Instructions for Halo Application in Children and Adolescents

Unique features of the pediatric skull

Fontanelles and sutures:

The posterior fontanelle closes at approximately 6-12 months whereas the anterior fontanelle remains open until approximately 18 months. The skull sutures are highly mobile until fontanelle closure is complete and remain slightly mobile until 24-30 months of age. This may partially explain halo dislodgment in infants and small children.

Skull thickness:

Skull thickness in the "safe" frontal and parietal areas has been shown to be as little as 2 mm with high variability up until 10 years of age. Beyond age 10, skull thickness is proportional to skeletal age, reaching adult thickness (8-12 mm) around 14-16 years of age.

Cervical spine position:

Due to disproportionate cephalic anteroposterior diameter (which grows in an exponential manner in children) compared with chest wall anteroposterior diameter (which grows in a linear manner), the pediatric cervical spine may be positioned in an exaggerated position of flexion when the child is lying supine on a firm surface. Neutral cervical position is best achieved by aligning the external auditory meatus with the point of the shoulder. In general, this is the most appropriate position of the cervical spine within the halo ring and vest.

Guidelines

Preparation:

Obtain adequate help for positioning of the patient while safely maintaining a neutral cervical position. Three or four capable and knowledgeable individuals are recommended.

A pre-application CT scan is recommended to assess the skull thickness below the skull equator. The CT technician should be directed to obtain measurements at both frontal and parietal locations from a cut obtained on a line from 0.5 to 1.0 cm above the orbital rim and 1.0 to 1.5 cm below the maximum bi-parietal diameter.

Positioning:

The primary surgeon is responsible for safely positioning the head and neck which is usually suspended off of the upper end of the operating table or emergency stretcher with the shoulders resting on the supporting surface of the table (within the posterior shell of the halo vest).

Two assistants apply the halo pins simultaneously with equal force in opposite directions (diagonal pin sites) while another assistant holds the halo ring positioned appropriately on the skull in an effort to prevent ring migration or asymmetric application.

Application:

Pin number:

The number of pins to be applied may be varied based on the age of the child and the number of available locations achievable through the ring.

4 halo pins are used in adolescents and older children (>10 years)
6-8 halo pins are used in children age 5-10 years
8-10 halo pins are used in children 4 years and younger.

Selection of torque wrench:

Recent studies indicate that commercially available halo torque wrenches demonstrate a spectrum of accuracy and reliability. Comparative testing of torque wrenches suitable for pediatric halo application has shown that the Ergo Micro Torque Driver wrench of Mountz which is supplied with the PMT halo performed with good accuracy and reliability.[1]

Insertion torque:

No evidence based standards have been established in this regard. However, a rule of thumb guideline is based on the age of the child.

One inch pound (16 inch ounces) per year of age may be applied to each pin for children up to age 5, then six inch pounds may be applied to each pin for children age 6 and above.

While a case report has been published demonstrating the application of a halo in a 7 month old with multiple pins using finger-tightness[2], we recommend considering alternative forms of immobilization in any child under 18 months of age or with open

fontanelles. This may reduce the risk of halo dislodgment due to highly mobile skull plates.

Technique Guidelines:[3]

1. Anterior pins should be placed above the outer 1/3 of the supra-orbital space in order to avoid the frontal sinus, supra-orbital nerve and trochlear nerve.
2. Anterior pins should be placed medial to the lateral orbital wall in order to avoid the temporalis muscle and the thin temporal bone.
3. Anterior pins should be placed 0.5 to 1.0 cm above the orbital rim and posterior pins should be placed 1.0 to 1.5 cm below the widest bi-parietal diameter (equator) of the skull to avoid superior migration of the halo and dislodgment.
4. Caution should be given to avoid resting the ring on the pinna of the ear.
5. The ring position should be carefully controlled during pin insertion to achieve a symmetric space between the ring and the skull. This prevents asymmetric load at the pin sites which could promote early pin loosening. Pins should be applied with equal torque in opposite directions (diagonally) by two assistants simultaneously. First pins are applied to finger-tightness. Then the torque wrenches are used for final tightening.
6. Pin sites should be prepared by shaving and then scrubbing and painting the skin to create a surgically clean site. The pin tips should be kept sterile until immediately prior to application.
7. Pins should be tightened to the intended torque setting and then re-tightened 15 minutes later to account for stress relaxation at the pin-bone interface. Another re-tightening should be performed after 24 hours. No further attempts at re-tightening should be performed.
8. If a pin continues to advance during insertion despite a sense that the target torque should have been achieved (comparing to the diagonal pin), then insertion of that pin site should be abandoned in favor of another site. Alternatively, a lower torque setting may be chosen for all pins.
9. Upon re-tightening, if the target torque is not achieved by two full rotations, the pin site should be abandoned in favor of another site.

