

# **Birth injury**

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# INTRODUCTION

- ▶ Birth injury is defined as an impairment of the neonate's body function or structure due to an adverse event that occurred at birth. Injury may occur during labor, delivery, or after delivery, especially in neonates who require resuscitation in the delivery room.
- ▶ There is a wide spectrum of birth injuries ranging from minor and self-limited problems (eg, laceration or bruising) to severe injuries that may result in significant neonatal morbidity or mortality (ie, spinal cord injuries).

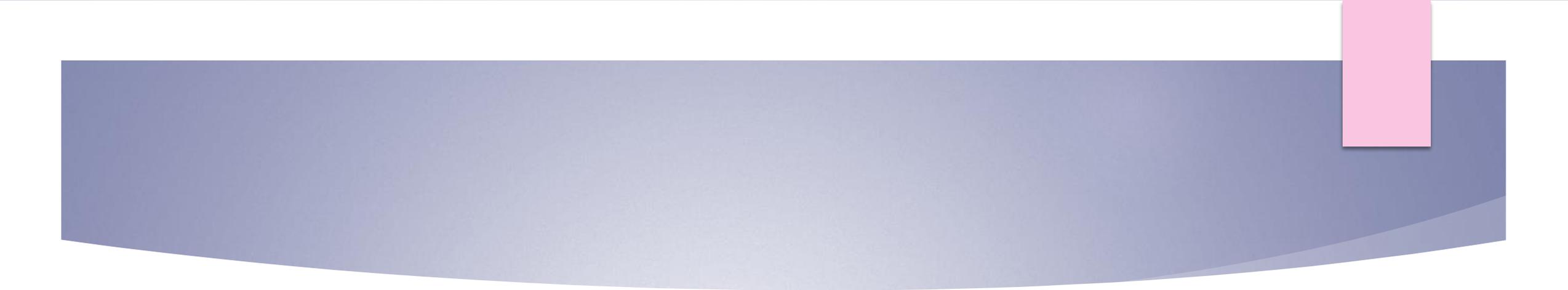
# EPIDEMIOLOGY

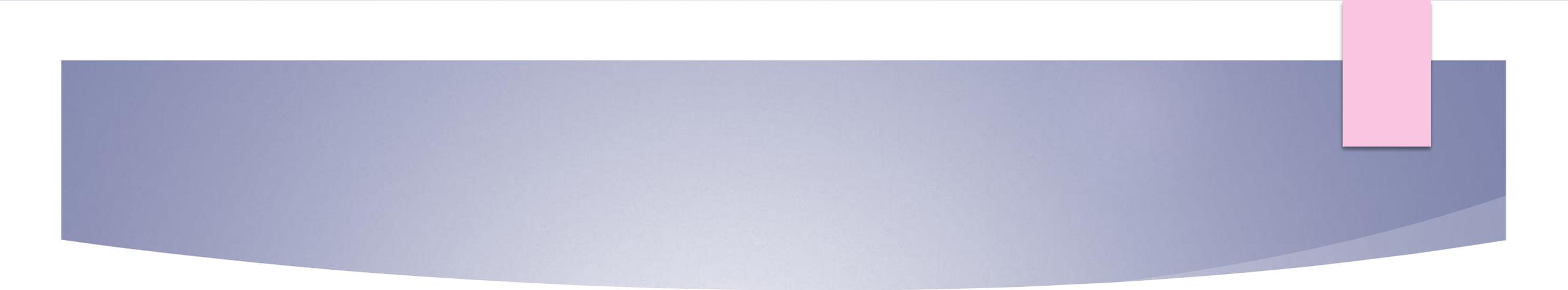
- ▶ The overall incidence of birth injuries ranges from 2 to 3 percent based on an analysis of neonatal discharge records between 2006 and 2014 from the Nationwide Inpatient Sample database .
- ▶ In this study, 80 percent of birth injuries were due to scalp injuries (eg, lacerations and bruising) and the remaining were considered major trauma (eg, clavicular fractures, brachial plexus injuries, and intracranial hemorrhage).

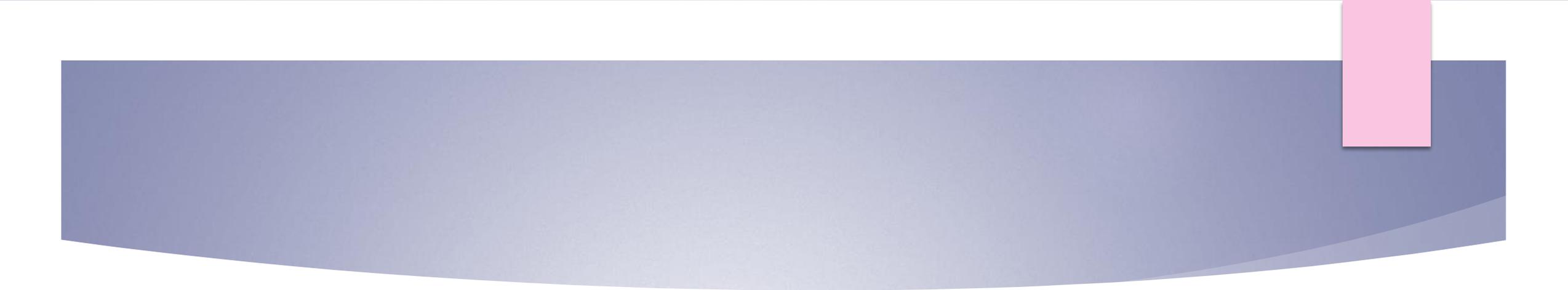
# RISK FACTORS

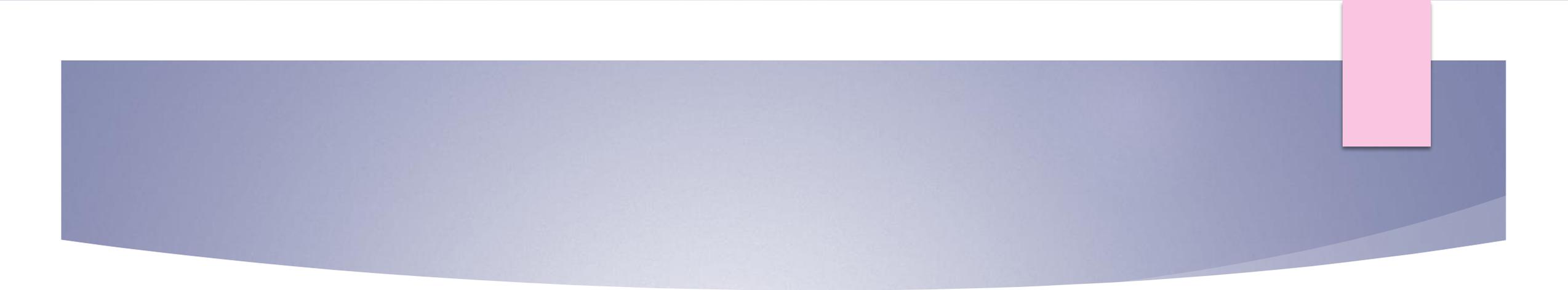
- **Increased risk of birth injury** – The following factors increase the risk of birth due to the fetus (eg, fetal size and presentation), the mother (eg, maternal size and the presence of pelvic anomalies), or the use of obstetrical instrumentation during delivery:

**Macrosomia** – When the fetal weight exceeds 4000 g, the incidence of birth injuries rises as the fetal size increases. In one study, when compared with normosomic neonates, the incidence of birth injury was twofold greater in infants weighing 4000 to 4499 g, three times greater in those with births weights between 4500 to 4999 g, and 4.5 times greater in those with a birth weight greater than 5000 g.

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- ▶ **Maternal obesity** – Maternal obesity (defined as a body mass index **greater than 40 kg/m<sup>2</sup>**) is associated with an increased risk of birth injuries.
  - ▶ This may be due to the greater use of instrumentation during delivery or the increased risk of delivering a large for gestational age infant, which is associated with an increased risk of shoulder dystocia.

