Review Article:
Complications of Halo Vest Orthosis: A Narrative Study

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Background and Aim: Perry and Nickel introduced the halo vest in 1959. It is the most common immobilization device for the unstable cervical spine. In the literature review, most articles review the beneficial effects of the halo vest, and a few report its complications. This study aims to evaluate the complications associated with halo orthosis.

Methods and Materials/Patients: This is a narrative study about halo vest complications. To provide up-to-date information, we reviewed the articles written about halo complications. All relevant articles were retrieved from Google Scholar, Medline, PubMed, etc., using the keywords of “halo vest orthosis”, “unstable cervical spine fracture”, “halo vest complications”, “halo vest immobilization”, “pin-site-related complications”, and “vest-related complications”. Afterward, we reviewed and critically analyzed the articles.

Results: At first, the halo vest was used for postoperative paralyzed poliomyelitis patients, and later, it was also used for traumatic injury of the cervical spine or postoperatively in cervical spine reconstructive surgery. Compared to other orthoses, the halo vest provides a more effective external fixation and maintains normal anatomic alignment of the cervical spine without impacting jaw motion and resulting in eating problems. However, it has many temporary complications. To prevent halo vest complications, experienced people should apply it, and the patients should be regularly followed up for early detection and treatment of complications.

Conclusion: Our review is the starting point for the evaluation and investigation of halo vest complications. Because of the high incidence of pin loosening and infection, it is better to evaluate the design and application of halo pin. Since the initial design of the halo vest, only its superstructure has been redesigned without any significant change in other parts of it.
1. Introduction

About 60% of spinal injuries occur in the cervical spine, and 20% of its fractures occur in the upper cervical spine. We can use different orthoses such as halo vest, Minerva, CTLSO (cervicothoracic lumbo-sacral orthosis), etc., for nonoperative treatment of cervical spine fractures. In many centers, the halo vest is the first choice for nonsurgical treatment and external fixation. However, the halo vest has some complications (with a relatively high rate). So for the usage of the halo vest in these conditions, we must consider these disadvantages. We conducted this study to evaluate the associated complications of halo vest immobilization [1-10].

Halo vest can protect against neurological damage in posttraumatic cervical spine instability. Still, because of incomplete immobilization, there is a chance of progressive deformity that may result in surgical treatment for spinal instability. Also, restriction of halo vest for three months is not tolerable for some patients [11]. Complications of halo vest are relatively high and include pin loosening, migration, penetration, scalp infection, skull fracture, cerebral hemorrhage, paresthesia, and pres sure sores [12]. The fracture healing rates with halo vest in the cervical spine are about 67% to 93.9% [13-15]. Overall, the halo vest has a failure rate of 39.1%, with complications in 60.9% of patients and an intolerability rate of 68.4%. Pin-site problems are the most prevalent complications of halo. Because of the many complications and high failure rate of halo vest immobilization, the clinicians must rethink before applying halo. To prevent these problems, physicians must consider pin-site problems for early detection and treatment [15]. This narrative study aims to evaluate and search the rate and type of complications of halo vest orthosis.

2. Methods and Materials/Patients

This article is a narrative study about the halo vest complications. To provide up-to-date information on the complications of the halo vest, we briefly reviewed its complications in related articles. We retrieved all relevant articles from Google Scholar, Medline, PubMed, etc. using the keywords of “halo vest orthosis”, “unstable cervical spine fracture”, “halo vest complications”, “halo vest immobilization”, “pin-site-related complications”, and “vest-related complications”. Finally, the extracted papers were reviewed and critically analyzed.

3. Results

The halo vest is a rigid orthosis with a ring and four pins attached to the outer cortex of the cranium. It has a complication rate of 0%-100% because of its rigid ring that attaches to the outer cortex of the cranium. We briefly reviewed the halo complications and classified them based on the etiology (pin, vest, underlying pathology, etc.) of complications.

Pin-related complications

Pin loosening: This is the most prevalent complication in adults, occurring in as many as 36% of patients. In adults, loosening is slightly more common with anterior pins than with posterior pins. In children, anterior pin loosening also is predominant, occurring in up to 87% of cases. A loose pin without signs of infection can be retightened one to two turns. When the pin remains loose after this maneuver, a new pin should be placed in another location. It is essential to place the new pin
within the safe zone [16, 17]. The loose pin must be re-
tightened, but if loosening is not fixed, the pin must be
removed and placed in another location [18]. Loosen-
ing is considered when any of the following conditions
occur: first, if a pin is freely twisted and moved by the
examiner without any restriction or pin tip is visible at
the edge of the skin rather than at the edge of the skull.
In these circumstances, first of all, tighten the loosened
pins. If there is some resistance during tightening of
the pin, there is no need for its removal. However, the
pin must be removed and placed in another location if
there is no resistance to the pin turning [3].

