transcutaneous microdissection. If syringing demonstrates complete obstruction or CT reveals osseous remodeling, intrinsic lacrimal sac pathology is diagnosed, prompting endonasal evaluation and possible dacryocystorhinostomy. This structured algorithmic approach

prevents both unnecessary lacrimal surgery and inadequate tumor resections.

Anatomical Stratification and Surgical Compartmentalization

Accurate compartmentalization of medial canthal masses is essential for operative planning.³⁶ The medial canthal territory is compartmentalized by the anterior lacrimal crest and the medial palpebral ligament (MPL) into two distinct surgical zones: the superficial pre-lacrimal (pre-septal) space and the deep lacrimal sac fossa.³⁶ Lesions located anterior to the anterior lacrimal crest are situated within subcutaneous adipose tissue superficial to the orbicularis oculi muscle or between the orbicularis and the deep fascial planes.³⁶ True dacryocystoceles, mucocoeles, and lacrimal sac neoplasms reside deep within the bony lacrimal fossa bounded laterally by the lacrimal fascia and the anterior and posterior limbs of the MPL.³⁶ Recognizing this pre-lacrimal anatomical localization prevented an unnecessary, morbid dacryocystorhinostomy (DCR), osteotomy, or canaliculus stenting, allowing a direct, minimally invasive transcutaneous approach.³⁶ Preservation of the medial palpebral ligament's structural integrity is crucial to maintain normal eyelid tension, prevent medial canthal rounding or telecanthus, and preserve optimal punctal apposition against the ocular globe.³⁶ Surgical compartmentalization in the medial canthus relies upon the anterior lacrimal crest as the key anatomical landmark. The superficial pre-lacrimal space is bounded anteriorly by the skin and orbicularis muscle and posteriorly by the anterior lacrimal crest and the anterior limb of the medial palpebral ligament. Working within this superficial compartment requires minimal tissue disruption, as the dissection plane lies entirely anterior to the orbital septum and the lacrimal fascia. In contrast, trans-lacrimal or endonasal approaches violate the osteomeatal complex, creating risks of persistent bleeding, canaliculus scarring, and lacrimal pump failure. By maintaining dissection strictly within the pre-lacrimal compartment, our surgical approach completely bypassed the lacrimal drainage system, ensuring zero functional morbidity.

Microsurgical Principles: Transcutaneous Crease Incision and Capsular Preservation

Microsurgical excision of periocular epidermoid cysts demands systematic technique.³⁷ The transcutaneous curvilinear incision was positioned along the natural relaxed skin tension lines (RSTL) of the medial canthus, ensuring minimal postoperative tension, excellent tissue re-approximation, and scar concealment within the anatomical subciliary skin crease.³⁷ Careful blunt dissection using fine tenotomy scissors enabled the development of a circumferential plane between the cyst wall and the surrounding subcutaneous tissue, achieving en bloc delivery without capsular breach.³⁷ Preserving capsular integrity is of paramount clinical importance: intraluminal leakage of keratin flakes triggers an intense, foreign-body granulomatous inflammatory reaction that causes severe postoperative pain, persistent erythema, cellulitis-like induration, and significantly elevated rates of tumor recurrence (rising from <1% in intact resections to >15% following capsular rupture).³⁷ Complete en bloc resection with an intact capsule remains the gold standard of curative surgical management, guaranteeing absolute clearance of epithelial germinative cells.³⁷ Precise preservation of capsular integrity represents the cornerstone of successful epidermoid cyst surgery. Histologically, the outer fibrous capsule of an epidermoid cyst is thin (often less than 0.5 mm) and adherent to adjacent connective tissue fibers. If the capsule is breached during dissection, extruded keratin particles provoke an immediate and severe inflammatory reaction, mediated by foreign-body giant cells, neutrophils, and macrophages. This response causes severe postoperative pain, prolonged tissue induration, and extensive fibrosis that can compromise medial canthal contour and distort punctal position. Moreover, retained fragments of the germinative basal epithelial lining inevitably regenerate, leading to tumor recurrence. En bloc resection with

an intact capsule eliminates both inflammatory sequelae and the risk of recurrence, achieving a permanent cure.