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- ▶ **Abnormal fetal presentation** – Fetal presentation other than a vertex position, particularly **breech** presentation, is associated with an increase in the risk of birth injury with vaginal delivery.
  - ▶ Delivery by cesarean delivery reduces the morbidity associated with vaginal delivery of breech infants .

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- ▶ **Operative vaginal delivery** – Both forceps and vacuum delivery are associated with an increase in birth injury when compared with nonoperative vaginal delivery.
  - ▶ **Other factors** – One study reported an increased incidence of birth trauma to the head and neck in male infants and in babies born to **primiparous** mothers .
  - ▶ Additionally, **small maternal stature** and the presence of maternal **pelvic anomalies** are associated with an increased risk of birth injuries.

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- ▶ **Decreased risk of birth injury** – It is unclear whether cesarean delivery is protective with a lower risk of birth trauma compared with vaginal deliveries.

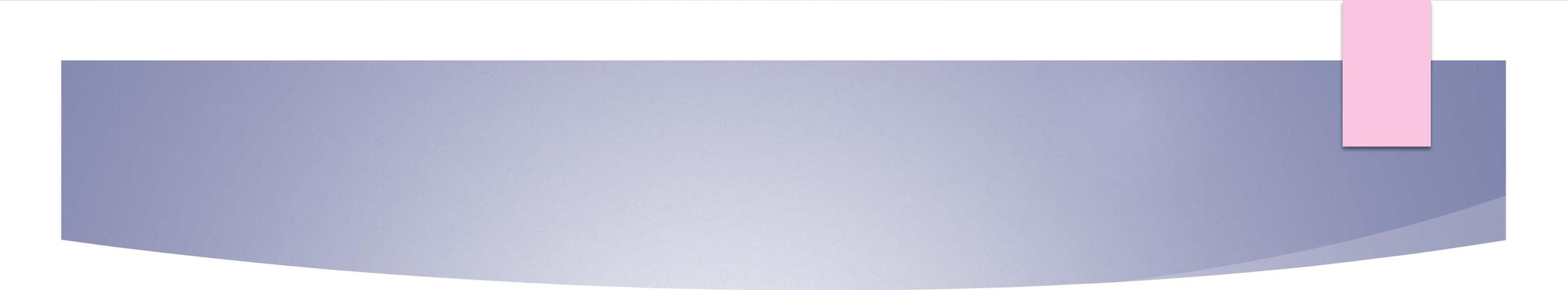
# Soft tissue injuries

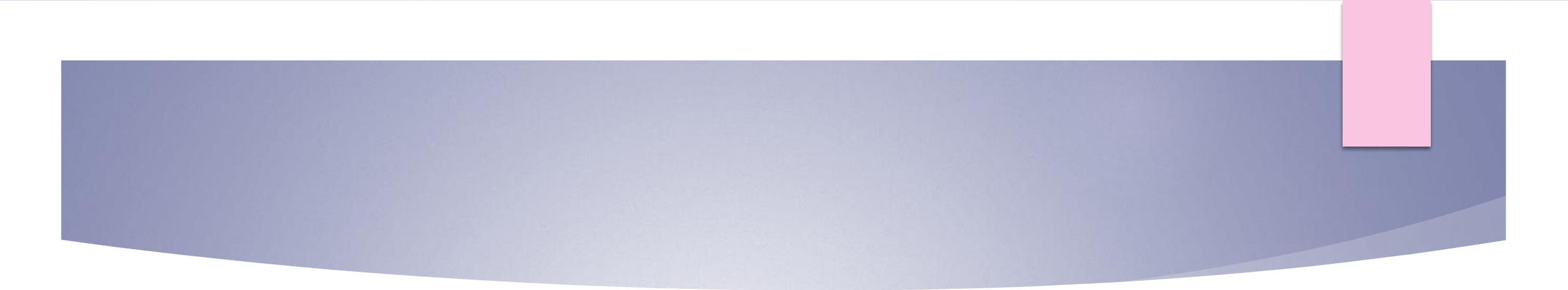
- ▶ The most common form of traumatic birth injuries are soft-tissue injuries including bruising, petechiae, subcutaneous fat necrosis , and lacerations.
- ▶ **Lacerations** are the most common injury associated with cesarean delivery and are generally mild, requiring repair only with sterile strips.
- ▶ The other three conditions are generally self-limited and resolve without any intervention.

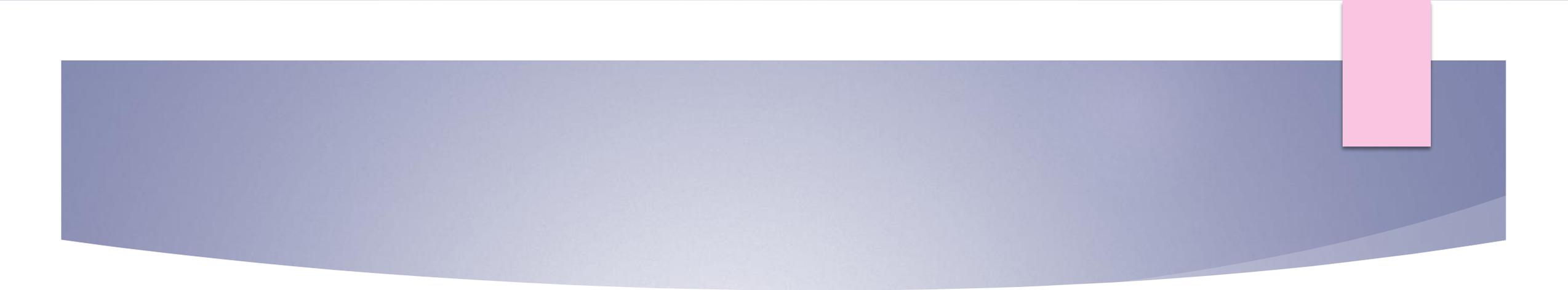
# EXTRACRANIAL INJURIES

## Caput succedaneum

- ▶ Caput succedaneum is an edematous swelling of the scalp above the periosteum, which is occasionally hemorrhagic . It presents at birth after **prolonged engagement** of the fetal head in the birth canal or after vacuum extraction.
- ▶ Unlike cephalohematoma, it extends across the suture lines. Caput succedaneum is generally a benign condition, and it usually resolves within a few days and requires no treatment.
- ▶ There are reported complications in infants with caput succedaneum that include necrotic lesions resulting in long-term scarring and alopecia .
- ▶ Rarely, systemic infection may occur as a complication of an infected caput succedaneum .

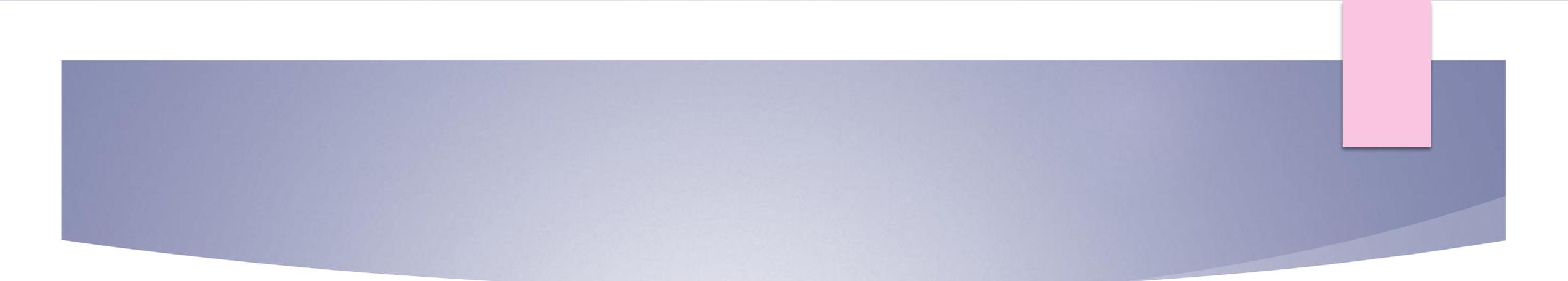
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- ▶ **Cephalohematoma** — Cephalohematoma is a subperiosteal collection of blood caused by rupture of vessels beneath the periosteum (usually over the parietal or occipital bone), which presents as swelling that does not cross suture lines .
  - ▶ The swelling may or may not be accompanied by discoloration, rarely expands after delivery, and does not generally cause significant blood loss.
  - ▶ Cephalohematoma is estimated to occur in 1 to 2 percent of all deliveries and is much more common when forceps or vacuum delivery is performed.