Supraorbital and supratrochlear nerve palsy: Ideal
pin-site placement for anterior pins prevent this com-
plication. If anterior pins of the halo vest are inserted
at the medial third part of the eyebrow, there is a high
risk of damage to the supraorbital and supratrochlear
nerve. This complication clinically manifests with pain
and paresthesia in the forehead area above the anterior
pins. After removing anterior pins and changing the pin-
site area at the more lateral position, the patient’s clin-
cal manifestations should be improved [3].

Pin-site bleeding: In patients who require anticoagu-
ulant therapy while using a halo device, pin-site bleeding
must be considered [3].

Pin scars: [3].

Pin discomfort: Severe pin discomfort is reported in
18% of patients with a halo vest [3].

Pin-site infection: Pin-site infection is more prevalent
in children than adults, with reported rates between
39% and 57%. There are two types of pin-site infections:
superficial infections that may not be associated with
pin loosening and deep infections that may be associ-
ated with osteomyelitis or rarely intracranial abscess.

Diagnosis of infection is initially based on the presence
or absence of cellulitis at the pin-site and then positive
or negative culture results. Superficial infections can be
treated with oral antibiotics (e.g., oral cephalosporin),
with or without pin removal, but deep infections require
pin removal with a new pin at a new site, debridement,
and systemic antibiotics. If the infection is resistant to
treatment with permanent drainage, cellulitis, or other
signs of infection, the pin-site must be changed and
placed in another location with the initiation of more
potent local and possibly intravenous antibiotic therapy.

Regarding the prevention, at the initial stage for pins
placement, all pins must be inserted under aseptic condi-
tions. After pin insertion, they must be cleaned every oth-
er day with betadine or hydrogen peroxide at a hospital
and after discharge at home. Because of low-grade infec-
tion, more frequent cleansing is not suitable. The risk of
infection in anterior pins is more than other pins without
any known reasonable cause. The usefulness of wound
cultures is not known, and these cultures are not part of
routine practice. Nemeth and Mattingly reported that a
six-pin construct increased stability without increasing the
rate of pain-related complications; however, this is cur-
rently not considered standard practice in adults [16-19].

Overpenetration of pins: Skull has an outer and inner
table, and all pins must only penetrate the outer table.
If pins traverse through the inner table of the skull, they
cause dural puncture, and if infection occurs, it can
cause a brain abscess. Titanium conical pins are gradu-
ally blunted. Even newly replaced pins can be blunted in
four weeks. Reusing halo rings and vests after cautious
examination to rule out any defect is possible, but reuse
of skull pins should be avoided. Pin loosening can occur
because of microfractures and creep of the outer cortex
of the skull around the pin tip after insertion of conical
pins. The risk of pin loosening and penetration to the in-
ner cortex increases whenever a blunt or hooked pin tip
is rotated during the checking of poundage or routine
re-torquing. The routine practice of re-torquing skull
pins beyond three weeks should be revised. Whenever
patients have pin-site pain, and the pin tip is deformed,
it should be changed rather than re-torquing [20, 21].

Pneumocranium: If pins penetrate the frontal sinus,
pneumocranium occurs. Halo vest anterior pins must be
placed at about 1 cm superior to the orbital rim and at
the lateral half of the eyebrow for preventing frontal sinus
penetration and supraorbital and supratrochlear nerve
injury. However, there is a variation of normal anatomic
landmarks of the frontal sinus, and these typical anato-
ic landmarks for halo vest pin placement are not always
safe, especially on the left side, in which the frontal sinus
is potentially larger. So it is obligatory to take a skull x-
ray with a marker in the pin insertion area or CT-scan of the
skull and frontal sinus before halo vest pin placement.
Furthermore, tactile evaluation during insertion is criti-
cal to detect penetration. If there is a loss of resistance
during pin insertion, the surgeon must consider potential
cranial penetration and pneumocranium [22, 23].

Pin-site myiasis: Maggots are parasites and are classi-
fied into two types of obligatory and facultative. Obligat-
ory maggots are invasive and affect the living tissue, but
facultative consume the necrotic dead tissue. It most commonly affects the lower limbs ulcer and wounds with necrotic dead tissues. Based on Park et al., because of the dead necrotic tissue around the pin, pin-site myiasis can occur. For effective improvement of this complication, maggots must be completely removed [24-27].

**Brain abscess:** This is a rare fatal complication of halo vest. Overpenetration of pins that traverse through the inner skull table and enter the cranium increase the risk of intracranial infections. Standard correct pin-site placement is crucial to prevent minor complications with resulting cerebral abscess. So, it is better to avoid pin placement at the temporalis muscle area. Pins are designed with a broader body and sharp tip to prevent overpenetration through the inner table. As mentioned, it is better to avoid pin placement in the temporals muscle area because it is painful, causes difficulty in chewing, and underlying bone is thin and susceptible to puncture and overpenetration. The ideal good position for posterior pins is at the area of the 4 and 8 o’clock of calvaria as 12 o’clock is glabella, and 6 o’clock is occipital protuberance.

