

Pediatric Inguinal Hernia: Contemporary Diagnosis, Timing, and Operative Management

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How to cite this paper: Tang, L., Yin, C.C. (2026) Pediatric Inguinal Hernia: Contemporary Diagnosis, Timing, and Operative Management. *Journal of Biosciences and Medicines*, 14, 218-230.

<https://doi.org/10.4236/jbm.2026.1410015>

Received: September 9, 2026

Accepted: October 20, 2026

Published: October 23, 2026

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Abstract

In most children, an inguinal hernia arises because the processus vaginalis remains open. Repair is therefore directed at closing the internal-ring communication, and mesh reinforcement is seldom required. Although the operation is routine, several decisions are still debated. In premature infants, the risk of incarceration must be weighed against anesthetic and respiratory risk. An open contralateral processus vaginalis may remain asymptomatic, and laparoscopic operations vary enough that their complications should not be considered as a single group. Both open herniotomy and laparoscopic repair usually have low recurrence rates, but available comparisons are too imprecise to exclude meaningful differences in rare injuries and late outcomes. Intracorporeal suturing and percutaneous extraperitoneal closure also have different failure patterns, including incomplete capture of the ring, loss of knot security, and access injury. Recent randomized data favor postponing repair in carefully selected stable premature infants whose hernia is reducible and whose caregivers have reliable follow-up and prompt access to pediatric surgical care. A similarly selective policy is appropriate for the opposite groin. With a pooled metachronous hernia risk of about 6%, approximately 17 prophylactic procedures would be required to prevent one later hernia if every closure were effective. A recent infant trial reported a number needed to treat of 24 to prevent one reoperation during the first year. A dependable number needed to harm is unavailable because complications attributable to treatment of the second side are uncommon and poorly reported. This review considers how age, clinical presentation, operative method, and family circumstances influence diagnosis, timing, choice of repair, contralateral management, and follow-up.

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Keywords

Pediatric Inguinal Hernia, Patent Processus Vaginalis, Laparoscopy, Open Herniotomy, Prematurity, Contralateral Exploration, Incarceration

1. Introduction

Inguinal hernia repair is routine work in pediatric surgery, but the circumstances around the child often determine how urgent or difficult that work becomes. A comfortable school-age child with a reducible swelling presents a different problem from a premature infant with bronchopulmonary dysplasia. Likewise, an open processus vaginalis seen on the opposite side during laparoscopy does not necessarily predict a symptomatic hernia. Guidance from the American Academy of Pediatrics and the European Pediatric Surgeons' Association accordingly recommends that age, comorbidity, reducibility, and the family's access to care be considered together [1]-[3].

A patent processus vaginalis, rather than weakness of the posterior inguinal wall, accounts for most hernias in children; routine mesh reinforcement is therefore unnecessary. Open herniotomy and laparoscopic closure treat this same communication through different routes. Laterality, the exact laparoscopic method, equipment, and local experience all affect the practical choice. Recurrence and major complications are uncommon with either approach in comparative studies, although those studies give less certainty about cord injury, later testicular outcomes, and differences between laparoscopic techniques [2] [4] [5]. The discussion below focuses on decisions encountered in practice: confirming the diagnosis, choosing the timing and approach, dealing with the opposite groin, and managing higher-risk presentations.

2. Literature Identification

We searched PubMed from database inception through September 15, 2026. The principal query combined ("Hernia, Inguinal" [Mesh] OR inguinal hernia*[tiab] OR processus vaginalis [tiab]) with ("Child" [Mesh] OR infant*[tiab] OR child*[tiab] OR pediatric*[tiab] OR paediatric*[tiab]). Additional searches paired these terms with laparoscop*, open repair, herniotomy, intracorporeal, percutaneous, extraperitoneal, prematur*, preterm, contralateral, incarceration, ovary, and anesthesia. We also reviewed the reference lists of relevant guidelines and systematic reviews. Publisher records were checked when recent citations or bibliographic details required confirmation.

English-language guidelines, randomized trials, systematic reviews, meta-analyses, and comparative cohorts of patients younger than 18 years were eligible. We excluded adult-only reports, duplicate cohorts, isolated case reports, conference abstracts without adequate outcome data, and studies that did not report pediatric results separately. Case reports were used only to clarify an uncommon diagnosis

or operative hazard. After screening titles and abstracts, we reviewed in full the papers that addressed diagnosis, timing, operative approach, the contralateral groin, incarceration, ovarian hernia, anesthesia, or long-term outcomes. Recent higher-level evidence was given priority, while older publications were retained when they described an established technique or addressed a question not covered later.

