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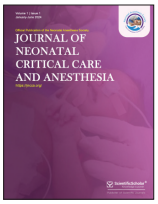

Editorial

Safety in Neonatal Anesthesia – The Neonatal Skin

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Anesthesia is about the safety and comfort of the patient. Anesthesiologists pay great attention to that front by providing sedation, pain relief, relaxation, and loss of consciousness while maintaining oxygenation, hemodynamic stability, and functions of other vital organs. One organ that is most used, ignored or even abused is the "Skin."

Skin and its appendages, the integumentary system, have developed as one of the largest organs of the body, endowed with multiple functions, essential for survival and life. Being outermost, it is the primary interface and first point of contact after birth. It covers the entire body, forming a barrier that protects the body from extraneous attacks, and from injuries (mechanical, chemical, and biological). Skin plays a major role in maintaining body homeostasis by regulating fluid and electrolyte balance, maintaining core body temperature, sensory mediation (sense of heat, cold, touch, pain, and comfort), and tactile perception. It has synthetic and secretory functions and can absorb from substances applied to it.[1-4]

Touch being the first sense to develop, plays a role in the development of a sense of perception and exhibition of response to external stimuli and is thus important in neonate's neurodevelopment. Newborn skin is very informative. Visible color changes, for example, pallor, cyanosis, redness, marbling (hematoma or burns), peripheral and regional blood flow, and surface temperature, provide significant clinical information.[5,6]

With this background, it becomes imperative that the anesthesiologists understand the significance of knowing about and taking care of such a vital organ of the neonate's body, right from the time the baby is first seen preoperatively, extending into the perioperative period and beyond.

The skin of a neonate markedly differs from that of an adult. It is thinner and less elastic, and the connection between the dermis and epidermis is less strong. Total surface area is more (700 cm^2/kg body weight) compared to an adult (250 cm^2/kg body weight). The epidermal barrier is not well developed, the stratum corneum is more permeable, the adipose fat in the subcutaneous layer is thinner, and it is highly susceptible to trauma and infection.[2] Skin development and epidermal differentiation occur in 2 stages: Stratification and keratinization. Keratinization and development of sebaceous glands begin in the 2nd trimester. In 3rd trimester, there is a surge in sebaceous gland activity with the secretion of vernix caseosa that covers the entire fetus.[2,7]

Skin consists of two layers – outer epidermis, and inner dermis and hypodermis. The stratum corneum, the outermost layer of the epidermis, imparts the skin its barrier function. In term neonates, stratum corneum is well developed and skin barrier function is competent, yet it undergoes growth and maturation up to 1 year of life.[5] Skin maturation is enhanced by birth as it gets exposed to different adverse environmental conditions, such as handling, clothing, and use of various chemicals and skin products. In preterm and low birth weight neonates, stratum corneum is immature, deficient in structural proteins, and lacks the protection that it provides in term neonates. It is very delicate and thin and prone to injury and delayed healing. Birth does stimulate the maturation of the epidermal barrier, but complete barrier maturation is not fulfilled until 2–4 weeks of age or longer, depending on the degree of prematurity, gestational age, and birth weight. Poor barrier function results in high surface water and heat losses.[5,6]

Vernix, the hydrophobic, slimy whitish viscous fatty material, forms a barrier between the fetus and amniotic fluid. A term baby is covered with vernix, but this cover is missing in babies born prematurely (especially under 30 weeks gestation). This too makes them vulnerable to cutaneous heat, water, and electrolyte losses, increasing their susceptibility to hypothermia, dehydration, and dyselectrolytemia, adding to the impact of the surgical pathology.[1,2,5-7]

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Skin serves several functions besides sensory perception and tactile discrimination. It plays a significant role in thermoregulation by helping maintain body temperature and prevention of hypothermia, maintenance of water and electrolyte balance by reducing surface water loss by evaporation, protection from infections and invasion by microorganisms, and immunological protection through cells of Langerhans.[1,5]

There are two major types of sweat glands – Apocrine, which are larger, non-thermoregulatory, restricted to the axilla and external genitalia, and Eccrine, which are very small, numerous (in Millions), distributed over the entire skin. Eccrine is the functional gland in the neonate. Their secretion contains lactate, urea, sodium, potassium, and several peptides that endow the skin with antimicrobial and anti-inflammatory properties. Sweat mixed with sebum forms a lipid layer that acts as a natural moisturizer. Skin can also absorb substances applied to it during the performance of various procedures such as cleansing solutions and antiseptics.[1,6,8]

Newborn skin loses heat by rapid evaporation (due to temperature difference), by conduction to the surface, by convection (rapid air movement), by radiation to surrounding objects (incubator walls), and fever, increases losses drastically. Thermal stability is an essential factor in the neonatal period. The normal body temperature of a newborn baby ranges between 36.5 and 37.5°C. They are poikilothermic and their core temperature drops rapidly (as much as 0.3°C/min), causing hypothermia, its adverse effects, and increased risk of morbidity and mortality.[3,6]

The amount of epidermal water loss (EWL) depends on the body surface and is transproportional to gestational age, with a greater risk of hypernatremia and dehydration in the premature. Skin damage, breech in skin integrity, crying, increased motor activity, and nutritional and vitamin deficiency, all increase water loss from the skin surface.[1,2,5]