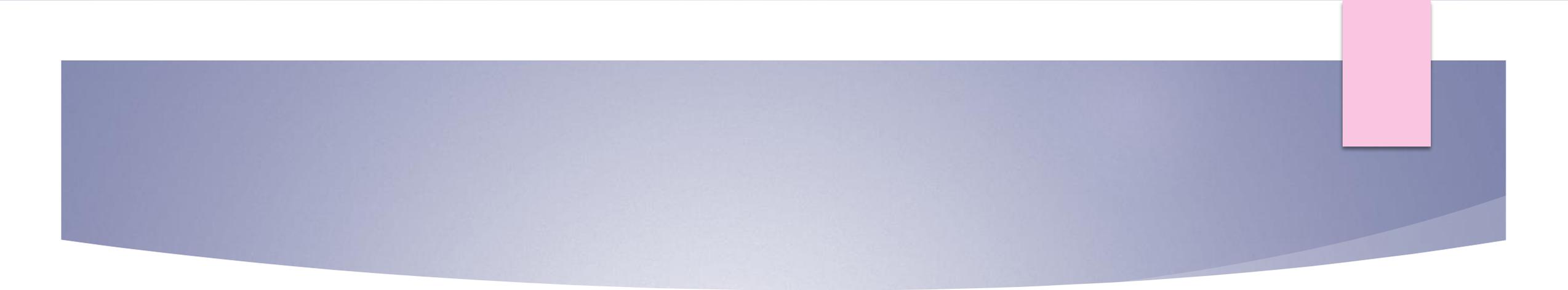
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- ▶ Ultrasound is useful for characterization of the fluid collection; however, it may not clearly depict the location of the hematoma relative to the skull sutures .
  - ▶ Imaging with CT or MRI will confirm the subperiosteal location of the cephalohematoma and can also be useful for evaluating the presence (or absence) of associated osteomyelitis.
  - ▶ Cephalohematoma has been recognized as a risk factor for the development of early and/or severe **hyperbilirubinemia**. Close follow-up after the newborn hospital discharge is recommended for infants with cephalohematoma in order to assess for jaundice.

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- The majority of cephalohematomas will resolve **spontaneously** over the course of a few weeks without any intervention.

However, calcification of the hematoma can occur with a subsequent bony swelling that may persist for months.

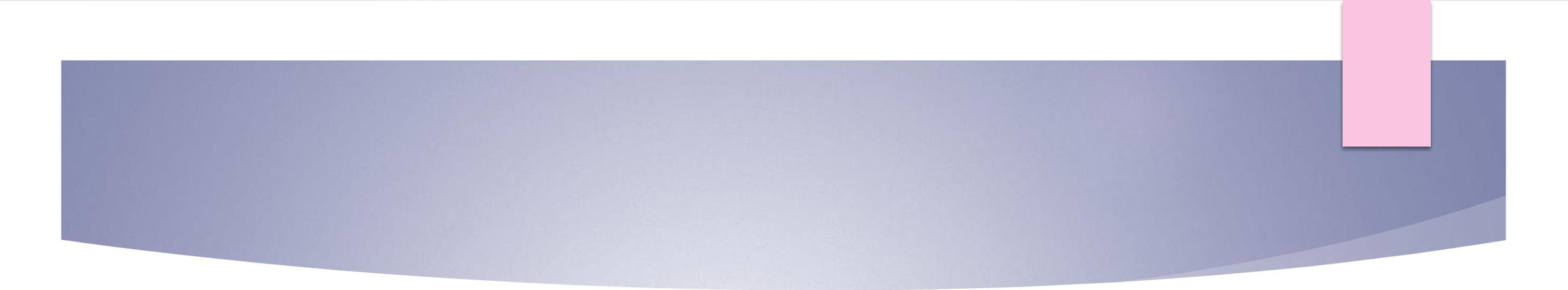
Significant deformities of the skull may occur when calcification or ossification of the cephalohematoma occurs.

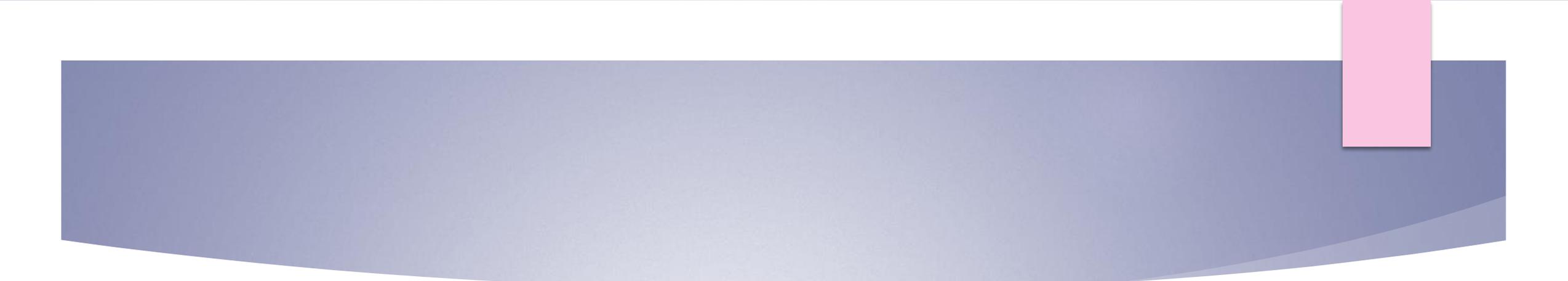
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- ▶ Other complications of cephalohematoma include **infection and sepsis**, with Escherichia coli being the most commonly reported causative agent.
  - ▶ Infected cephalohematomas present as erythematous, fluctuant masses that may have expanded from their baseline size. Needle aspiration and culture of the hematoma are considered to be mandatory to diagnose infection for suspected cases .
  - ▶ **Osteomyelitis** is a reported complication of an infected cephalohematoma .
  - ▶ In these affected infants, treatment includes incision and drainage of the abscess with debridement of the necrotic skull and a prolonged course of parenteral antibiotics.

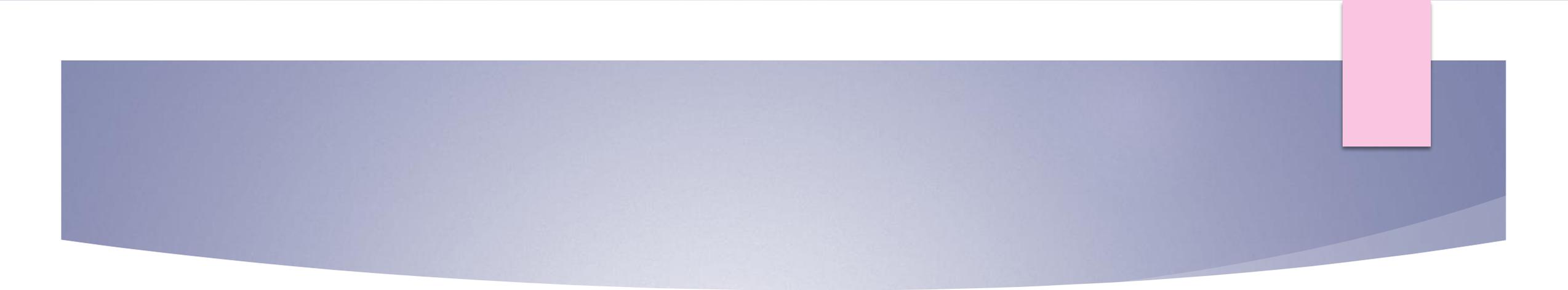
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- ▶ **Subgaleal hemorrhage** — Subgaleal hemorrhage (SGH) develops when blood accumulates in the loose areolar tissue in the space between the periosteum of the skull and the aponeurosis.
  - ▶ SGH presents as a diffuse, fluctuant swelling of the head that may shift with movement. Expansion of the swelling due to continued bleeding may occur hours to days after delivery.
  - ▶ Affected neonates may have tachycardia and pallor due to blood loss, although blood loss may be massive before signs of hypovolemia become apparent.
  - ▶ Treatment includes volume resuscitation with packed red blood cells, fresh frozen plasma, and normal saline as appropriate for ongoing bleeding and coagulopathy correction.

