The White Test

A New Dye Test for Intraoperative Detection of Bile Leakage During Major Liver Resection

Silvio Nadalin, MD; Jun Li, MD; Hauke Lang, MD, MA; Georgios C. Sotiropoulos, MD; Randolph Schaffer, MD; Arnold Radtke, MD; Fuat Saner, MD; Christoph E. Broelsch, MD; Massimo Malago, MD

Objective: To describe a new intraoperative bile leakage test in patients undergoing a major liver resection aimed to combine the advantages of each of the other standard bile leakage tests (accurate visualization of leaks, reproducibility, and ease of use) without their disadvantages.

Methods: At the end of the major hepatic resection, 10 to 30 mL of sterile fat emulsion, 5%, is injected via an olive-tip cannula through the cystic duct while manually occluding the distal common bile duct. As the biliary tree fills with fat emulsion solution, leakage of the white fluid is visualized on the raw surface of the liver resection margin. The detected leakages are closed by means of single stitches. Afterwards, the residual fat emulsion on the resection surface is washed off with saline and the White test is repeated to detect and/or exclude additional bile leakages. At the end, residual fat emulsion is washed out from the biliary tract by a low-pressure infusion of saline solution.

Results: Intraoperatively, additional potential bile leakages (not seen using a conventional saline bile leakage test) were identified in 74% of our patients. Postoperative bile leakages (within 30 days) occurred in only 5.1% of patients when the White test was used. No adverse effects related to this technique were observed.

Conclusions: The White test has clear advantages in comparison with other bile leakage tests: it precisely detects bile leakages, regardless of size; it does not stain the resection surface, allowing it to be washed off and repeated ad infinitum; and it is safe, quick, and inexpensive.


Bile leakage is the primary complication occurring after liver surgery and directly affects the quality of the postoperative course of patients, influencing both morbidity and mortality rates.\(^1\)\(^2\) Despite a significant decrease in the overall surgical complication rate in hepatic resections, the rate of postoperative bile leakage has not changed. Many large series have recently reported an incidence ranging from 3.6% to 33%.\(^1\)\(^0\)

See Invited Critique at end of article

A reliable method for detecting and localizing sites of bile leakage intraoperatively, therefore, is of paramount importance. To this end, several different intraoperative bile leakage tests have been proposed, but despite their routine use, they still have significant inadequacies (Table) and are associated with a relative high incidence of bile leakage.

Therefore, we have developed the White test, a new intraoperative bile leakage test for patients undergoing a major liver resection aimed to combine the advantages of each of the other standard bile leakage tests (accurate visualization of leakages, reproducibility, and ease of use) without the disadvantages associated with those same tests. This new localization technique of bile leakage uses fat emulsion (normally used for parenteral nutrition), which is easily recognized, innocuous to the tissues, and can be easily removed without misleading tissue staining, as previously reported by McFadden et al,\(^13\) who used a similar technique for intraoperative localization of urinary leakage.

METHODS

At the end of the major hepatic resection (done using the standard clamp transection technique\(^14\)), 10 to 30 mL of sterile fat emulsion, 5%, is injected by means of an olive-tip cannula through the cystic duct while manually occluding the distal common bile duct. As the
biliary tree fills with fat emulsion solution, leakage of the white fluid is visualized on the raw surface of the liver resection margin (Figure). The detected leakages are closed by means of single interrupted sutures (5-0 or 6-0 polydioxanone sutures). After closing the leakage site, the residual fat emulsion on the resection surface (potentially masking other bile leakages) is washed off with saline and the White test is repeated to detect additional bile leakages. At the end of the White test, residual fat emulsion is washed out from the biliary tract by a low-pressure infusion of 20 to 50 mL of saline solution.

As noted, fat emulsion solution is usually injected via the cystic duct (which is intentionally left long during cholecystectomy), but alternatively, the injection can be performed through a Kehr tube (which we place in patients with impaired underlying liver parenchyma), through the main bile duct stump in cases of resection of the main duct or bile duct bifurcation, or through a transanatomotic stent when a hepaticojunostomy is performed.