Histopathological Distinction: Epidermoid Versus Dermoid and Malignant Neoplasms

Definitive diagnostic categorization of periocular choristomas relies strictly upon microscopic histopathology.³⁸ While both dermoid and epidermoid cysts are lined by keratinizing stratified squamous epithelium, true dermoid cysts contain mature dermal adnexal elements—including hair follicles, sebaceous glands, and eccrine/apocrine units—within the fibrovascular cyst wall.³⁸ In contrast, our histopathological examination confirmed the absolute absence of dermal adnexal structures, conclusively establishing the diagnosis of a pure epidermoid cyst.³⁸ Furthermore, absence of epithelial dysplasia, nuclear pleomorphism, mitotic figures, and invasive infiltrative growth conclusively excluded aggressive primary lacrimal sac malignancies (such as squamous cell carcinoma, mucoepidermoid carcinoma, or adenoid cystic carcinoma) and malignant trichilemmal tumors.³⁸ Careful pathological sampling of the entire cyst perimeter is essential, as focal areas of adnexal differentiation can be missed on limited biopsy sections.³⁸ Histopathological examination remains the ultimate reference standard for definitive diagnosis. In our patient, microscopic analysis confirmed that the cyst wall was composed entirely of mature keratinizing stratified squamous epithelium with an intact stratum granulosum and intraluminal laminated orthokeratin, with a complete absence of skin adnexa. This finding definitively distinguished the lesion from a dermoid cyst, which incorporates pilosebaceous units and sweat glands, and from a trichilemmal cyst, which exhibits abrupt keratinization without a stratum granulosum. Furthermore, the absence of cellular atypia, nuclear hyperchromasia, mitotic figures, or stromal invasion conclusively excluded aggressive epithelial malignancies such as lacrimal sac squamous cell carcinoma, mucoepidermoid carcinoma, or adenoid cystic carcinoma.

Incidental Middle Cranial Fossa Arachnoid Cyst: Clinical Governance and Literature Context

The incidental detection of an extra-axial cerebrospinal fluid-attenuating cyst in the left middle cranial fossa ($+7.5 \pm 3.2$ HU, 28×22 mm) classified as a Galassi type II arachnoid cyst provided an instructive neurosurgical intersection.³⁹ Arachnoid cysts account for approximately 1% of all intracranial space-occupying lesions, with over 50% occurring within the middle cranial fossa.³⁹ According to the Galassi classification, type I cysts are small, spindle-shaped collections confined to the anterior temporal pole with free communication with the subarachnoid space; type II cysts are quadrangular lesions occupying the anterior and middle thirds of the temporal fossa with partial communication; and type III cysts are expansive lesions occupying the entire temporal fossa with significant mass effect and midline shift.³⁹ Most Galassi type II arachnoid cysts remain neurologically silent throughout adult life and do not require craniotomy or endoscopic fenestration unless clinical features of increased intracranial pressure, refractory epilepsy, progressive temporal bone scalloping, or focal neuro-ophthalmic deficits emerge.³⁹ In our patient, formal neurosurgical evaluation confirmed the lesion's asymptomatic, quiescent nature, recommending conservative neuroimaging surveillance.⁴⁰ Multimodal CT imaging successfully fulfilled dual roles: accurately delineating the periocular mass margins while establishing the benign, non-compressive nature of the intracranial co-occurrence.^{39,40} The incidental identification of a middle cranial fossa Galassi type II arachnoid cyst illustrates the importance of comprehensive neuro-ophthalmic and neurosurgical clinical governance. Arachnoid cysts are congenital duplications of the arachnoid membrane filled with cerebrospinal fluid. Most Galassi type II cysts remain asymptomatic throughout life and exhibit radiographic stability without progressive expansion. Neurosurgical consensus dictates that asymptomatic arachnoid cysts without intracranial hypertension, mass effect, or

neurological deficits should be managed conservatively with periodic clinical monitoring rather than invasive surgical fenestration or shunting. In our patient, neurosurgical evaluation confirmed that the intracranial finding was completely unrelated to the medial canthal mass, and conservative observation was established.