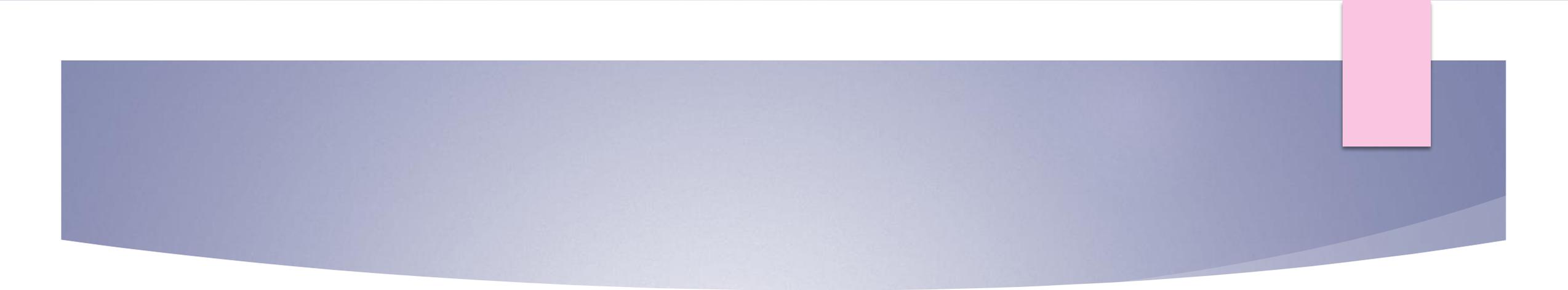
# INTRACRANIAL HEMORRHAGE

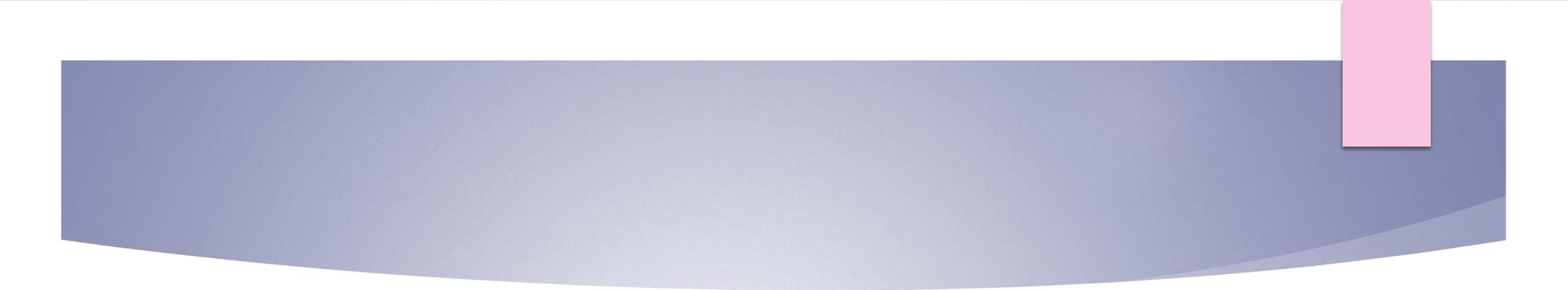
- ▶ **Subdural hemorrhage** — Although the overall incidence is rare, subdural hemorrhage (SDH), or hematoma, is the most common type of intracranial hemorrhage noted in neonates.
- ▶ **Risk factors** – The rate of intracranial hemorrhage is higher among infants delivered by vacuum extraction, forceps, or cesarean section during labor than among infants delivered spontaneously

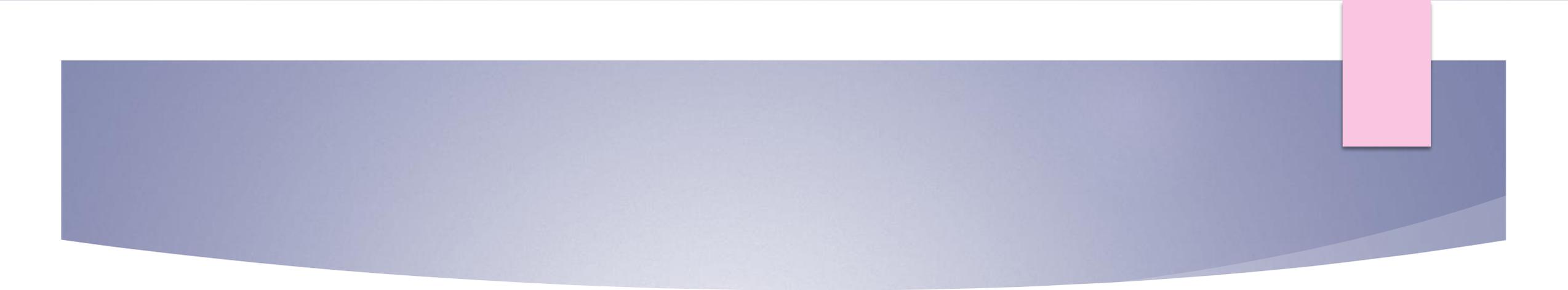
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- ▶ **Presentation and clinical findings** – The diagnosis may be made incidentally in asymptomatic neonates .
  - ▶ Symptomatic infants usually present within the first 24 to 48 hours of life.
  - ▶ Presenting symptoms or findings generally include seizures, respiratory depression, and apnea .
  - ▶ Rarely, SDH is associated with increased intracranial pressure resulting in an increase in head circumference, tense fontanelle, apnea, bradycardia, and coma.

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- ▶ **Imaging and diagnosis** – The diagnosis is made with cranial imaging CT or MRI.
  - ▶ **Management**– The management of SDH depends upon the location and extent of the bleed.
  - ▶ Most cases can be managed with conservative therapy without surgical intervention.
  - ▶ Surgical evacuation is necessary for infants with SDH and signs of increased intracranial pressure.

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- ▶ **Subarachnoid hemorrhage** — Subarachnoid hemorrhage (SAH) represents the second most commonly detected neonatal intracranial hemorrhage.
  - ▶ Although SAH can occur with normal, spontaneous vaginal deliveries , the risk of SAH increases with operative vaginal deliveries .

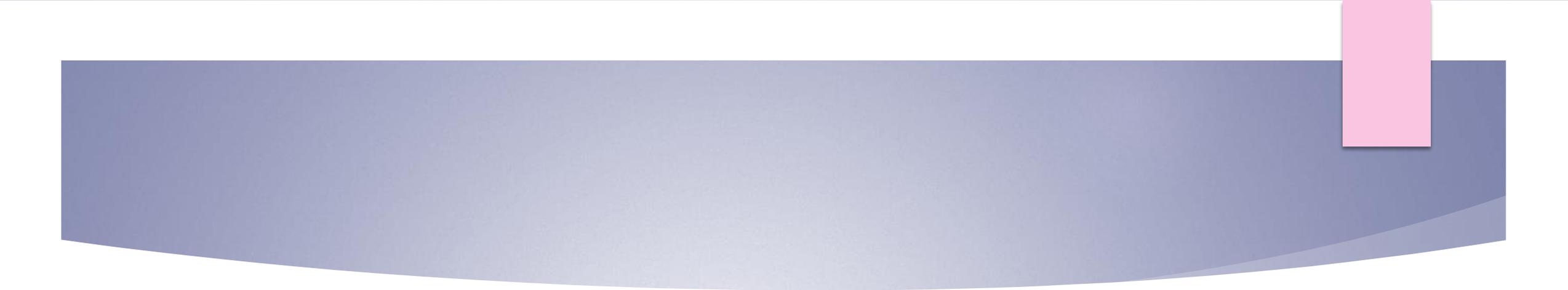
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- ▶ As with subdural hemorrhage, newborns with SAH most often present at 24 to 48 hours of life with apnea, respiratory depression, and seizures .
  - ▶ The diagnosis is made by CT of the head or, in nonemergent scenarios, MRI of the head.
  - ▶ Treatment is usually conservative. Rarely, a large SAH can cause posthemorrhagic hydrocephalus.