The review was designed as a focused narrative synthesis and was not prospectively registered. Screening was not duplicated independently, and we did not perform a formal risk-of-bias assessment or a new meta-analysis. Reporting the search and eligibility criteria allows readers to judge its scope, but the resulting recommendations should be read as a clinical interpretation of selected evidence, not as a newly developed guideline.

3. Embryological and Anatomical Basis

The processus vaginalis is a peritoneal outpouching that descends with the testis through the inguinal canal. Normally, its proximal portion closes and the distal portion remains as the tunica vaginalis. Persistent communication allows abdominal contents to pass into the canal or scrotum. In girls, the analogous tract accompanies the round ligament through the canal of Nuck and may contain bowel, an ovary, a fallopian tube, or fluid. Whether and where the tract has closed helps distinguish an inguinal hernia and communicating hydrocele from an encysted cord or canal-of-Nuck hydrocele [1].

Most inguinal hernias in young children are indirect. A direct or femoral defect is unusual and warrants reconsideration of the diagnosis, previous operations, connective-tissue disease, and atypical pelvic anatomy. Because the pediatric canal is short, a delicate sac may be closely adherent to the vas deferens and testicular vessels. In open surgery, protecting these structures during proximal dissection is more important than excising the distal sac. Laparoscopic repair has an equivalent requirement: the peritoneum must be closed completely at the internal ring without catching or constricting the vas, vessels, or round ligament [1] [6].

An open internal ring is an anatomical observation; it is not, on its own, a clinical diagnosis. Surgeons identify contralateral patency far more often than children subsequently develop a metachronous hernia. Counseling should reflect this difference, because routine closure of every opening would expose many children to treatment of a side that would never become symptomatic [5] [7].

4. Diagnosis and Initial Assessment

The diagnosis is usually made from the history and examination. Parents often notice an intermittent groin or scrotal bulge during crying, coughing, straining, or play; it may disappear during sleep or with gentle pressure. If the examination is normal in clinic, a photograph obtained while the swelling is present can be helpful. Laterality, reducibility, tenderness, skin changes, testicular position, and extension into the scrotum should be recorded. A firm, tender, irreducible groin

mass in a girl may contain an ovary [1].

Ultrasound has a defined but limited role. It is helpful when the history and examination are discordant, when another type of groin mass is being considered, or when perfusion of an incarcerated testis or ovary needs assessment. Routine imaging adds little when a reducible hernia is clinically obvious. Ultrasound is also an imperfect way to screen the opposite side: performance varies with technique and with the definition of patency, and a patent tract does not establish that a hernia will later appear [8]. CT and MRI are rarely required for an uncomplicated case.

Urgent surgical review is required for a painful irreducible mass, increasing abdominal distension, bilious vomiting, erythema, systemic illness, or peritoneal signs. Possible alternatives include communicating or noncommunicating hydrocele, retractile or undescended testis, torsion of the testis or an appendage, epididymitis, lymphadenitis, abscess, and disease of the canal of Nuck. If strangulated bowel or gonadal ischemia is a realistic concern, uncertainty over the precise diagnosis should not delay assessment by a surgeon [9].

5. Operative Indication and Timing

Once a pediatric inguinal hernia is confirmed, repair is generally advised because spontaneous permanent closure is unreliable and incarceration can occur. Same-day surgery is not required for every reducible hernia. The appropriate interval depends on the child's age and gestational history, previous incarceration, ease of reduction, cardiopulmonary condition, and access to emergency services. A systematic review documented clinically important incarceration during the waiting period; estimates in preterm children varied widely but remained concerning [10]. Infants and children with a previous incarceration should therefore receive an early date, while a reducible hernia permits treatment of respiratory infection, anemia, or cardiopulmonary disease before anesthesia.

