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# The Gott Shunt and Intra-Thoracic Aortic Injuries

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## ABSTRACT

Major intra-thoracic and intra-abdominal aortic trauma can and should be treated without the use of heparin and upon discovery without hesitation or conservative watch and wait methods. The use of a heparin bonded disposable flexible plastic tube tapered at both ends (Gott shunt) is described for use in intra-thoracic aortic trauma and patient statistics are applied to its use and rational in hopes of stimulating further research into its use by other surgeons for closed chest aortic trauma.

## KEYWORDS

Aortic injury; Aortic trauma; Systemic non-heparinized shunt; Intra-thoracic aortic injury/dissection

## INTRODUCTION

The Gott shunt (heparin bonded disposable flexible plastic tube tapered at both ends) is of vital use in trauma surgery of the intra thoracic aorta from the level of the proximal/mid arch of the aorta to the intra-abdominal bifurcation of the aorta with appropriate incisions [1]. In this research study only the use of the Gott shunt in the thorax will be discussed. Using the Gott shunt means no heparinization of the patient is necessary. These patients (30% - 49%) may have additional injuries to solid organs (liver, spleen, brain, heart, kidneys), hollow organs (lung, stomach. esophagus, intestines) and/or bone fractures which are not discovered during the initial workup but later in the operating room or ICU [2,3]. Discrete intra-thoracic/intra-abdominal aortic injury/partial transection must not be treated by watchful waiting or other conservative methods no matter the age of the patient, or other medical condition as this injury poses a greatly increased risk of catastrophic rupture and death. The exception to this rule is that if you are seeing a patient for the first time and they have been treated expectantly for a long period of time, are stable, with a non-expanding lesion, then continued expectant treatment may be warranted. I have no bias against the use of heparin as I used it and protamine copiously in my elective and emergency open heart surgery practice. In this research paper, I will describe four patients where the Gott shunt was used and one patient where the shunt was unavailable. Major intra-thoracic and abdominal aortic trauma can be treated without heparin so that fracture, hollow visceral and solid organ injuries along with intra cranial trauma do not become fatal secondary to hemorrhage.

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## MATERIAL

1. A 22-years-old white male with 0.38 caliber gunshot wound from behind nicking the proximal inferior side of the aortic arch between the innominate artery origin and the left common carotid origin.
2. Three patient's ages 30 years to 65 years of age with the garden variety distal aortic arch to proximal descending aorta tearing from a deceleration injury caused by a moving vehicle deceleration accident.
3. Control patient: 52 year old Jehovah Witness female patient (with a moving vehicle deceleration injury as described in "2") where the Gott Shunt was not available, a normal heparin dose was used, and rapid cut, insert graft, and sew technique was used.

## PROCEDURE

1. In trauma vascular surgery such as ruptured abdominal aortic aneurysms and tears of the intra thoracic aorta, the surgeon must realize that only with a large amount of "luck" can a heparin dose be reversed accurately and totally by protamine [4]. This is primarily secondary to the loss of intrinsic clotting factor into the wound, drapes and sponges, and the suction/"cell saver. Any overshot of the absolutely precise dose of protamine to reverse heparin will result in protamine anticoagulation that takes hours to reverse; and leads to uncontrolled hemorrhage through wound edges, torn tissue, graft walls, and needle holes.
2. A Gott shunt can be placed anywhere in the thoracic/abdominal aorta. The proximal end can be placed in the proximal end of the aortic arch or distal end of the ascending aorta at the usual open heart aortic canulation site or the partially transected end of the left Subclavian artery via a 3$^{rd}$ or 4$^{th}$ rib left lateral thoracotomy. The distal end can be inserted in the descending thoracic aorta anywhere below the damaged area, preferably just above the diaphragm. In patients 2, 3 & 4, the left subclavian was used proximally and, in patient 1, the distal ascending aorta was the proximal site. All shunt insertion sites were placed at the center of double purse string partial wall thickness stitches of 4-0 braided suture held to the shunt by rubber "snubbers" and tape ties. Prior to insertion of the shunt into the distal purse string suture, it is filled with blood and allowed to "leak" as it is inserted through a stab wound in the center of the purse string suture. The use of a "cell saver" is a great convenience.
3. After shunt flow is established, the aorta proximal and distal to the site of injury can be dissected free and cross clamped proximally and distally with vascular clamps. Then and only then is the site of injury be examined, dissected free from surrounding tissue with small arterial structures preserved, and opened. Very careful and rapid dissection of the poster wall of the injury is done looking for the artery of Adamkiewicz. In the four Gott cases this was identified positively only twice. In all of these cases, the back was of the injured segment which contained the small vessel was included in the intra segmental graft of either woven Dacron or Gortex. The ends of the damaged segment were trimmed back to viable strong arterial material which could hold sutures and had all layers present and attached to each other. If the layers are not attached to each other, I used plageted suture on the outside of the tissue line to attach the tissue layers to each other and the graft. This is done to prevent dissection of the aorta either proximately or distally from the graft. The artery of Adamkiewicz was not recognized (may have been two smaller vessels) in the control patient who was heparinized and the back wall of the aorta was excluded from the graft.
4. At the end of accomplishing the end to end anastomoses of the graft to replace the damaged aorta, unclamp the proximal end first and test the suture line while bleeding air out of the highest part