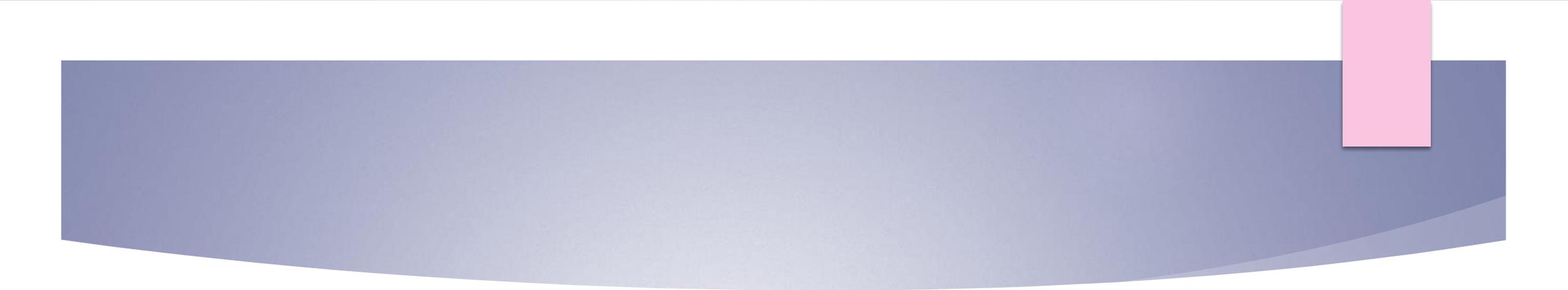
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- ▶ **Epidural hemorrhage** — EDH and cephalohematoma can coexist when accompanied by an underlying skull fracture due to communication through the skull fracture.
  - ▶ Neonates with EDH present with nonspecific neurologic symptoms, such as seizures and hypotonia.
  - ▶ Increased intracranial pressure may develop and is manifested as a bulging fontanelle, changes in vital signs, and level of consciousness.

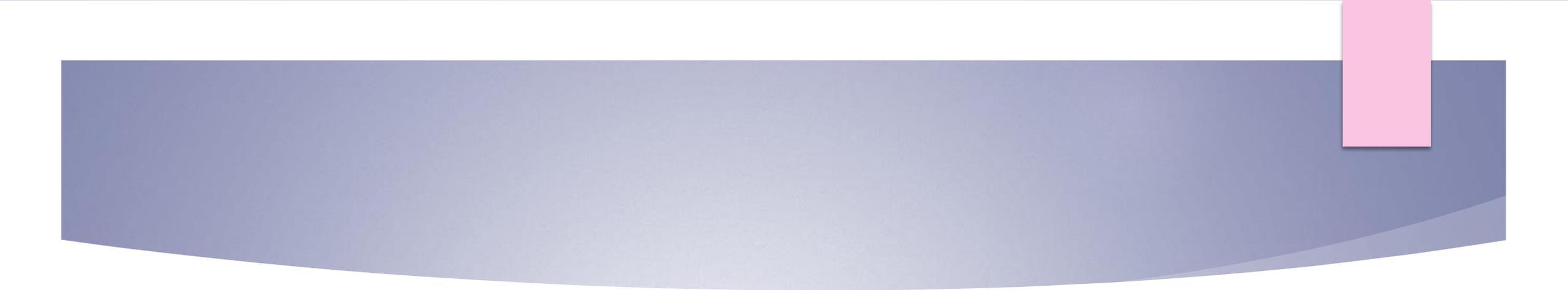
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- ▶ Patients with very small lesions and a stable clinical course may be managed with supportive therapy.
  - ▶ Surgical evacuation is necessary when there is evidence of increased intracranial pressure and/or the EDH is large.

# FRACTURES

- ▶ **Clavicle** — Clavicular fractures are the most commonly reported fractures in neonates.
- ▶ **●Incidence and risk factors** – Based upon data from large case series, the incidence of clavicle fractures due to birth trauma ranges from 0.5 to 1.6 percent.
- ▶ Fractured clavicles are often associated with difficult vaginal delivery; however, clavicular fractures also occur in infants who are products of a normal spontaneous vaginal or cesarean delivery.
- ▶ Reported risk factors for clavicular fractures include **operative delivery, shoulder dystocia, increased maternal age, increased birth weight (particularly if >4 kg), and lower mean head-to-abdominal circumference ratio.**

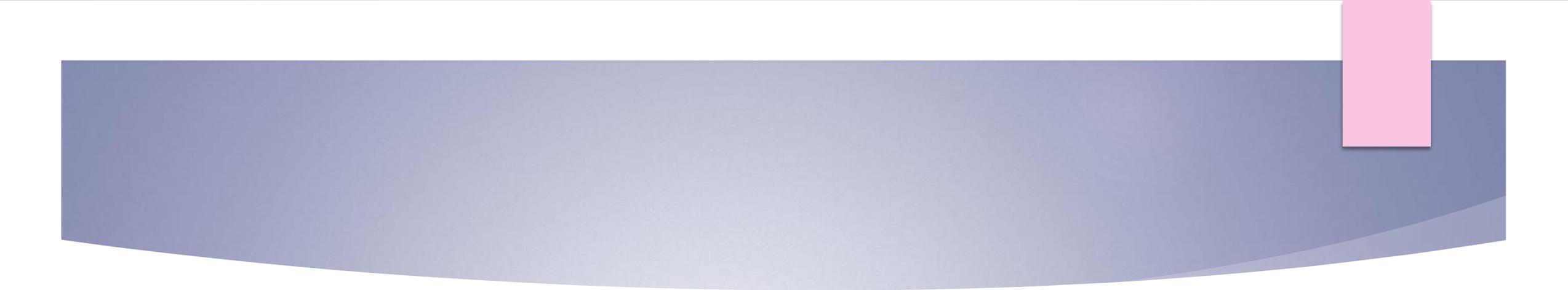
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- ▶ **Presentation** – The timing of the presentation is dependent on whether the fracture is displaced or nondisplaced.
  - ▶ **Displaced** (complete) fractured clavicles are more likely to be accompanied by physical findings in the immediate post-delivery time period. These include crepitus, edema, lack of movement of the affected extremity, asymmetrical bone contour, and crying with passive motion.
  - ▶ The diagnosis of nondisplaced clavicular fracture is often delayed by days or weeks until there is a formation of a visible or palpable callous because the neonate is usually asymptomatic.