An experienced clinician may attempt manual reduction when an incarcerated hernia is present without peritonitis, perforation, marked systemic toxicity, or convincing signs of established strangulation. Adequate analgesia, a quiet setting, and sustained gentle pressure are preferable to repeated force. After successful reduction, repair is usually arranged during the admission or soon afterward, once local edema and anesthetic issues have been reviewed. Failure to reduce the hernia, suspected injury to bowel or gonad, or deterioration under observation is an indication for emergency surgery [9].

Neither a truss nor prolonged external pressure will close a patent processus vaginalis. Occasionally, definitive repair must be deferred in a critically ill infant while more immediate physiological problems are treated. Such a delay is a temporary risk-management decision, not curative therapy.

6. Open Herniotomy

Open herniotomy continues to be a standard repair. A short groin-crease incision

allows the surgeon to identify the sac, separate it from the vas deferens and testicular vessels, divide it, and ligate it close to the internal ring. The external oblique aponeurosis can sometimes be left intact in infants and small children. Extensive work on the distal sac is usually unnecessary; leaving it open can limit scrotal dissection and edema. Posterior-wall reconstruction is reserved for the uncommon direct defect or a substantial tissue abnormality [1] [4].

For a unilateral hernia, an experienced surgeon can perform open repair quickly and with little specialized equipment. Selected infants may also be suitable for regional anesthesia. The main operative risk lies in separating a thin sac from the cord: traction, cautery, and mistaken tissue identity can injure the vas or vessels. Distal dissection adds morbidity without strengthening the proximal ligation. Open surgery does not directly show the opposite internal ring, but that limitation has little consequence when routine treatment of an asymptomatic side is not indicated [2] [11].

Incision length alone says little about the quality of the repair. A useful operative note records identification of the sac, secure proximal control, gentle handling of the vas and vessels, and the final position of the testis.

7. Laparoscopic Repair

Laparoscopic repair closes the internal ring under intraperitoneal vision, but the name encompasses operations that use different routes and fail in different ways. Broadly, techniques use either intracorporeal suturing or percutaneous extraperitoneal closure. Whichever method is chosen, the entire peritoneal circumference must be captured while the vas deferens, gonadal and epigastric vessels, round ligament, bladder, and bowel remain protected [6].

7.1. Intracorporeal Suturing

Intracorporeal repair generally uses two or three ports. From inside the abdomen, the surgeon places and ties a purse-string or interrupted suture around the ring and may divide the peritoneum selectively. Direct control over needle placement and knot construction is an advantage. Recurrence may nevertheless follow shallow bites, a gap in the suture line, tissue cut-through, or an insecure knot. Trocar insertion introduces separate risks, including injury to viscera or the inferior epigastric vessels and later port-site problems. Those additional ports may be relevant in a very small infant, although their size and position differ between techniques.

7.2. Percutaneous Extraperitoneal Closure

In percutaneous extraperitoneal repair, an umbilical camera is combined with a needle passed through a small puncture in the groin. The needle carries the suture around the internal ring within the preperitoneal plane; the knot is commonly tied outside the abdomen and buried beneath the skin. This avoids intracorporeal knot tying and often requires only the camera port. Problems arise when peritoneum

is skipped beside the vas or vessels, tissue bridges across the loop, the circuit is incomplete, or the external knot loosens or migrates. The needle itself can injure epigastric or gonadal vessels, the vas, bladder, or bowel unless its course remains visible. Large series show reproducible results, but published procedures use different needles, suture paths, and knot locations despite sharing the same label [6] [11].

7.3. Comparative Evidence and Technique Selection

A pooled analysis that kept the laparoscopic methods separate included 738 intracorporeal and 2942 extracorporeal repairs. Recurrence was reported less often after single-port extracorporeal closure than after three-port intracorporeal purse-string closure (0.6% vs 5.5%), and operating time was shorter. Interpretation is limited by heterogeneous procedures and the largely observational evidence base [12]. A 2026 meta-analysis restricted to percutaneous extraperitoneal closure found no clear recurrence difference from open repair, along with small differences in contralateral hernia, testicular ascent, and operating time. Most comparisons were again nonrandomized [13]. The appropriate conclusion is that outcomes should be reported by technique; these data do not establish the superiority of laparoscopy as a single category.