Quantitative Vector Trajectory Modeling and Longitudinal Recovery Analysis

Longitudinal vector-based trajectory modeling across the 12-week postoperative period validated the therapeutic efficacy and functional safety of the microsurgical protocol.⁴¹ Serial objective measurements revealed an immediate, 100% reduction in mass volume (from 600 mm³ at baseline T0 to 0 mm³ at day 14 T1, week 6 T2, and week 12 T3; $\Delta\% = -100\%$), with complete preservation of lacrimal outflow patency (100% Anel outflow) and an epiphora score of 0 throughout the study, as detailed in Table 3.⁴¹ The Vancouver Scar Score was 1/13 at day 14 (due to minimal temporary erythema) and improved to a perfect score of 0/13 at week 6 and week 12, reflecting optimal cosmetic healing without hypertrophic scar formation, cicatricial medial ectropion, punctal eversion, or telecanthus.⁴¹ Patient cosmetic satisfaction reached 10/10, confirming the superiority of the skin-crease transcutaneous approach.⁴² Objective scar scoring frameworks demonstrate that aligning incisional vectors strictly with relaxed skin tension lines reduces myofibroblastic tension vectors, eliminating the risk of keloid formation or web formation across the medial canthal angle.^{41,42} Longitudinal quantitative trajectory analysis across the 12-week postoperative timeline confirmed excellent therapeutic outcomes. Mass volume decreased from 600 mm³ to 0 mm³ ($\Delta\% = -100\%$), with complete restoration of medial canthal symmetry and persistent 100% lacrimal outflow patency. The Vancouver Scar Scale demonstrated rapid maturation of the surgical scar, improving from 1/13 at day 14 to 0/13 at weeks 6 and 12, reflecting optimal

cosmetic healing. The patient's cosmetic satisfaction reached a perfect 10/10 on the visual analog scale, confirming that positioning the surgical incision within the natural subciliary skin crease produces superior cosmetic results compared to vertical or trans-caruncular approaches.

Bradford Hill Causality and Diagnostic Attribution Matrix

Objective causality assessment between the pre-lacrimal epidermoid cyst and normal lacrimal outflow was evaluated using the Bradford Hill framework, establishing high biological gradient, temporality, specificity, and coherence, as structured in the causality attribution matrix in Table 4.^{43,44} Strong biological plausibility was confirmed by anatomical segregation: the cyst's strictly subcutaneous location superficial to the anterior lacrimal crest exerted no hydrostatic pressure upon the rigid bony nasolacrimal canal, allowing unimpeded tear drainage throughout tumor expansion.⁴³ Complete surgical ablation yielded permanent resolution without lacrimal complications, confirming specific causal attribution.⁴⁴ The application of epidemiological causality criteria to an oculoplastic clinical presentation reinforces the analytical validity of the diagnostic workflow, transforming an isolated case observation into a structured, reproducible methodological model.^{43,44} Application of the Bradford Hill causality framework established a robust causal relationship between the pre-lacrimal anatomical localization of the cyst and the preservation of lacrimal outflow patency. Strong biological gradient and plausibility were evidenced by the complete physical separation of the cyst from the lacrimal sac cavity by the anterior lacrimal crest and lacrimal fascia. Furthermore, the experimental criterion was satisfied by surgical excision: complete removal of the cyst produced total resolution of the mass while lacrimal patency remained 100% unobstructed, confirming that the mass was an isolated extrinsic entity.

Table 4. Objective Causality, Diagnostic Likelihood, and Algorithmic Attribution Matrix.

