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Subcutaneous Tethering of Ventriculoperitoneal Shunt Catheter Due to Calcification- A Late Complication of VP Shunt Surgery

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Abstract

Tethering of shunt tube in subcutaneous plane is due to aging of silicon material and its reaction to body tissue. There is formation of fibrous sleeve around shunt tube due to deposition of calcium, phosphate and minerals around shunt tube. Complications associated with VP shunt are broadly classified into the mechanical/nonmechanical types The mechanical complications include obstruction, disconnection, and migration. The nonmechanical complications include infection and distal compartment-related complications (pseudocyst formation, ascites, and pleural effusion). Shunt dysfunction is considered to be the most common neurosurgical complication encountered. The quantity of silica and vulcanizing agent, which are added to medical-grade silicone rubber may be responsible for the soft-tissue reaction. In my hypothesis another factor responsible for calcification and tethering of shunt tube is the stimulation of muscular plane through which the shunt passes because of contraction of platysma muscle in neck and intercostal muscles in chest wall area and due to these frequent neck movements and platysma muscle contraction results in subclinical inflammation leading to calcification around the tube. The muscle cells use calcium ions to coordinate muscular contractions. When a muscle cell is given the signal to contract from its associated nerves, it releases a flood of calcium ions from a special intracellular organelle, the sarcoplasmic reticulum, that surrounds the bundles of actin and myosin filaments hence there is high chances of deposition of calcium around tube which further adheres to the subcutaneous tissue resulting ins tethering and dysfunction of shunt.

***Keywords:* VP Shunt surgery late complication; Shunt catheter tethering; Calcification**

1. Introduction

Ventriculoperitoneal shunt is a widely used surgery for treatment of hydrocephalous and Shunt failure is the most common complication of this procedure. Shunt-related complications are broadly classified into the mechanical/nonmechanical types [1,2]. The mechanical complications include obstruction, disconnection, and migration. The nonmechanical complications

include infection and distal compartment-related complications like pseudocyst formation, ascites, and pleural effusion [1,2]. Chhabra Hydrocephalus Shunt System is today a widely used low cost system all over the world. It is used in more than 50 countries of all continents. Almost 1/5th Population of the world is benefitted by this simple & low cost system. Chhabra VP Shunt system is commonly in India and it is made up of SILICON tube, known for least tissue reaction.

Tethering of shunt tube in subcutaneous plane is due to aging of silicon material and its reaction to body tissue. There is formation of fibrous sleeve around shunt tube. With ageing of silicon shunt tube deposition of calcium, phosphate and minerals occur around shunt tube which is responsible for tethering of shunt tube in subcutaneous plane. Patients commonly present with hard thick cord in neck and upper part of chest, sometimes disconnection of ventricular catheter from valve i.e. fracture of VP shunt have also been noticed and patients usually present with malfunction of VP Shunt system. Out of 306 shunt surgeries done for hydrocephalous 16 patients presented with tethering and calcification of Shunt tube and VP shunt system failure.

2. Material and Method

This study was conducted at SVBP HOSPITAL associated with government LLRM Medical college, Meerut and private hospitals of Meerut during period of January 2013 to December 2018. Out of 306 patients who underwent VP shunt surgery 106 patients were admitted for revision of V P shunt due to failure of VP Shunt surgery because of various etiopathogenesis. These patients presented with symptoms of tightening and pain along shunt tube, sub cutaneous puckering of skin and redness along shunt tube. On turning the neck in the opposite direction the shunt tube become more prominent.

3. Results

During the study period from January 2013 to December 2018, among the total of 306 VP shunt surgeries, 84 patients underwent ventriculoperitoneal shunt revision once while 22 patients underwent revision twice i.e. revision was performed in 106 patients due to failure of VP shunt in the Department of Neurosurgery, S.V.B.P. Hospital, associated with L.L.R.M. Medical College, Meerut and nearby private hospitals. Out of these 106 patients 16 showed calcification around shunt tube (TABLE 1 and 2).

TABLE 1. **The time interval between the last shunt placement and malfunction of shunt system due to tethering of shunt.**

Age group	**No. of patients**
0-5 years	N=0
5-10 years	N=8
11-15 years	N=4
15 years and above	N=4

TABLE 2. **Symptom of presentation of patients.**

Symptoms	No. of patients
Redness along tract of tube.	N=4
Tightness along shunt tube.	N=10
Headache of and on.	N=12
Vomiting of and on.	N=3
Pain in abdominal wall and chest wall along shunt track	N=6

Out of the 16 patients who showed calcification a minimum period for shunt revision due to tethering and calcification post VP shunt surgery was 5 years and a female presented for shunt revision due to calcification and tethering after 18 years of VP shunt surgery. Another female presented with calcification and tethering of shunt tube along with unusual migration of VP Shunt tube in urinary bladder wall post 10 years of VP Shunt surgery. The lower end of the tube was stony hard and was removed cystoscopically. The usual complaints of the patients suffering from this condition are pain in the neck and chest wall along shunt track and limitation of neck movements as a result of shunt tube tethering. In addition, features of shunt dysfunction and skin irritation above the shunt tube and inflammation of subcutaneous tissue and skin may also be present as late complication (FIG. 1-6).