Fibrin sealant is routinely applied in most cases to the raw cut surface of the liver to promote hemostasis and to prevent minor occult bile leakage. Drainage of the operative field is usually performed by using 2 Penrose drains, which are removed when the drainage is serous and not bile stained (usually around the fifth postoperative day).

Since we began using the White test, we have intraoperatively identified additional potential bile leakages (not seen using a conventional saline bile leakage test) in 74% of our patients (mean, 1.5 [range, 1–6] leakages per patient). Postoperative bile leakage (within 30 days) occurred in only 5.1% of patients when the White test was used. This potentially represents a significant reduction in our incidence of bile leakage (previously 8% in nearly 1600 major hepatic resections). No adverse effects related to transductal injection of fat emulsion (eg, cholesterol) were observed.

### RESULTS

Postoperative bile leakages still represent a challenge in liver surgery and especially in major liver resection in which it is associated with serious complications, such as sepsis and liver failure. Unfortunately, the traditional bile leakage tests have significant inadequacies (Table). Therefore, we developed the White test as a new alternative to the traditional tests.

Regrettably, the main disadvantage of the White test as well as all other bile leakage tests is their inability to detect bile leakages that originate from a separate bile duct not communicating with the main biliary tree. However, in our experience, the White test has clear advantages compared with other bile leakage tests. The fat emulsion allows for precise detection of bile leakages, regardless of size; it does not stain the resection surface, allowing it to be washed off and repeated ad infinitum; it has no collateral effects on bile ducts or surrounding tissues; and it is quick and inexpensive.

Additional comparative trials of the White test to other bile leakage tests are warranted to confirm that the White test significantly reduces the risk of bile leakage in patients undergoing major hepatic resection. Additionally, another application of the White test being considered includes its use in segmental liver transplantation (ie, split liver transplantation and living donor liver transplantation, in situ or on the back table) whose high incidence of biliary complications (mainly bile leakage) still represents the Achilles’ heel of the procedure.

**Submitted for Publication:** October 26, 2006; final revision received January 3, 2007; accepted January 5, 2007.

**Correspondence:** Silvio Nadalin, MD, Department of General, Visceral and Transplantation Surgery, University Hospital Essen, Hufelandstrasse 55, 45147 Essen, Germany (silvio.nadalin@uni-due.de).

**Financial Disclosure:** None reported.
REFERENCES

5. Nadelin and 8 coauthors from Essen, Germany, have described an intraoperative technique to localize bile leakage from the hepatic parenchymal surface using a cystic duct injection of fat emulsion, 5%. This technique, previously described to detect urinary leakage after renal transplantation, has allowed the authors to identify bile leakages in 74% of their patients. Once identified and sutured, a postoperative biliary leak rate of 5.1% was reported. This incidence is lower than the authors’ previously published leakage rate of 8% in more than 1600 hepatic resections, though a statistical comparison is not included.

N

Bile leakages after liver resection occur in up to 36% of patients and contribute substantially to morbidity and mortality. Therefore, technical diligence is required intraoperatively to minimize their occurrence. Biliary injection of dyes, such as methylene blue, have been recommended, but have the drawback of staining surrounding tissues, making precise localization or identification of multiple sites of leakage difficult. The use of a fat emulsion, the authors’ White test, eliminates these disadvantages. Adverse effects associated with fat emulsion administration, including allergic reactions, fat emboli, immunosuppressive effects, and fungal infections, are not commented on but are unlikely. Experimentally, intraperitoneal fat infusion results in prompt absorption by peritoneal lymphatic channels. The cost and availability of this technique also appears acceptable. In the United States, standard fat emulsions (Intralipid; Fresenius Kabi AG, Hamburg, Germany) are 10% concentrations and cost approximately $1 to $2 per milliliter; the widespread use of parenteral nutrition makes access almost universal.

It would have been better if the authors had told us just how many patients were included in their study and had statistically evaluated the difference between this group and their larger series of patients. Nevertheless, the White test appears to be useful for the hepatic surgeon, and its use could be extended into the surgical management of other hepatobiliary and pancreatic disease.

David W. McFadden, MD

Correspondence: Dr McFadden, Department of Surgery, University of Vermont, Fletcher House 301, 111 Colchester Ave, Burlington, VT 05401 (david.mcfadden@vtmednet.org).

Financial Disclosure: None reported.