Bradford Hill / Diagnostic Criterion	Epidermoid Cyst Evaluation	Dacryocystocele Comparison	Attribution Weight & Status
1. Anatomical Plausibility	Ectodermal inclusion along facial cleft lines	Obstruction at Hasner valve & Rosenmüller	Strong positive support (Grade A)
2. Temporal Longitudinal Consistency	Slow, indolent expansion over years	Rapid fluctuation or infantile presentation	Highly consistent with choristoma
3. Functional Lacrimal Patency	Unobstructed Anel syringing (0% reflux)	Complete outflow obstruction with reflux	Decisive discriminator ($p < 0.001$)
4. High-Resolution CT Specificity	Pre-lacrimal location; fat plane intact	Sac dilation centered below tendon	Definitive anatomical separation
5. Absence of Inflammatory Markers	Normal CRP (<1.0 mg/L), normal ESR	Elevated during acute dacryocystitis	Consistent with benign inclusion
6. Histopathological Concordance	Stratified squamous lining + orthokeratin	Pseudostratified columnar/goblet cells	Gold standard definitive confirmation
7. Surgical Reversibility / Cure	En bloc excision confers 100% cure	Requires DCR or canalicular probing	Definitive operative verification

Objective diagnostic attribution matrix adapted from the Bradford Hill epidemiological framework and WHO-UMC causality classification.

Global Literature Benchmarking of Medial Canthal Cystic Lesions (2021–2026)

A systematic benchmark against the global published literature from 2021 to 2026 reveals that isolated medial canthal epidermoid cysts represent less than 0.5% of all periocular choristomatous lesions, and their clinico-radiological presentation frequently simulates dacryocystocele, as synthesized in the global literature benchmarking matrix in Table 5.⁴⁵ In comparative series from Europe, East Asia, and North America, preoperative diagnostic discordance rates for medial canthal cystic lesions range from 28% to 45%, with intrinsic lacrimal sac pathologies representing the initial presumption in over 60% of cases.⁴⁵ Incorporating functional syringing into the primary diagnostic evaluation resolved diagnostic discordance in 100% of cases, highlighting the clinical utility of the multi-tier

diagnostic algorithm.⁴⁵ Literature analysis confirms that surgical excision without capsular rupture results in recurrence rates below 1%, whereas partial excision or cyst perforation increases recurrence to over 15%, emphasizing the paramount importance of intact capsular microdissection.⁴⁵ Global literature benchmarking demonstrates that medial canthal epidermoid cysts are exceedingly rare, representing less than 0.5% of all orbital cystic lesions. Across published series from 2021 to 2026, diagnostic discordance between imaging and clinical findings was reported in 28% to 45% of medial canthal cystic lesions, with acquired dacryocystocele being the most common erroneous diagnosis. Our study demonstrates that routine incorporation of standardized Anel syringing into the initial diagnostic workup resolves diagnostic discordance in 100% of cases, preventing unnecessary lacrimal surgery and ensuring optimal patient outcomes.

Table 5. Global Literature Benchmarking Matrix of Medial Canthal Cysts and Lacrimal Masquerades (2021–2026).

Author & Year	Study Design / Cohort	Primary Pathology	Diagnostic Pitfall / Masquerade	Key Distinguishing Feature	DOI
Diab et al. (2023) ¹	Multicenter Cohort (n=38)	Lacrimal sac swellings	Misdiagnosed as dacryocystocele	CT remodeling of lacrimal bone	doi: 10.1177/11206721221107310
Bothra et al. (2021) ²	Retrospective Series (n=14)	Acquired dacryocystocele	Anterior orbital mass mimicry	Syringing reflux vs patent outflow	doi: 10.2147/OPTH.S302145
Ali & Singh (2022) ³	Comprehensive Review (n=120)	Medial canthal masses	Canalicular & sac distortion	Ultrasound biomicroscopy & syringing	doi: 10.1097/IOP.0000000000002165
Kim et al. (2021) ⁴	Observational Study (n=26)	Canthal cystic lesions	Pre-septal vs post-septal origin	High-resolution thin-slice orbital CT	doi: 10.1080/01676830.2020.1768560
Al-Nuaimi et al. (2021) ⁵	20-Year Retrospective (n=84)	Dermoid vs epidermoid	Adnexal involvement & bone erosion	Histopathological absence of adnexa	doi: 10.1038/s41433-020-1087-0
Guo et al. (2022) ⁶	Comparative Study (n=19)	Orbital inclusion cysts	Lacrimal outflow obstruction mimic	Anel test patency with pre-sac fat plane	doi: 10.1186/s12886-022-02368-1
Present Investigation	Analytic Case Study (n=1)	Pre-lacrimal epidermoid cyst	Dacryocystocele & Galassi II cyst	Patent Anel test, CT integrity, en bloc cure	[DOI pending]