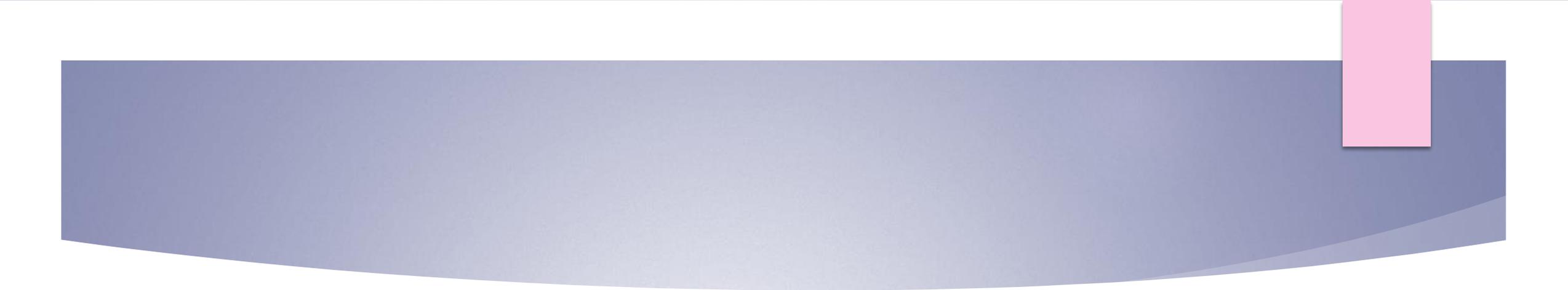
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- ▶ **Diagnosis** – The diagnosis is made by a **radiograph of the clavicle**, which differentiates clavicular fracture from brachial plexus injury, traumatic separation of the proximal humeral epiphysis, humeral shaft fractures, and dislocations of the shoulder.
  - ▶ When evaluating a neonate for suspected clavicle fracture, obtaining a full radiograph of the chest and upper extremities is suggested because these other diagnoses, which present with similar findings, may be detected in the fuller view.
  - ▶ In addition, the presence of a clavicle fracture warrants further investigation for accompanying brachial plexus injury.

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- ▶ **Management** – Because clavicular fractures in infants heal spontaneously with no long-term sequelae, parental reassurance and gentle handling are all that are required for management.
  - ▶ For comfort, the arm on the affected side can be placed in a long-sleeved garment and pinned to the chest with the elbow at 90 degrees of flexion.

# Humerus

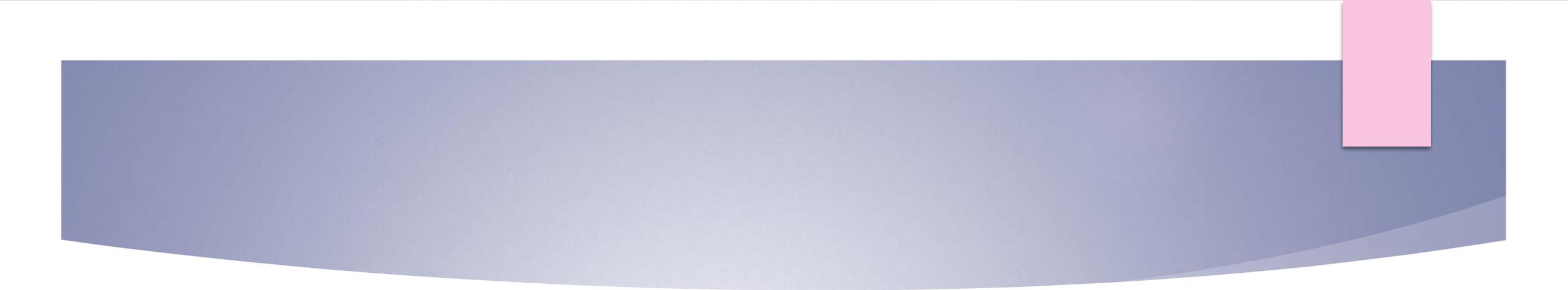
- ▶ **Incidence and risk factors** – Although it is the most common long bone neonatal fracture, humeral fractures are rare with a reported incidence of 0.2 per 1000 deliveries.
- ▶ Risk factors for humeral fractures include **shoulder dystocia, macrosomia, cesarean delivery, breech delivery, and low birth weight.**

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- ▶ **Clinical manifestations** – Most fractures occur at the proximal third of the humerus and are transverse and complete .
  - ▶ Clinical manifestations of a neonatal humeral fracture include decreased movement of the affected arm, decreased Moro reflex, localized swelling and crepitation, and an increased pain response with palpation and movement of the arm.

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- ▶ **Diagnosis** – The diagnosis is generally made by a plain radiograph of the arm.
  - ▶ In rare instances of very proximal or distal humeral fractures (ie, near the epiphysis), ultrasonography or MRI is a more useful diagnostic tool because plain radiography is less reliable due to the lack of ossification of the epiphysis.

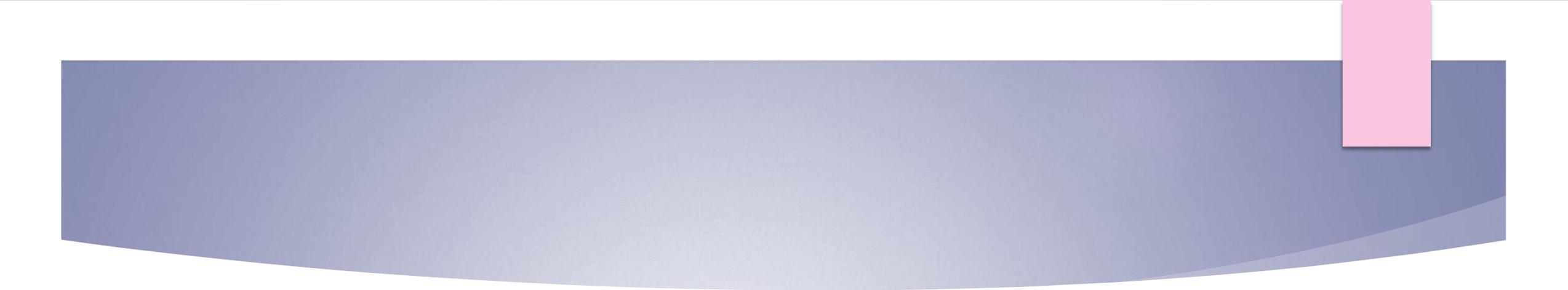
# Femur

- ▶ **Incidence and risk factors** – Fractures of the femur as a result of birth trauma are rare, with a reported incidence of 0.13 per 1000 live births . The fracture is typically spiral and involves the proximal half of the femur.
- ▶ Risk factors for femoral fractures include **twin pregnancies, breech presentations, prematurity, and diffuse osteoporosis.**
- ▶ **Clinical manifestations** – The fracture is typically spiral and involves the proximal half of the femur. Neonates with femoral fractures may initially be asymptomatic with only an increased pain response upon manipulation of the affected extremity.

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- ▶ **Diagnosis** – The diagnosis of femoral fracture is generally made by a plain radiograph of the leg. It may be an incidental finding.
  - ▶ **Outcome-** Outcome is excellent with evidence of callus formation usually seen on radiography by 7 to 10 days. Radiographs to confirm healing can be performed at three to four weeks post-injury.

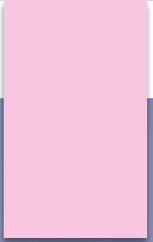
# Skull

- ▶ Skull fractures as a result of birth trauma include linear and depressed skull fractures.
- ▶ Depressed skull fractures are due to the inward buckling of the skull bones and are often associated with forceps-assisted deliveries.
- ▶ The diagnosis is made by a plain radiograph of the head.
- ▶ Skull fractures in infants of unassisted vaginal births are rarely associated with neurological sequelae. In these cases, reassurance and, perhaps, repeat skull radiographs are all that is required.

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- ▶ In contrast, there is an increased risk of intracranial bleeding and/or cephalohematoma in forceps-assisted delivered infants with depressed skull fractures.
  - ▶ Further imaging with CT is required to determine the presence or absence of intracranial lesions.
  - ▶ Neurosurgical consultation should be obtained in those with evidence of an intracranial process, and if the depression is greater than 1 cm, as these often require surgical intervention.
  - ▶ Smaller fractures (ie, less than 1 cm) without any intracranial injury can be managed conservatively with observation.