of the graft with a 18 gauge needle. Then, after all air is out and, if the suture line has no leaks, open the distal clamps. Tie the double purse string sutures as the shunt is remove and repair the proximal arterioriphy of the left subclavian with interrupted 5-0 Proline sutures and re-establish its' flow. Use a routine closure of the thoracotomy with 1-2 chest tubes after irrigating the thoracic cavity with 1 liter of normal saline with a neomycin kanamycin mix finishes the procedure unless other injuries are to be repaired.

## RESULTS

1. All four patients treated with the Gott shunt as outline in "Procedures" were discharged from the hospital in an average time of seven days. They had no hemorrhage from wounds or chest tubes, no neuropathy, no paralysis, and no transfusion other than that received in the operating room.
2. Control patient survived. She bled from the woven graft, all suture lines in the aorta, chest tube sites, thoracotomy closure suture holes, and mouth. By collecting shed blood from her chest tubes via "cell saver and infusing it into her circulation (which was allowed by her religion's elders) she was kept alive until her liver and bone marrow could make enough clotting factor to stop the hemorrhage. Unfortunately she was paraplegic. She barely survived.

## DISCUSSION

I have used heparin for greater than 20-years while doing elective cardiovascular and vascular surgery and have done these procedures on Jehovah's Witnesses. I am very comfortable with its reversal by protamine without any adverse results. I will stress that these are elective or semi-elective surgical procedures and are without significant loss of clotting factors.

The declaration injury occurs in the following manner as described by many other authors The heart and the arch of the aorta with the innominate artery, left common carotid artery and the left subclavian artery keep moving forward, while the chest wall and the descending thoracic aorta abruptly stop when the chest encounters a relatively immobile object causing the tear. Most patients with this type of injury bleed out immediately into their chests and never arrive in the emergency room. In the ones who do arrive in the emergency room alive it is only a thin slowly ballooning layer of adventitia that is preventing catastrophic hemorrhage. Surgical repair must be carried out immediately, often without diagnosis of other injuries other than suspicion of them. Some of these injuries will involve tears and bleeding from solid organs (liver, spleen, kidneys, heart, and brain) from hollow viscera(large and small intestine, stomach, esophagus, urinary bladder) bone fractures, and lungs/trachea. Heparinization in the face of these types of injuries will start catastrophic bleeding. Hematomas from bleeding and dissection of the thoracic aorta with leakage into the negative pressure pleural space will use up an unknown amount of clotting factor which a patient in shock will not immediately replace. Heparinization in this case will almost always be fatal.

By not using heparin but by using the Gott Shunt, there is no significant loss of these clotting factors Downstream clotting, hypopergfusion anomalies such as increased createnine from renal damage, liver function anomalies from liver necrosis, bowel necrosis, or ischemic limbs including the left arm does not occur.

This is a small series of cases but if the usual morbidity and mortality statistics were applied 2 of the 4 Gott shunt cases would be dead, one paraplegic, and one dancing out of the hospital. The only variable is the use of the Gott shunt: not the skill or speed of the surgeon as witnessed by the outcome for the control patient.

## CONCLUSION

The use and virtues of the Gott shunt and the techniques in it use have been documented in this research paper and others [5,6] and its use has led to 100% success on my patients on which it was used. A control patient has been included. Since, there are many excellent CV Surgeons, vascular surgeons, and general surgeons with some thoracic and vascular fellowships who are much better surgeons than I, it is hoped that if they use the simple Gott shunt, they can obtain equal results to mine making its use the standard of care.

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