Randomized comparisons of laparoscopy with open repair remain underpowered for uncommon outcomes. The 2026 Cochrane review identified 12 trials involving 1247 children. Nine trials (1099 participants) reported recurrence, with an odds ratio of 0.64 (95% confidence interval 0.26 - 1.61), which did not show a clear difference. Certainty was low, and information on long-term recurrence and chronic pain was absent [14]. In a large propensity-adjusted cohort, percutaneous closure was associated with fewer subsequent contralateral hernias, longer anesthesia, and a slightly higher but still low recurrence rate than open repair [11]. A separate cohort found similar recurrence but more umbilical-port complications after laparoscopy [15]. Selection bias, evolving technique, and unequal follow-up complicate both observations.

Laparoscopy is useful when disease is bilateral, laterality is uncertain, an open repair has recurred, or an incarcerated hernia requires inspection of bowel or ovarian viability. Many unilateral hernias are dealt with efficiently by open herniotomy. In practice, the choice should reflect which defined operation the team performs reliably and whether its audit can identify recurrence, access injury, altered testicular position, and later reoperation.

8. The Contralateral Groin

Six prospective studies comprising 1669 children produced a pooled metachronous contralateral hernia incidence of 6% (95% confidence interval 4% - 8%) after unilateral repair. The risk was higher after a left-sided index hernia and when the opposite processus vaginalis was known to be open. Girls and children younger than one year appeared to have higher rates, but these differences were not statis-

tically significant in that analysis [7]. Because a patent ring is much more common than a later clinical hernia, seeing the ring and deciding to close it are separate decisions.

The pooled estimate can be translated for counseling. At a baseline risk of 6%, and assuming that closure prevents every future hernia, about 17 opposite sides would be treated to prevent one metachronous hernia (1/0.06). This is an average rather than a precise prediction for an individual child. In the HERNIA trial, which enrolled infants aged 0 - 6 months undergoing open repair, contralateral exploration lowered one-year reoperation from 6.1% to 2.0%; the corresponding NNT was 24. Total complication rates were similar [16]. The study could not provide a stable NNH for the additional procedure. Injury to an otherwise asymptomatic side, extra operating time, and treatment of a tract that might never cause symptoms still matter, but available studies are too small and inconsistent in reporting those events to support a credible NNH. Describing that value as zero or infinite would be incorrect.

Age, sex, prematurity, the side of presentation, and the appearance of the contralateral ring can inform the discussion, but no combination has been validated as a prediction rule. A premature infant younger than six months with a left-sided hernia may gain more from avoiding another anesthetic than an older child whose family has easy access to follow-up. If a future hernia contains an ovary, delay may carry different consequences for a girl. Surgeons may also judge a wide, deep opening differently from a shallow dimple, although published morphological cutoffs are not reliable enough to mandate closure. The anesthetic argument is bidirectional: prophylactic closure lengthens the present operation, whereas observation leaves open the possibility of a second anesthetic. Travel time to urgent care and the caregivers' ability to recognize incarceration deserve explicit attention.

Selective treatment is therefore reasonable. Observation suits an asymptomatic opposite side when follow-up is reliable and the expected benefit of another procedure is small. Closure can be discussed when the probability of another operation appears higher, the anatomical opening is convincing, and little additional anesthetic or technical burden is expected. Preoperative ultrasound cannot resolve the issue because identifying a patent tract does not show that it will become symptomatic [8]. Neither current guidelines nor the available evidence require routine open exploration or closure of every patent ring found at laparoscopy [1] [2]. Families should understand that most observed children will not develop a contralateral hernia, while some children treated prophylactically would never have needed that intervention.

9. Special Clinical Settings

9.1. Premature Infants

Repair before neonatal intensive care discharge prevents an infant from going home with a known hernia, but anesthesia is then given at a lower weight and

often during a period of respiratory vulnerability. The 2024 HIP trial assigned 338 preterm infants at 39 US hospitals either to repair before discharge or to planned repair after discharge and after 55 weeks' postmenstrual age. Primary-outcome data were complete for 308 infants. Serious adverse events occurred in 44 of 159 infants (28%) in the early group and 27 of 149 (18%) in the late group. The Bayesian analysis estimated a 97% probability that later repair reduced serious adverse events; infants born before 28 weeks and those with bronchopulmonary dysplasia appeared to benefit most [17].