Preventive care in the form of wrapping the exposed body parts of the baby (non-surgical areas) in a low-heat conducting sheet (plastic/polyethylene bags/foil), maintaining thermoneutrality in the pre-operative area and operating room, maintaining higher environmental humidity, use of heated mattresses, avoiding use of open heaters, and continuous monitoring of core body temperature.[6] Skin surface pH in a newborn is higher than in adults. It drops soon after birth and by the end of a week, pH drops to nearly 5.0 forming the "acid mantle" essential for the skin's antimicrobial function. Skin surface pH can be disturbed when skin is exposed to antiseptic and chemical cleaning before performing any invasive procedure, enhancing desquamation, rise in skin pH, and risk of skin damage.[1,2,5]

INJURIES AND RISK FACTORS FOR INJURY

Skin is the most important defense mechanism in a neonate. A surgical baby will need various non-invasive and invasive interventions that expose them to the risk of skin injury. Even minor injuries can lead to serious short-term and long-term consequences. Therefore, it is necessary to identify the cause and prevent such injuries. Prematurity, low birth weight, nutritional deficiencies, and major surgical conditions are in themselves major risk factors for skin injuries.[3,4]

Common procedures, equipment, and a variety of care interventions can injure the delicate skin of a neonate. They may be mechanical, chemical, thermal, and infectious and present as blisters and maceration.[3,4]

Skin injuries in the surgical neonate can be considered under the following headings -

a. General handling – it is understandable that these babies should be handled with extreme care.
b. Gloves related – Latex and talc in the gloves may cause allergic reactions.
c. Chemical injury caused by cleaning solutions, antiseptics, strong iodine solutions, gels, and creams used for ultrasound procedures and application of Electrocardiogram (EKG) electrodes – disturb skin pH and epidermal barrier, making it more prone to damage.[2] Chlorhexidine in alcohol is recommended, but warm water is a safer option whenever feasible.[3,6]
d. Vascular access-related – venous (blood sampling and cannulation) and arterial blood gas and hemodynamic (HD) monitoring, extravasation of fluid and drugs, and damage to the skin and underlying tissues. Caution and care in the selection of the proper size and site of peripherally inserted central catheter is important depending on the viscosity and osmolality of fluids transfused. Arterial lines should be kept for a minimal possible duration.[3]
e. Adhesive related – Application of monitors, pulse oximeter probes, fixing of IV cannula and infusion lines, and airway-related equipment. Adhesive tape should be neonate-friendly and should not damage the skin when being removed.
f. Draping and clipping – avoid exposure of non-surgical areas, and small surgical sites, and avoid pinching of the skin in the clamp.
g. Thermal care related – overhead warmers and hot air blowers increase water loss and skin dryness, proneness to injury, and delayed healing.
h. Cautery care – burns from improper size, site, placement, and earthing of cautery plates.
i. Related to the size of equipment used – for Oxygenation and airway devices, face mask and non-invasive mask continuous positive airway pressure (CPAP), endotracheal tube, nasal catheter, feeding tubes, etc.[3]

j. Drainage and feeding devices – orogastric and nasogastric tubes, bladder catheter, suction catheter, etc.
k. Positioning related – lateral, prone, kidney position, lithotomy for anesthesia, and surgery.[4]
l. Procedure-related (as an essential part of anesthesia) – during regional anesthesia and nerve blocks, subarachnoid/epidural blocks, and ultrasound-guided blocks.
m. Accidental injuries – cuts, bruises, needle stick injury, pressure over the orbit, etc.
n. Extravasation of drugs and leakage of infusion fluids.[4]

CONCLUSION

Skin is the first and most important defense mechanism in a neonate. It is important that anesthesiologists understand the significant role skin plays in the neonate and take measures to prevent and minimize skin injuries in the perioperative period, especially when the baby is under their care. Selection of the proper size of equipment, the most appropriate site, the use of safer cleansing agents, care during positioning for specific procedures, and general precautions during handling are important. Knowledge, prevention, early recognition, and prompt attention in the perioperative period will go a long way in reducing perioperative neonatal morbidity and mortality. It is important that anesthesiologists understand the significant role skin plays in the neonate and take measures to prevent and minimize skin injuries in the perioperative period, especially when the baby is under their care.

REFERENCES

1. Fluhr JW, Darlenski R, Taieb A, Hachem JP, Baudouin C, Msika P, *et al*. Functional Skin Adaptation in Infancy – Almost Complete but not Fully Competent. Exp Dermatol 2010;19:483-92.
2. Sarkar R, Basu S, Agrawal RK, Gupta P. Skin Care for the Newborn. Indian Pediatr 2010;47:593-8.
3. Santos SV, Ramos FR, Costa R, Batalha LM. Evidence on Prevention of Skin Lesions in Newborns: Integrative Review. ESTIMA Braz J Enterostomal Ther 2019;17:e2219.
4. Abkenar MJ, Mojen LK, Shakeri F, Varzeshnejad M. Skin Injuries and Its Related Factors in the Neonatal Intensive Care Unit. Iran J Neonatol 2020;11:1756.
5. Visscher MO. Update on the Use of Topical Agents in Neonates. Newborn Infant Nurs Rev 2008;9:31-47.
6. Jurica SA, Čolić A, Gverić-Ahmetašević S, Lončarević D, Filipović-Grčić B, Stipanović-Kastelić J, *et al*. Skin of the Very Premature Newborn – Physiology and Care. Paediatr Croat 2016;60:21-6.
7. Bautista MI, Wickett RR, Visscher MO, Pickens WL, Hoath SB. Characterization of Vernix Caseosa as a Natural Biofilm: Comparison to Standard Oil-Based Ointments. Pediatr Dermatol 2000;17:253-60.
8. Cui CY, Schlessinger D. Eccrine Sweat Gland Development and Sweat Secretion. Exp Dermatol 2015;24:644-50.

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