# Preterm infants

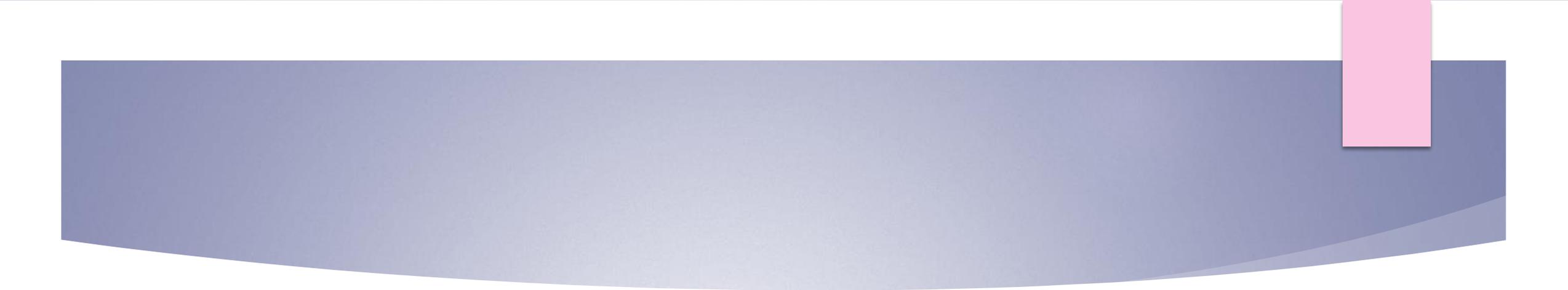
- ▶ Preterm infants are at higher risk for birth-associated fractures compared with term infants, especially multiple fractures .
- ▶ In a case series of preterm infants, 71 fractures were reported in 27 infants (mean gestational age 27 weeks) during admission to a neonatal intensive care unit .
- ▶ Ribs were the most common site of fractures .



# **Neonatal brachial plexus palsy**

# ETIOLOGY

- ▶ Potential mechanisms of neonatal brachial plexus palsy (NBPP) include:
  - ▶ stretching/traction, compression, infiltration, and oxygen deprivation . Of these, stretching is considered the most common mechanism.
  - ▶ The etiology of NBPP traditionally has been attributed to **iatrogenic lateral traction** on the fetal head, typically when shoulder dystocia impedes delivery.

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- ▶ However, NBPP can occur even when axial traction is properly applied; the occurrence of NBPP following birth does not automatically indicate that the practitioner applied forces or maneuvers that caused the nerve injury .
  - ▶ The forces of uterine contraction and maternal pushing alone are probably sufficient to cause excessive traction on the brachial plexus.
  - ▶ In addition, antepartum factors may predispose to NBPP, including uterine abnormalities such as Müllerian anomalies and fibroids that can result in fetal malpositioning and compression.
  - ▶ A substantial proportion of NBPP cases are not associated with antecedent shoulder dystocia.

# EPIDEMIOLOGY

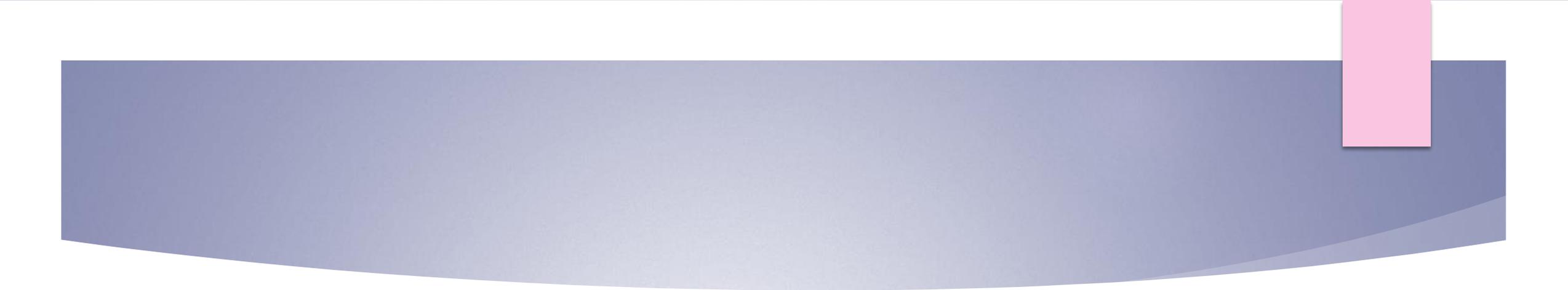
- ▶ Neonatal brachial plexus palsy (NBPP) is uncommon, with an incidence that ranges from 0.04 to 0.3 percent of live births.

# Risk factors

- ▶ The only established risk factor for NBPP is **shoulder dystocia**.
- ▶ Other possible risk factors include substantial maternal weight gain, maternal diabetes, multiparity, fetal macrosomia/high birth weight, fetal malposition, labor induction, labor abnormalities, operative vaginal delivery, and previous pregnancy complicated by shoulder dystocia or NBPP .
- ▶ Of note, probably the majority of NBPP cases occur in vaginal deliveries without shoulder dystocia or other putative risk factors.
- ▶ Cesarean delivery and twin or multiple birth mates have been associated with a decreased risk of NBPP .

# Prevention

- ▶ There are no proven measures to predict or prevent NBPP .
- ▶ The occurrence of shoulder dystocia itself cannot be accurately predicted based upon antenatal risk factors or labor abnormalities.
- ▶ Therefore, clinicians should be prepared for possible shoulder dystocia in all vaginal deliveries and be cognizant of the various procedures that have been shown to be effective for delivering the impacted shoulders.

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- ▶ Despite the lack of proven interventions for preventing NBPP, there are several clinical situations where the ACOG suggests that practitioners consider an alteration of usual obstetric management .
  - ▶ Suspected **fetal macrosomia** with an estimated fetal weight  $>5000$  g in pregnant patients without diabetes or  $>4500$  g in others with diabetes
  - ▶ **Prior recognized** shoulder dystocia, especially when associated with a severe neonatal injury
  - ▶ **Midpelvic operative** vaginal delivery with a fetal birth weight  $>4000$  g

# CLINICAL FEATURES

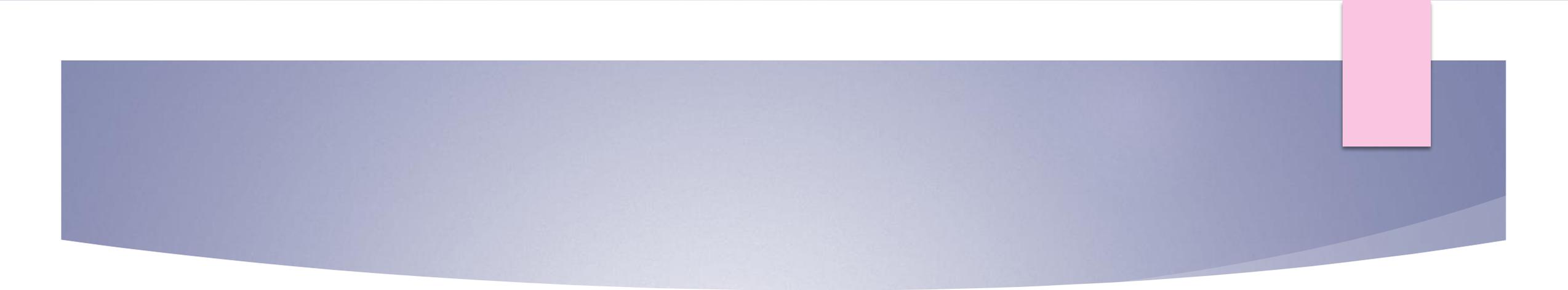
- ▶ Most cases of neonatal brachial plexus palsy (NBPP) are unilateral; bilateral involvement occurs in approximately 5 percent of cases . Five different patterns of nerve involvement have been described.
- ▶ **C5 and C6** injury (Erb palsy) accounts for approximately 50 percent of cases. Weakness involves the deltoid and infraspinatus muscles (mainly C5) and biceps (mainly C6). As a result, the upper arm is adducted and internally rotated, and the forearm is extended, while hand and wrist movement are preserved.