In applying these data, we regard an infant as suitable for delayed repair only when the hernia reduces readily, respiratory and cardiorespiratory status permit discharge, caregivers can recognize incarceration and return promptly, and both scheduled follow-up and urgent pediatric care are accessible. Delay is unsuitable after recurrent difficult reductions, with an irreducible hernia or clinical deterioration, or when emergency care cannot be reached reliably. The age threshold used in HIP defines that trial's strategy and should not be treated as a rule for every infant. A meta-analysis also reported more postoperative complications after laparoscopic repair in preterm than in term infants, further supporting separate counseling for these groups [18].

Regional anesthesia lowers the frequency of some early respiratory events but does not eliminate the need for postoperative observation. In the GAS trial, awake regional anesthesia reduced apnea during the first 30 minutes, whereas apnea over the full 12-hour period was not clearly reduced [19]. Some regional blocks failed or required additional sedation [20]. Neurodevelopment at five years was reassuring after a single general anesthetic lasting a median of 54 minutes in the GAS population, but that finding should not be generalized to repeated or prolonged anesthesia or to every critically ill neonate [21]. Thus, moderate-certainty randomized evidence supports considering later repair in eligible premature infants, while the date for an individual child still depends on clinical judgment.

9.2. Girls and Ovarian Hernia

An inguinal sac in a girl can contain an ovary and fallopian tube. Among 1,084 girls in one retrospective surgical cohort, 235 (21.7%) had an ovarian hernia; 14 of those ovaries (6%) were strangulated [22]. These figures come from a referred and operated population and do not describe the natural history of every ovarian hernia. A comfortable, reducible ovarian hernia warrants expedited elective repair. An irreducible ovary should be assessed surgically on the same day. Pain, tenderness, skin change, persistent crying, vomiting, or impaired Doppler perfusion heightens concern for torsion or strangulation and favors urgent exploration. Conversely, preserved Doppler flow should not override a worsening clinical examination. Evidence for a specific safe waiting interval remains observational and uncertain.

During exploration, the first objective is reduction with preservation of the ovary and tube. Color, turgor, perfusion, and the response after detorsion should

be reassessed before an irreversible decision is made. **Table 1** presents the practical timing used here and identifies whether each recommendation rests on trials or cohorts or mainly on clinical consensus.

9.3. Incarcerated and Recurrent Hernia

Gentle reduction of an incarcerated hernia removes the immediate emergency, but another incarceration can occur before definitive repair. If the child is clinically well, the abdomen is soft, and there is no concern for ischemic bowel or gonad, repair is commonly undertaken during the admission or within several days after edema and anesthetic risk are reassessed. No randomized trial defines a single best interval. Emergency operation is required when reduction fails or when peritonitis, worsening distension, bilious vomiting, systemic toxicity, perforation, or bowel necrosis is suspected. These recommendations derive mainly from observational evidence and accepted surgical practice [9] [23].

After reduction, laparoscopy offers direct inspection of bowel viability and the opposite internal ring. A systematic review suggests that either laparoscopic or open repair is feasible in selected incarcerated cases, although the included evidence is observational [23]. Physiological stability, distended bowel, possible perforation, surgeon experience, and readiness for bowel resection should guide the approach. For recurrence following open herniotomy, laparoscopy avoids the previously scarred groin plane. When a laparoscopic closure has failed, the original technique and likely failure mechanism should be reviewed before choosing repeat laparoscopy or an open operation.

Table 1. Practical urgency and evidence basis in higher-risk pediatric inguinal hernia.

Clinical scenario	Suggested action and timing	Evidence basis
Premature infant; reducible hernia; stable respiration; reliable follow-up and urgent access	Consider repair after discharge and beyond approximately 55 weeks' postmenstrual age; individualize to the infant and local access.	HIP randomized trial; moderate certainty for fewer serious adverse events [17].
Reducible ovarian hernia without pain or systemic features	Expedited elective specialist repair; give clear return precautions.	Retrospective cohorts and guidelines; low certainty [2] [22].
Irreducible ovary, or pain, tenderness, skin change, abnormal Doppler findings	Same-day surgical assessment; urgent exploration if reduction fails or ischemia/torsion is suspected.	Observational evidence and expert consensus; low certainty [2] [22].
Incarcerated bowel hernia successfully reduced; child clinically well	Repair during the same admission or within a few days after edema and anesthetic fitness are reassessed.	Observational evidence; no validated single interval; low certainty [9] [23].
Failed reduction, peritonitis, bilious vomiting, systemic toxicity, suspected perforation or bowel necrosis	Emergency operation without elective delay.	Guidelines, observational evidence, and surgical consensus; strong recommendation despite low direct comparative certainty [9] [23].