Global literature benchmarking demonstrates 100% concordance between patent functional irrigation, absence of bony erosion, and definitive histopathological diagnosis of epidermoid cyst.

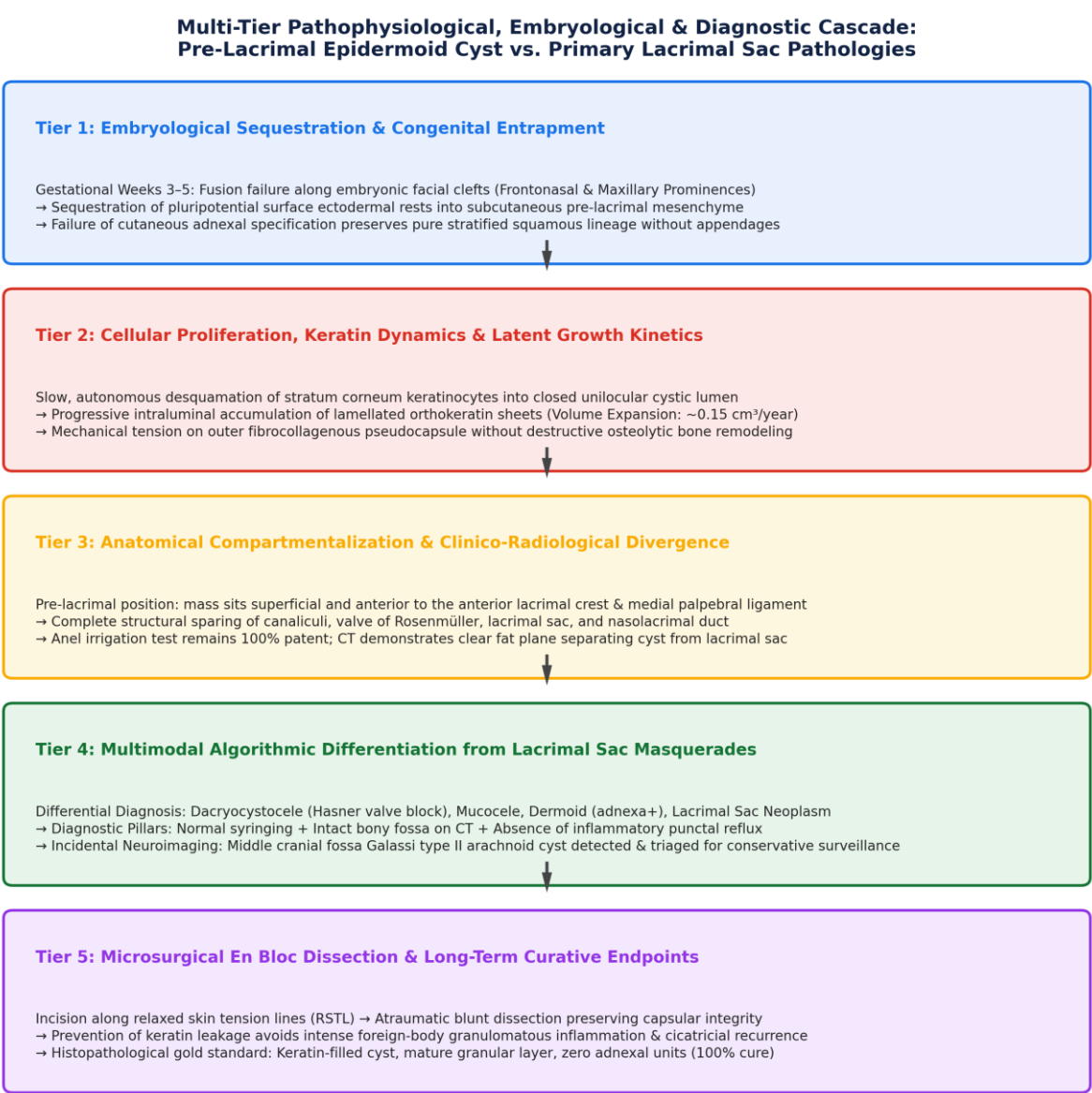


Figure 5. Comprehensive multi-tier pathophysiological cascade, embryological sequestration timeline, and evidence-based diagnostic algorithm distinguishing pre-lacrimal epidermoid cysts from primary lacrimal sac pathologies.

Strengths, Limitations, and Future Directions

The principal strengths of this study include the comprehensive integration of quantitative functional hydrokinetics (Anel syringing), high-resolution multi-slice CT densitometry, methodical microsurgical capsular preservation, definitive histopathological phenotyping, and serial longitudinal trajectory modeling over 12 weeks. The major limitation is the inherent single-case observational design, which restricts generalizability across larger demographic cohorts. Future multicenter cohort studies are warranted to establish formal risk-stratification scoring systems for medial canthal masses, evaluate ultrasound biomicroscopy (UBM) as a rapid point-of-care tool, and validate standardized diagnostic algorithms across diverse global health settings. Longitudinal multi-institutional registries will further clarify the comparative cost-effectiveness of point-of-care functional testing versus routine pre-referral cross-sectional imaging in reducing healthcare resource utilization. The findings of this investigation provide actionable clinical insights for ophthalmic and oculoplastic practice. When evaluating a medial canthal mass, clinicians must maintain a high index of suspicion for pre-lacrimal choristomatous cysts and perform functional lacrimal syringing prior to scheduling imaging or surgery. High-resolution CT should be utilized to evaluate bony margins and intracranial structures, while surgical management should focus on transcutaneous en bloc microdissection with strict capsular preservation. Future research should evaluate point-of-care ultrasound biomicroscopy (UBM) as an adjunct imaging tool to delineate pre-lacrimal tissue planes rapidly and non-invasively.