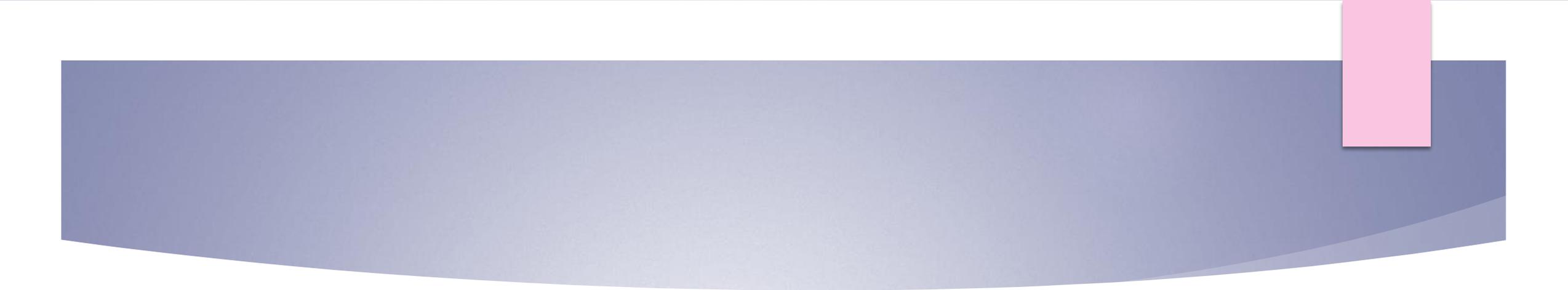
# CLINICAL FEATURES

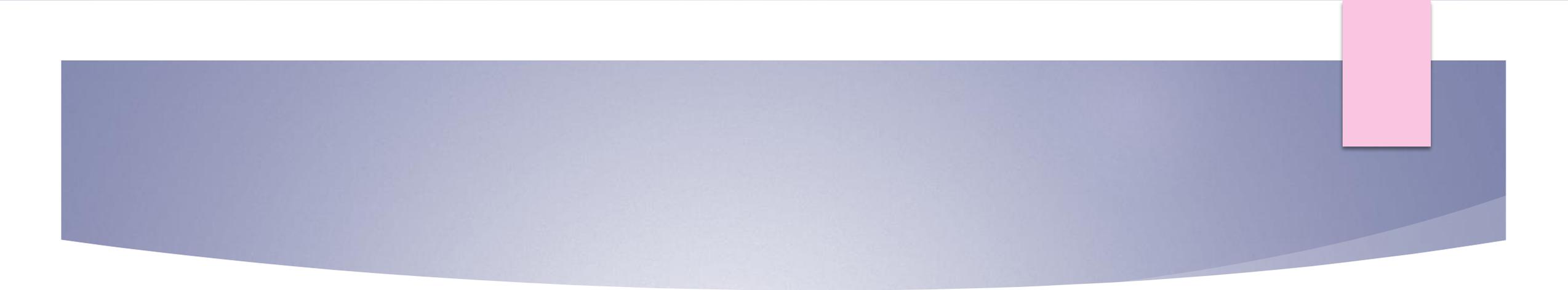
- ▶ **C5, C6, and C7** injury (Erb palsy plus) accounts for approximately 35 percent of cases and manifests as adduction and internal rotation of the arm, extension and pronation of the forearm, and flexion of the wrists and fingers, sometimes referred to as the "waiter's tip" posture (picture 1).
- ▶ **C5 to T1** injury usually presents with arm paralysis and some sparing of finger flexion. Severe damage to all C5 to T1 roots is characterized by a flail arm and Horner syndrome.
- ▶ **C8 and T1** injury (true Klumpke palsy) is the most infrequent pattern and manifests as isolated hand paralysis and Horner syndrome.

# EVALUATION AND DIAGNOSIS

- ▶ The diagnosis of neonatal brachial plexus palsy (NBPP) is made by the finding of arm weakness at birth with a distribution consistent with a brachial plexus injury.
- ▶ In many cases, the diagnosis is straightforward.
- ▶ The initial diagnostic work-up of NBPP starts with a complete family, maternal, and perinatal history. The infant should be evaluated by clinical examination and radiographic studies for fractures or any other injury.

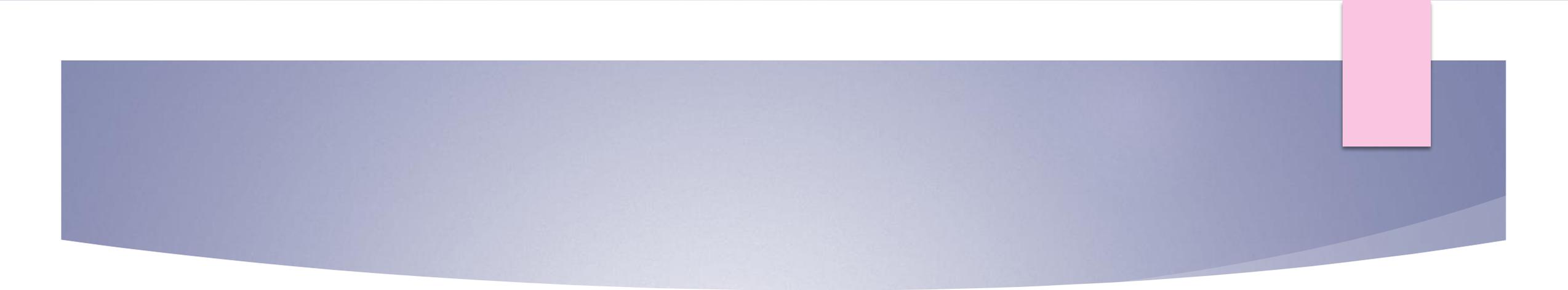
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- ▶ The neurologic examination should include observation of spontaneous movements, passive and active range of motion, stimulated motor and sensory responses, and assessment of reflexes to look for signs of focal or global neurologic deficits.
  - ▶ Adjuncts that may be useful for therapeutic decisions about the need for nerve repair or reconstruction include electrodiagnostic studies and neuroimaging.

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- ▶ **Timing of the palsy** — In order to estimate the time of onset of brachial plexus injury, practitioners should record the events leading up to delivery, fetal positioning, site of the brachial plexus injury, anatomic relationship of the affected brachial plexus to the anterior shoulder at delivery, neonatal bruising, associated injuries (eg, bone fractures), presence and location of the caput succedaneum, Apgar scores, and cord blood gas results .
  - ▶ Brachial plexus injuries that occurred well before delivery may have specific associated findings involving the affected arm, such as atrophy of the hand and arm muscles and the pectoralis major muscle, joint contractures, and bone demineralization.

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- ▶ **Electrodiagnostic studies** — Electrodiagnostic studies (electromyography and nerve conduction studies) can help to determine the localization and severity of nerve injury associated with NBPP.

# MANAGEMENT

- ▶ Infants and children with NBPP should be referred for physical and occupational therapy as soon as the diagnosis is suspected.
- ▶ Surgical intervention is advocated in select cases if functional recovery does not ensue, but there is no consensus regarding the utility or timing of surgery.

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- ▶ **Botulinum toxin injections** — Botulinum toxin injections have been used to treat contractures and muscle imbalance associated with NBPP, but data are limited and retrospective .
  - ▶ The clinical utility of this intervention needs further study before it can be recommended.
  - ▶ **Psychosocial issues** — Some children with NBPP have associated psychosocial problems in addition to functional limitations, both of which can interfere with quality of life

# PROGNOSIS

- ▶ The natural history of neonatal brachial plexus palsy (NBPP) is not precisely defined. Spontaneous recovery occurs over one to three months in many if not most cases of NBPP, but persistent functional impairment is seen in 18 to 50 percent of patients .
- ▶ Some children with persistent symptoms at three months may recover by one year.
- ▶ The more extensive initial injury associated with total brachial plexus palsy (panplexopathy) points to a less favorable outcome compared with upper (Erb) brachial plexus palsy.
- ▶ Children with C5 and C6 palsy had the highest functional recovery rate , children with C5 to C7 palsy had an intermediate rate , and children with C5 to T1 palsy had the lowest rate .

**Thanks**