Note: The evidence labels used in this narrative review are descriptive and are not the product of a new formal GRADE assessment.

10. Outcomes, Complications, and Quality Assurance

Recurrence is uncommon after either open or laparoscopic repair, but no single percentage applies across age groups and techniques. Risk may change with prematurity, emergency presentation, ring size, tissue fragility, incomplete circumferential closure, knot failure, and operator experience. A postoperative or recurrent bulge should also be distinguished from hydrocele, lymphatic edema, and expected early swelling. Operative documentation should include laterality, sac contents, the appearance of the ring, closure method and material, management of the distal sac, findings on the opposite side, and the final position of both testes.

Bruising, scrotal edema, and a transient hydrocele usually resolve without treatment. Aspiration is rarely necessary and carries a risk of introducing infection. Careful hemostasis and restrained distal dissection are more effective preventive measures than routine removal of the distal sac. Wound infection and port-site problems are also uncommon. Testicular ascent or atrophy and injury to the vas deferens are important because they may appear late and will be missed by very short follow-up. Parents should request review for persistent swelling, pain, fever, vomiting, wound changes, or a testis no longer lying in its usual position [4] [15].

Quality review should distinguish the operation that was actually performed. For laparoscopic cases, records should identify the method, any peritoneal gap, knot position, extra ports, conversion, access injury, and recurrence. Open-repair audit should include cord injury, hematoma, testicular position, and reoperation. Combining several laparoscopic techniques into one outcome category conceals preventable mechanisms of failure. Follow-up lasting only a few months is equally liable to miss late recurrence and testicular ascent.

11. Day Surgery and Future Priorities

Repair can be completed as day surgery for most otherwise healthy children, using multimodal analgesia and early oral intake. Admission decisions are influenced more by age, prematurity, respiratory history, social support, travel time to emergency care, and events during anesthesia than by the length of the incision. At discharge, caregivers need practical information about expected swelling and bruising, warning symptoms of incarceration or infection, and how to obtain advice after hours [3] [19].

Future reports should separate premature infants from older children and distinguish intracorporeal suturing from percutaneous extraperitoneal closure. Important unanswered questions include prediction of metachronous contralateral hernia, the individual benefit and harm of prophylactic closure, the effects of suture material and knot location, and reproductive outcomes in adulthood. Reoperation, unplanned health-care use, parental burden, cost, scar satisfaction, and testicular position and volume are more useful endpoints than the number of incisions alone. Current pooled data suggest broadly similar recurrence and complication rates with single- and multi-port repair [24]; reducing port number should never compromise complete closure of the ring.

12. Conclusions

The anatomical cause of pediatric inguinal hernia is usually straightforward, but the children who present with it are not a uniform group. Both open herniotomy and laparoscopic closure are valid options. A durable result requires sound timing, protection of the vas and gonadal vessels, and complete closure of the communication. Laparoscopy has particular value in bilateral disease, recurrence after open repair, and selected incarcerated hernias, whereas open repair remains efficient for many unilateral cases. Reports of laparoscopic outcomes should specify whether closure was intracorporeal or percutaneous because the access requirements and likely causes of failure differ.

For a stable premature infant who meets careful selection criteria, randomized evidence now supports waiting beyond neonatal intensive care discharge. Decisions about the other groin also warrant caution. Patency is common, only a minority progress to hernia, and even among young infants the NNT is relatively high. Counseling should cover the child's estimated baseline risk, the chance of a second anesthetic if observation is chosen, and the uncertain harm added by prophylactic closure. In both settings, an individualized plan with technique-specific follow-up is better supported than a universal preference for one operation.

Ethics Approval and Consent to Participate

Not applicable. This narrative review is based solely on published literature and did not involve human participants, identifiable personal data, or new data collection.

Author Contributions

Lei Tang: Conceptualization, methodology, literature review, writing - original draft. Chuanchang Yin: Conceptualization, supervision, writing - review and editing. All authors read and approved the final manuscript.

Conflicts of Interest

The authors declare that they have no competing interests.

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