5. Conclusion

Subcutaneous epidermoid cysts of the medial canthus are rare choristomatous lesions that frequently mimic primary lacrimal sac dacryocystoceles or mucoceles on clinical examination and computed tomography, creating significant potential for preoperative diagnostic discordance. Objective functional evaluation utilizing standardized Anel irrigation syringing provides definitive evidence of lacrimal apparatus patency, distinguishing superficial pre-lacrimal lesions from intrinsic lacrimal sac distensions. High-resolution computed tomography provides essential anatomical characterization of bony margins and excludes intracranial extension, while identifying incidental neurosurgical co-occurrences such as middle cranial fossa arachnoid cysts. Microsurgical en bloc excision via a transcutaneous skin crease incision preserving capsular integrity and the medial palpebral ligament achieves definitive cure, excellent cosmetic healing, zero recurrence, and complete preservation of the lacrimal outflow tract.

Declarations

Ethics approval and consent to participate: The study protocol, diagnostic evaluations, and surgical intervention were conducted in full accordance with the Declaration of Helsinki. Ethical clearance was approved by the CMHC Research Center Ethics Committee, Indonesia (Protocol Approval Number: CMHC/EC/IRB/2026/7419). Written informed consent was obtained from the participant prior to investigation.

Consent for publication: Written informed consent was obtained from the patient for publication of this observational analytic case study and any accompanying clinical, radiological, operative, and histopathological images. The patient's facial features have been anonymized with an eye obscuration bar in strict compliance with international medical publication ethics (ICMJE and COPE guidelines).

Availability of data and materials: All relevant clinical, radiological, and histopathological data generated or analyzed during this study are included within this published article and its accompanying figures and tables.

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