INTRACRANIAL MIGRATION OF HALO FIXATION PINS: A COMPLICATION OF USING AN EXTRAORAL DISTRACTION DEVICE

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ABSTRACT. Distraction osteogenesis is a well-accepted technique in the treatment of patients with hypoplastic craniofacial components. Complications of distraction osteogenesis are well described in the literature. We describe a complication of using an external distraction device in a nine years old female with Pfeiffer. A modified Lefort III osteotomy was performed for maxillary hypoplasia with application of an external distraction device. A Pediatric Neurosurgeon placed the halo device. A post-operative CT scan showed _ cm skull penetration of the cranial pins. The pins were repositioned and the patient was followed on a regular basis until discharge from the hospital. At 3 weeks follow-up a CT scan of the head showed migration of the pins 11/2 cm intracranially. The halo was removed and repositioned at a different site. No detectable neurological sequelae from the pin penetration were noted. The patient developed cellulitis at the site of the penetration and was admitted to the hospital for a course of intravenous antibiotics. There were no other complications and the rest of her treatment course proceeded as planned. A review of the literature on complications of halo usage as well as suggestions for their management in association with distraction osteogenesis is described.

Perry and Nickel (1960) first introduced the original principles of the halo in Orthopedics to immobilize the cervical spine. The popularity of the halo has grown since and has become the most common method used to immobilize the cervical spine. It has been used not only in trauma, but also for the treatment of other cases of instability such as neoplasm, infection, poliomyelitis, rheumatoid arthritis and for surgical stabilization. Recently, with the introduction of distraction osteogenesis to the craniofacial skeleton, the halo device is seeing its application adapted in this arena in the form of rigid external distraction devices for the maxilla. Polley and Figueroa (1997) introduced the Rigid

External Distraction (RED) system by KLS martin for maxillary advancement. Indications for use are severe cases of maxillary hypoplasia requiring large advancements and repaired palatal clefts with a resulting scar. An osteotomy is performed and the distraction device is attached to a prefabricated occlusal splint which is attached to a halo device secured with three scalp screws on each side.

The advantages of using a halo in external distraction include more precise positioning and effective traction, better vector control of the osteotomized maxilla, and ease of application and removal. Maxillary distraction osteogenesis after complete osteotomy with the RED technique is shown by Figueroa and Polley (1997) to be a highly effective treatment modality to manage maxillary hypoplasia. With the addition of this new technique to the surgeon's armamentarium, comes new complications and risks.

Many complications of halo usage have been reported, including loosening of the pins, soft-tissue infection about the pins, scaring at the sites of the pins and pain. More serious complications have included osteomyelitis of the skull, penetration of the skull and intradural and extradural abscesses (Tindall, 1959; Celli, 1985; Garfin, 1985; Glaser, 1986; Baum, 1989; Dorfmuller, 1992; Dormans, 1995). No case of intracranial penetration of fixation pins has been described with the use of an external distraction device using a halo. We describe a complication of an intracranial migration of halo fixation pins using an external distraction device.

CASE REPORT

A 9 year-old girl who had Pfeiffer Syndrome with severe maxillary hypoplasia was treated with a complete modified LeFort III osteotomy with mobilization through a bicoronal approach. Because the patient had previous craniofacial surgery including a frontal-orbital advancement, there were multiple osseous defects in her skull form. For this reason, a pediatric neurosurgeon was asked to place the halo portion of the rigid external distraction device. Three pins were placed on each side of the skull in the anterolateral portion of the head, torqued only to finger tightness. The rest of the halo framework was then attached to the distraction device accordingly. A post-operative CT scan was performed to check the position of the pins. This showed a _ cm penetration of the cranial pins intracranially. The pins were repositioned accordingly and another post-operative CT scan was performed confirming correct positioning of the pins. The patient was followed on a regular basis until discharge from the hospital. 3 weeks after surgery, the patient's mother noted loosening of the halo device. Careful examination of the device showed that the pins might have penetrated the skull. A CT scan of the head confirmed migration of two of the pins 11/2 cm intracranially (fig. 1). The patient as well as the mother denied any unusual activity that may have pushed the pins inside the skull, such as falling on the halo device. The halo device was once again repositioned. The remaining distraction course proceeded as planned.

At four weeks, the halo was removed. The patient had developed a cellulitis where her pins were placed. Because the cellulitis was close to the site where the pins had previously penetrated the skull, she was admitted to the hospital for intravenous antibiotics. After two days on antibiotics, the cellulitis resolved and the patient was discharged without any further incidence. No detectable neurological sequelae from the pin penetration were noted.

DISCUSSION

Generally, the halo is well tolerated by patients and significant complications are not common. Complications associated with the use of a halo have been reported frequently in the literature and include loosening of pins (21%), pin site infection (11%), severe pain associated with pins (10%), objectionable scarring (3%), failure of fixation of the ring to the skull (2%), dysphagia (2%), neural injury (2%), dural penetration (1%), CSF leak, and cerebral or epidural abscess (17 reported cases) (Tindall, 1959; Celli, 1985; Garfin, 1985; Glaser, 1986; Baum, 1989; Dorfmuller, 1992; Dormans, 1995). The most frequent complications associated with halo pins are loosening and superficial infection. Proper pin care is necessary to minimize this risk. Many institutions recommend using hydrogen peroxide three times a day.

Infection at the pin sites can cause pins to become loose and pain at the pin site and halo loosening. This was a finding in our patient where the development of cellulitis at the pin site was associated with loosening of the pins. Garfin (1986) reviewed 179 patients with halo usage and reported on its complications. 36% had pin loosening, 20% had pin-site superficial infections. Skull penetration with dural puncture occurred in one case. Glaser and Whitehill (1986) reviewed 245 cases and found 14 of 245 had pin-track problems. There were no incidences of skull penetration.