Due to the difficulty of achieving firm pin placement, the use of halo traction devices must be prohibited in the following cases because of the loose pin placement: prior craniotomy, recent skull fractures, and soft bone as in Rheumatoid Artheritis (RA) or multiple myeloma. All pins must be retightened 24 hours after pin placement and then after one week and again during 4-6 weeks follow-up periods. Delayed and excessive pin tightening must be prevented because of the pin overpenetration. If the patient has purulent discharge with or without neurological complaints, a brain CT scan must be done.

For detection of brain abscess in early stages, in all patients with halo device and neurological manifestations in favor of cerebritis or brain abscess, brain CT with contrast must be done immediately. Early recognition is mandatory because, at an earlier stage with only cerebritis, intravenous antibiotic treatment will be more effective. However, a well-developed abscess at the late stage has a firm fibrous capsule with necrotic material and debris resistant to parenteral antibiotic therapy. So the only available option for treatment is surgical evacuation followed by antibiotic treatment. Following pin penetration through the inner table with continuous pressure and irritation of the dural surface and an associated inflammatory process, infectious organisms enter into the subdural space. Deeper cerebral abscesses can occur because of retrograde thrombophlebitis through the dural veins with halo fixation devices [28-36].

**Infectious cavernous sinus thrombosis:** Infectious Cavernous Sinus Thrombosis (CST) was initially reported as an uncommon complication of facial infections. Infectious CST is an invasive infectious condition with a high fatality rate. Rahimizadeh et al. reported a case of septic CST secondary to a halo pin-site infection. In this case, CST occurred because of unrecognized pin-site infection and presented with proptosis and ipsilateral eyelid edema; however, with early consideration of CST and aggressive antibiotic and anticoagulant therapy, the patient had a favorable outcome [37-44].

**Orbital roof fracture and orbital cellulitis:** It is a rare halo complication caused by pin penetration into the orbit. It is followed by the inflammation of extraocular muscles and other orbital soft tissue, and this causes severe proptosis, ptosis, and diplopia. If anterior pins are placed too lateral and inferior, they can enter the orbit. The management is nonsurgical as parenteral antibiotics and topical antibiotic (ofloxacin eye drop) instillation into the eyes for ten days [45].

**Acute subdural hematoma:** This is a rare complication of the halo vest. To prevent this complication, it is obligatory to consider the bone quality, the patient’s coagulation status, and other comorbidities [46].

**Vest-Related complications**

**Pressure sores:** This complication most commonly occurs in quadriplegic patients that have disordered skin sensation. Pressure sores commonly occur in the area of the scalp and sternum under the halo cast or vest. Early surgical stabilization with internal fixation effectively prevents pressure sores in patients with spinal cord injury [47-49].

**Pulmonary complications:** This is more common in older adults over 65 years with a halo vest. Because of reduced pulmonary compliance and following pulmonary infections, respiratory failure can mainly occur in the elderly with halo vests [5, 50].

**Problems related to original pathology**

Immobilization created by halo vest is not complete and absolute; thus, graft failure, implant migration, loss of reduction, over distraction, and snaking motion can occur. Rotation in opposite directions, hyperextension of the upper cervical spine, and hyperflexion of the subaxial cervical spine can cause snaking motion. This issue is especially prominent when the patient moves from prone to supine position. Therefore, the halo vest strap and pins must be checked and retightened. If this com-
Complication continues, consider a form-fitting cast vest. Snaking motion can cause inadequate healing and non-union of the fractures/injured site [51, 52].

**Miscellaneous complications**

**Abducens and trochlear nerve palsy:** The most prevalent cranial nerve injury with halo is the sixth cranial nerve injury because of pin placement and traction. Because the sixth cranial nerve supply ipsilateral lateral rectus muscle, the patient presents with diplopia (double vision) and loss of the lateral gaze on the affected side. Watch and wait is the preferred treatment, and the condition will resolve itself. The fourth nerve palsy may be underreported because of masking by a coinciding sixth nerve palsy [53].

**Transient hearing loss:** [54].

**Visual disturbances:** [54].

**Dysphagia:** Overextension of the neck can cause dysphagia and improve with the halo adjustment [16]. Difficulty swallowing (dysphagia) occurs in 2% of the patients [55].

**Failure to thrive (elderly):** [56].

**4. Conclusions**

Based on this review, more evaluation and investigation about halo complications is obligatory, and our study delineates topics in need of further research. The most prevalent problems of the halo vest are pin loosening and infection, so it is better to change halo design and use. Halo vest cannot completely fix the cervical spine and prevent progressive deformity. Pin overpenetration is a serious complication of halo. For its prevention, only trained personnel with up-to-date information about the anatomy of this region can insert and place the halo in the right area. Regular exam after halo placement is obligatory for timely diagnosis and treatment of halo complications.

**Ethical Considerations**

**Compliance with ethical guidelines**

There were no ethical considerations to be considered.

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**Authors’ contributions**

All authors equally contributed to preparing this article.

**Conflict of interest**

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