FIG. 1. **Tighting due to tethering of shunt tube in neck and showing redness due inflammation and calcification around tube.**

FIG .2. **X-rays neck and chest showing deposition of calcium and minerals around shunt tube.**

FIG. 3. **Removed shunt tube, showing calcification around tube present in neck portion.**

FIG. 4. **CT Scan abdomen showing migration of distel end in to urinary bladder wall.**

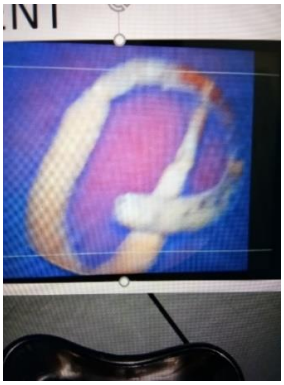

FIG. 5. **Cystoscopically seen ,calcified tube in urinary bladder wall.**

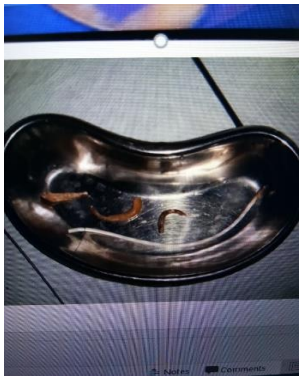

FIG. 6. **Cystscopically removed stony hard distel tube of V .P shunt catheter.S.**

4. Discussion

Various factors have been identified for the abnormal calcification around the shunt tubing [3-7]. It has been suggested that the variations in the quantity of silica and vulcanizing agent, which are added to medical-grade silicone rubber may be responsible for the soft-tissue reaction. It has also been shown that as a result of hydration the polymers may undergo biodegradation causing splitting of covalent bonds and dissolution and digestion by macrophages leading to abnormal calcification [8-14]. Most commonly the abnormal calcification involves the shunt catheter in the cervico-thoracic portion of the shunt tube rarely there may be calcification in proximity to ventricular wall [4,5,9]. It has been suggested that neck movements' increases tensile stress on the shunt tubing as it passes from the mobile neck to the relatively immobile chest wall causing stress-related degeneration in the cervicothoracic section of the tubing causing tethering of the shunt tube leading to fracture and disconnection of the tube [4,6]. Stannard and Rollins [4], in 1995 reported three patients who developed dystrophic calcification of the shunt catheter at the thoracic inlet that was associated with shunt disconnection in two patients.

In my hypothesis the shunt passes in subcutaneous plane and it comes in contact with platysma muscle in neck and intercostal muscles in chest wall area and due to frequent neck movements and platysma muscle contraction there is subcutaneous inflammation along the tube tract. The muscle cells use calcium ions to coordinate this muscular movement s. When a muscle cell is given the signal to contract from its associated nerves, it releases a flood of calcium ions from a special intracellular organelle, the sarcoplasmic reticulum, that surrounds the bundles of actin and myosin filaments hence there is high chances of calcification around tube.

In a published review of 64 cases with shunt calcification, Boch et al. [7] in 1998 concluded that shunt calcification is a late complication and appears to be partly related to aging of the shunt tube material.

Cakir et al. [8] in 2004 reported 16-year-old girl presented with shunt malfunction due to calcification, he reported that the attempt of removal of the calcified catheter has resulted in shunt rupture and he recommended replacement of the calcified shunt with a new one and avoidance of aggressive surgical attempts to remove the calcified shunt.

Sakai et al. [9] in 2004 reported 53-year-old man with renal failure who developed dense calcifications at the proximal end of the ventricular catheter of the VP shunt and the ventricular wall, he concluded that disturbed calcium and phosphate metabolisms associated with renal failure may have been involved in this abnormal calcification of the ventricle wall.

In a recent paper published in 2012, Kural et al. [6] reported 10-year-old boy who had ventriculoperitoneal shunt operation when he was 10 days old, the patient presented later with shunt dysfunction due to shunt calcification and rupture. They reported that the shunt tube calcification can occur in spite of normal blood calcium and phosphorus levels; this is attributed mainly to the altered cellular metabolism and the quality of the shunt tube used. Various factors have been adduced to account for calcium deposition about shunt tubing. Variations in the quantity of silica and vulcanizing agent added to medical-grade silicone rubber may provoke a soft-tissue reaction. Static electrical charges on the tubing may hold dust and lint. Benzalkonium chloride may be absorbed into the silicone rubber and may reenter the body after implantation. Detergents and dissolved ethylene oxide gas may excite soft-tissue fibrosis [4]. In addition, polymers are known to undergo

biodegradation as a result of hydration, splitting of covalent bonds, and dissolution and digestion by macrophages [8]. In a review of microscopic findings in 25 removed shunts [7], the most extensive mineralization of shunt tubing occurred near the nuchal line as the shunt catheter ran from the subgaleal layer to the subcutaneous layer, a site of mild constrictive stress subject to repeated tensile strain. The same study showed a marked loss of tensile strength in implanted tubing. The most important factors in the microcalcification of the shunt catheters were the youth of the patient at original implantation and the length of time the tubing was in the patient. In none of the patients in this series was the tubing disconnected.

The most reported cases of VP shunt calcifications are detected extracranially, especially around the neck region [3-11]. This might be because of the increased mechanical stress in that region [5,6,8,9]. On the other hand, only a few reports of intracranial calcification of a ventricular catheter were found in the literature.

5. Conclusion

Calcification around shunt tube is a late complication, usually observed after 5 years of V P Surgery. The shunt tube becomes hard and brittle resulting in its malfunction and disconnection and requires revision of shunt surgery with replacement of shunt.

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