Because pin loosening occurs quite frequently, it is important to monitor the pin sites frequently. The symptoms of loose pins include pin-site pain and/or drainage, clicking, or moving of the halo, and infection. Rizzulo and Piazza (1993) reported on the effect of pin torque on halo pin complication rates, and found a trend toward a higher complication rate in halos whose pins were inserted at 8 inch-pounds of torque as compared with 6 inch-pounds. Pin loosening occurred in 20% with an infection rate of 7% in the 6 inch-pounds groups as oppose to 26% and 13% in the 8 inch-pounds groups. There were no cases of pin penetration or intracranial abscess.

If a pin becomes loose, it should be retightened to the original application torque, assuming that resistance is met during this procedure. The pin site should be changed and a new pin should be used if osseous engagement does not occur after a few complete turns. If infection or drainage is seen, cultures should be obtained and the patient should be started on the appropriate antibiotics. If the patient does not respond to the antibiotics in the appropriate time, then consideration should be given to changing of the pin sites.

The use of the halo device in children is especially associated with a significantly high complication rate. Dormans and Criscitiello (1995) reported on complications in children and found an overall complication rate of 68% in 37 children. Baum and Hanley (1989) found major problems in five of thirteen children. The nature and distribution of these compilations were similar to those reported by Garfin (1986) in an adult population, except for a higher incidence of pin site infection.

To accommodate for the pediatric skull size and thickness and to reduce the risk of complications, adjustments have been made in the size of the halo ring, the number of pins used, and the magnitude of insertional torque. Garfin and Botte (1985) have done osteology studies on children and its affect on halo placement to determine the areas of maximum skull thickness and to map approximate thickness of the safe area for pin placement based on age. From this work, the posterolateral and anterolateral sites have been considered to be the safest areas for pin placement. Garfin and Botte (1985) have recommended that the ring be placed just over the eyebrows and the anterior pins over the lateral one-third of the orbit. They based this on the fact that the skull table thickness is the greatest in this area, which was shown in a previous study. Also, the pin should not be placed over the temporal fossa or in the temporalis muscle. The cranial cortex is thin in that area, and penetration of the temporalis muscle may cause pain during mastication. The authors recommend obtaining a computed tomography (CT) scan before halo application because of the variability of skull thickness, even in the safe areas, in children as old as 10 years of age. This is especially true in children with craniosynostosis syndromes who are characterized by severe developmental disturbances of the craniofacial regions including the calvarias. Many of these children may have also had previous craniotomy and craniofacial surgeries that may leave bony defects.

Certainly, consideration should be given to obtaining a neurosurgical consultation if there is any question to the risk of placement of the halo. If there is a question as to the correct placement of the pins, a post-operative CT scan should be obtained. Even with placement by a board certified pediatric neurosurgeon with vast experience, we still encountered difficulty. Some patients with extremely thin cortex may not be candidate for external distraction devices that use a halo. For these patients, consideration may be given to placement of an internal distraction device or surgery using traditional rigid fixation.

Lastly, although CT scan after placement of the halo confirmed correct placement of the pins, a CT scan 3 weeks later showed that the pins had moved a significant amount with 11/2 cm of the pins penetrating the skull. There was no evidence of trauma, which indicated that the pins might have migrated in slowly. We theorize that the pins may have migrated while the patient laid down, causing the pins to penetrate the already thin skull. Fortunately, this child did not develop any serious complications from the penetration of these pins.

If there is evidence that a pin has penetrated the inner cortex, the pin should be removed immediately and local care of the wound should be initiated. The patient should be started on broad-spectrum antibiotics. If there is evidence of CFS leak, the patient should be positioned with continuous elevation of the head to decrease CSF pressure. As we have previously discussed, the complication of dural penetration, subdural and epidural abscesses have been numerously reported in the literature as complication of intracranial penetration of halo pins. Severe intracranial injury has also been reported from a fall while wearing a halo external fixator.

There has been no attempt to modify halo fixation pins for pediatric application. To date, there still is a lack of data to guide the clinician on torque value relative to skull thickness. In general, the halo pins in an adult skull should be tightened to eight inch-pounds of torque at the time of insertion and retightened at twenty-four to forty-eight hours after insertion. Copley and Pepe (1998) mechanically tested three commonly used halo pins on fetal calf skull. Their results indicated that by increasing the flange width of a standard, short tipped (2.5mm) halo pin by approximately 1mm, the load of application can be increased significantly. This may allow a more secure halo construct in a pediatric population by allowing for improved fixation at the pin-skull interface. This would result in less pin-associated complications in children providing an improved capacity to resist penetration despite increased loads of application. Clinical trials are currently underway to determine if indeed this new pin design does indeed decrease the complication rate in children. Furthermore, the possibility of using a mechanical stopper on the pins placed on the outside of the skull may help to prevent penetration.

CONCLUSION

In summary, external distraction using the halo device is a useful tool for the treatment of maxillary hypoplasia. The literature on the use of rigid external distraction device has paid little attention to the possible complications associated with use of the halo. Halo fixation device application is a demanding technique that requires meticulous attention to small details in order to ensure its successful use. There is a lack of standardized instructions on methods of application, type of device, patient instruction, and follow-up care. We have identified some of the major problem areas that are directly related to the halo device use and its management. With skillful application and close monitoring, problems related to its use can be minimized.

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Fig. 1 CT scan of the head showing migration of two halo pins intracranially 3 weeks after placement of distraction device. Note the thinness of the cortex of the skull.