Follow-up care:

Meticulous follow-up care is recommended for children in halos. It is worth the extra time to schedule frequent follow-up visits to ensure that pin care is appropriate. Superficial pin site infections may be aggressively treated with oral antibiotics and improved pin care preventing the development of deep infection. Loose pins may be

recognized and replaced preventing further loosening of the halo which may lead to dislodgment.

References:

1. Copley LA, Dormans JP, Pepe MD, Tan V, and Browne RH. The Accuracy and Reliability of Torque Wrenches at Low Settings for Halo Application in Children. Journal of Bone and Joint Surgery 85A (11): 2199-2204, 2003.
2. Mubarak SJ, Camp JF, Vuletich W, Wenger DR, Garfin SR. Halo Application in the Infant. Journal of Pediatric Orthopaedics 9: 612-614, 1989.
3. Copley LA and Dormans JP. Cervical Spine Disorders in Infants and Children. Journal of the American Academy of Orthopaedic Surgeons 6(4): 204-214, 1998.

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PEDIATRIC HALO VEST SIZES

VEST SIZE	HEIGHT & WEIGHT	XYPHOID CIRCUMFERENCE	SHOULDER TO XYPHOID	SHOULDER TO ILLIAC	NECK OPENING
PED 00		19" - 21" (48 cm - 53 cm)	4 ¼" (11 cm)	6 ¾" (17 cm)	3 ¼" (8 cm)
PED 0		20" - 21 ½" (51 cm - 55 cm)	5 1/8 " (13 cm)	7 ½" (19 cm)	3 ½" (9 cm)
PED 1		22" - 28 ½" (56 cm - 72 cm)	6 ¾" (17 cm)	9 ½" (24 cm)	4" (10 cm)
PED 2		22" - 28 ½" (56 cm - 72 cm)	7 ¼" (18 cm)	10 ¾" (27 cm)	4 ¼" (11 cm)
PED 3		22" - 28 ½" (56 cm - 72 cm)	8 ½" (22 cm)	12 ¼" (31 cm)	4 ½" (11 cm)
PED 4		26½" - 32 ½" (67 cm - 83 cm)	8" (20 cm)	11 ½" (29 cm)	4 ¾" (12 cm)

PEDIATRIC HALO RING SIZES

MODEL	XX SMALL	X SMALL	SMALL	MEDIUM	LARGE	X LARGE	XX LARGE
1211-1	14" - 17" (36 cm - 43 cm)	16" - 19" (41 cm - 49 cm)	16" - 21" (41 cm - 53 cm)	21" - 24" (53 cm - 61 cm)	24" - 26" (61 cm - 66 cm)	26" - 28" (66 cm - 71 cm)	
1201-1		14" - 16" (36 cm - 41 cm)	16" - 19" (41 cm - 48 cm)	19" - 22" (48 cm - 56 cm)	22" - 24" (56 cm - 61 cm)	24" - 26" (61 cm - 66 cm)	26" AND UP (66 cm AND UP)

Pediatric Sizes PMT manufactures a full line of pediatric vest sizes. When ordering a pediatric vest, extra measurements are necessary.

Sizing Information

To ensure proper fit for halo ring and vest for pediatrics the following four (4) measurements need to be considered: (A) Head Circumference; (B) Xiphoid Circumference; (D) Shoulder to Illiac Crest; (E) Shoulder to Xyphoid . (See diagram on second page)

Halo Ring: Measurement for the halo ring should be made by measuring the circumference of the patient's head 1 cm above the eyebrow and ear. If measurement falls in between sizes order the larger size.

Vest: Measurements for the vest size should be made by measuring the circumference of the chest at the xyphoid process. If the patient is borderline between two sizes measure the vertical distance from the top of the shoulder to the iliac crest and from the top of the shoulder to the line of the xyphoid process.

PHONE (952) 470-0866 – FAX (952) 470-0865 – ecaille@pmtcorp.com

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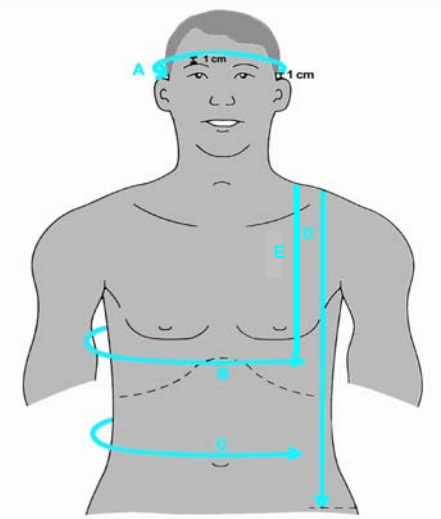
Diagram Description

A. Head Circumference (for ring size)
B. Xyphoid Circumference
C. Waist Circumference (only adult)
D. Shoulder to Illiac Crest
E. Shoulder to Xyphoid (only pediatric)



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