Glaucoma drainage devices (GDDs) have become instrumental in the management of glaucoma. The efficacy of these devices compared with more traditional trabeculectomy in lowering IOP was first demonstrated in the Tube Versus Trabeculectomy (TVT) study. Although both procedures were associated with a similar level of IOP reduction and use of supplemental medical therapy over a 5-year follow-up period, the Baerveldt tube (Johnson & Johnson Vision) was more likely to avoid persistent hypotony, reoperation, and loss of light perception than trabeculectomy with mitomycin C.\(^1\)

As with any surgical intervention, GDDs have a potentially wide complication profile, including injection, iritis, hypotony, strabismus, infection, and excess capsular fibrosis.\(^2\) One of the most serious complications, however, is exposure of the tube and/or plate that comprises the GDD (Figure 1). It is estimated to occur in approximately 2.5% to 8.9% of cases\(^3\) and can happen any time after implantation, often 1 to 2 years postoperatively.\(^4\) Tube exposure can lead to vision-threatening endophthalmitis,\(^5\) as the exposed tube can serve as a pathway for organisms to enter the eye from the ocular surface. This article presents five fundamentals that may assist in preventing and managing GDD exposure, should it occur.

1. RECOGNIZE THE CAUSES OF TUBE EXPOSURE

   During the implantation of most GDDs, the native sclera or a patch graft material (such as donor cornea, Tenon capsule, dura mater, pericardium, etc.) is used to cover the anterior aspect of the device. This is followed by closure of the conjunctiva. Early tube exteriorization is often caused by a dehiscence of the suture securing the material that overlies the device. Late-onset tube extrusion, however, is likely related to an erosion of the overlying...

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**AT A GLANCE**

- Glaucoma drainage devices are essential in the management of glaucoma.
- Tube exposure, a complication of glaucoma drainage device implantation, results from the erosion of the overlying patch graft and/or conjunctiva.
- The risk of tube exposure can be decreased by placing the tube superiorly as opposed to inferiorly. An exposed tube should be repaired immediately.

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Figure 1. Slit-lamp photographs demonstrating conjunctival erosion over a glaucoma drainage device.
patch graft and/or conjunctiva. This degradation may be due to micro-
movements of the tube with eyelid 
blinking or ocular movements. It may 
also be related to increased tension 
of the overlying conjunctiva and/or 
abnormal positioning of the tube.

2. CONSIDER PATIENT RISK FACTORS

A number of potential risk fac-
tors for tube exposure have been 
proposed. In a retrospective study, 
Netland et al. found the proportion 
of patients with intraocular inflam-
mation prior to tube exposure to be 
higher than in control patients, which 
may suggest an underlying immune 
process as a causative factor. In a 
retrospective review of 1,073 tube 
implants, Muir et al. found female 
patients to be at higher risk of tube 
extrusion than male patients. The 
authors theorized that the smaller 
orbital dimensions of women may 
lead to increased friction between the 
GDD and ocular tissues, leading to 
tube exposure. This theory, however, 
remains controversial and has not 
been duplicated in most other studies.

Prior ocular surgeries, neovascular 
glaucoma, increased number of preop-
erative glaucoma medications, and dia-
abetes have also been cited as potential 
risk factors for tube erosion; however, 
other similar studies did not find the 
same associations. The relationship 
between age or race and tube exposure 
also remains debatable.

3. PRIORITIZE PLACEMENT OVER 
MATERIAL

There does not appear to be a sig-
ificant correlation between the type 
of GDD utilized and the risk of tube 
extrusion. On the other hand, 
there remains some controversy as to 
whether tube exposure is caused by the 
melting of certain types of patch grafts. 
Advocates of this theory suggest that 
these grafts can thin and dissolve due 
to poor integration with the host tissue 
and a lack of vascular infiltration.2 

However, most studies comparing 
patch graft material types do not 
show that one material is necessarily 
more prone to disintegrating than 
another. Levinson et al. found that, 
although the choice of patch graft 
material approached statistical sig-
ificance (9.2% risk of exposure with 
cornea, 7.9% risk with pericardium, 
and 0.5% risk with sclera), it did not 
reach it (P = .072). The authorsulti-
mately posited that corneal patch 
grafts appeared to fail at an increased 
rate because the implants were often 
placed inferiorly (see below).9

4. IMPLANT SUPERIORLY

Overall, GDDs implanted inferiorly 
are more likely to become exposed 
than those implanted superiorly.11 
This is likely related to the fact that 
there is less superficial tissue for 
implant coverage inferiorly due to 
shorter inferior fornices. This, in turn, 
leads to increased tissue tension at 
the sutured incisions and wound 
dehiscence. Further, the tear film 
pools inferiorly and harbors environ-
mental organisms. Thus, patients with 
inferior device exposure are believed 
to be at increased risk of endophthal-
mitis as there is a more direct conduit 
for bacteria to pass into the eye from 
the tear film.9

5. REPAIR EXPOSED TUBES 
IMMEDIATELY

Exposed tubes should be repaired 
immEDIATELY. Typically, repair involves 
dissection of the eroded conjunctiva 
(Figure 2A), followed by placement 
of a dual layer of coverage—first 
with a sutured patch graft to cover 
the exposed tube (Figure 2B) and 
second with a conjunctival auto-
graff (Figure 2C). Surgeons should 
consider switching the type of patch 
graft material used during the repair 
in case an immunologic component 
contributed to the initial patch graft 
 failure. Free conjunctival grafts or 
rotation flaps, double-layer amniotic 
membranes, and buccal membrane 
transplants may also be used for 
superficial coverage in the event of 
conjunctival scarring.13

Techniques that involve partial-
thickness scleral flaps, scleral tunnels, 
or a combination of both are now 
being utilized during initial GDD 
implantation (Figure 3) and as a meth-
od of repairing exposed tubes. Ollila 
et al. reported a 0% erosion rate after 
initial GDD implantation with a scleral 
graft (Continued on page 49)
tunnel. Similarly, Lee et al.\textsuperscript{15} noted a 0% re-erosion rate when exposed tubes were repaired with a split-thickness hinged scleral flap. These techniques are believed to be superior to the use of patch graft materials because the host sclera can act as a vascular bed that releases growth factors and enhances the viability of the tissues overlying the tube.\textsuperscript{15} Moreover, the tubing is embedded in the patient's own sclera, which tamponades it against the globe and prevents micromotions that may ultimately contribute to tube exposure.\textsuperscript{15}

**CONCLUSION**

GDDs have become essential in the management of glaucoma. Tube exposure, however, is a potentially vision-threatening complication of GDDs that results from the erosion of the overlying patch graft and/or conjunctiva. The risk of exposure can be decreased by placing the tube superiorly as opposed to inferiorly. Any exposed GDD should be repaired immediately, and the use of a different type of patch graft material and/or a scleral tunnel or flap should be considered.

\begin{itemize}
  \item \textsuperscript{10} Smith MF, Doyle IV, Turvey JW. A comparison of glaucoma drainage implant tube coverage. J Glaucoma. 2002;11(2):141-147.
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