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Clinical Study

The value of intraoperative Gram stain in revision spine surgery

Grant D. Shifflett, MD*, Benedict U. Nwachukwu, MD, MBA, Benjamin T. Bjerke-Kroll, MD, MS, Janina Kueper, BS, Jayme B. Koltsov, PhD, Andrew A. Sama, MD, Federico P. Girardi, MD, Frank P. Cammisa, MD, Alexander P. Hughes, MD

Spine and Scoliosis Service, Department of Orthopaedic Surgery, Hospital for Special Surgery, 535 East 70th St, New York, NY 10021, USA

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Abstract

BACKGROUND CONTEXT: Intraoperative cultures and Gram stains are often obtained in cases of revision spine surgery even when clinical signs of infection are not present. The clinical utility and cost-effectiveness of this behavior remain unproven.

PURPOSE: The aim was to evaluate the clinical utility and cost-effectiveness of routine intraoperative Gram stains in revision spine surgery.

STUDY DESIGN: This was a retrospective clinical review performed at an academic center in an urban setting.

PATIENT SAMPLE: One hundred twenty-nine consecutive adult revision spine surgeries were performed.

OUTCOME MEASURES: The outcome measures included intraoperative Gram stains.

METHODS: We retrospectively reviewed the records of 594 consecutive revision spine surgeries performed by four senior surgeons between 2008 and 2013 to identify patients who had operative cultures and Gram stains performed. All revision cases including cervical, thoracic, and lumbar fusion and non-fusion, with and without instrumentation were reviewed. One hundred twenty-nine (21.7%) patients had operative cultures obtained and were included in the study.

RESULTS: The most common primary diagnosis code at the time of revision surgery was pseudarthrosis, which was present in 41.9% of cases (54 of 129). Infection was the primary diagnosis in 10.1% (13 of 129) of cases. Operative cultures were obtained in 129 of 595 (21.7%) cases, and 47.3% (61 of 129) were positive. Gram stains were performed in 98 of 129 (76.0%) cases and were positive in 5 of 98 (5.1%) cases. Overall, there was no correlation between revision diagnosis and whether or not a Gram stain was obtained ($p=.697$). Patients with a history of prior instrumentation were more likely to have a positive Gram stain ($p<.0444$). Intraoperative Gram staining was found to have a sensitivity of 10.9% (confidence interval [CI] 3.9%–23.6%) and specificity of 100% (CI 93.1%–100%). The positive and negative predictive values were 100% (CI 48.0%–100%) and 57.3% (CI 45.2%–66.2%), respectively. Kappa coefficient was calculated to be 0.1172 (CI 0.0194–0.2151). The cost per discrepant diagnosis (total cost/number discrepant) was $172.10.

CONCLUSIONS: This study demonstrates that while very specific for infection, the sensitivity of intraoperative Gram staining is low, and agreement between positive cultures and Gram stains is very poor. Gram staining demonstrated limited cost-effectiveness because of the low prevalence of findings that altered patient management.

Keywords: Revision spine surgery; Operative culture; Gram stain; Cost-effectiveness; Value; Infection

FDA device/drug status: Not applicable.

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* Corresponding author. 310 East 71st St, Apt 3D, New York, NY 10021, USA. Tel.: 540-421-1794; fax: 212-606-1477.

E-mail address: shifflettg@hss.edu (G.D. Shifflett)

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Introduction

As rates of primary spinal surgery continue to grow, so, too, have the rates of revision spinal surgery [1,2]. An essential element of every preoperative evaluation of a patient who may require revision spinal surgery is to determine whether an infection may have led to the failed prior surgery. A variety of preoperative instruments including clinical evaluation, laboratory testing, imaging, and aspiration are used to evaluate for the presence of infection when there is concern. Ultimately, when an infection cannot be ruled out, a surgeon may opt to obtain intraoperative tissue samples for microbiologic evaluation.

Gram staining is a well-established, commonly available test with laboratory personnel trained in its performance at most institutions [3]. At many institutions, it is routine to obtain Gram stains in addition to culturing tissue samples. Ideally, prompt, informative data may be obtained allowing for immediate decisions regarding both intraoperative care and initiating postoperative antimicrobial prophylaxis. In practice, however, many surgeons malign this test as uninstructive, and many favor clinical signs/symptoms in association with culture results over this preliminary test. Recent investigations into the clinical utility of routinely obtaining Gram stains support surgeons' skepticism with reports of the sensitivity of this test ranging from 0% to 50% [4–8]. These studies have largely been published in the arthroplasty literature, and to date, the spine surgery literature has not investigated this practice. As such, many spine surgeons continue to order this study as a part of the microbiological analysis of intraoperative cultures.

In the absence of available spine literature on this subject, this study was designed to answer the question of whether or not there is any clinical value in obtaining Gram stains with intraoperative cultures? Moreover, with the evolving health-care landscape and elevated importance of value-driven care, we aim to define the cost-benefit analysis of Gram stains in the setting of revision spine surgery.

EVIDENCE & METHODS

Context
The authors sought to evaluate the clinical utility and cost-effectiveness of intraoperative Gram stain in revision spine surgery. This study was performed among 129 patients treated at a single center.

Contribution
Nearly half of all cases included in this study were culture positive for an infectious organism. Gram stains were performed in only 76% of cases and were positive in just 5%. The authors question the clinical utility and cost-effectiveness of obtaining routine Gram stains in revision spine surgery.

Implications
This study adds to the literature by demonstrating the limited potential for Gram staining to influence clinical practice in this setting. However, the potential for indication and selection bias to confound study results is important and largely renders this work Level IV evidence. This should be taken into account when applying the findings to clinical practice. Conversely, the presence of selection and indication bias might mean that the findings presented here are a ''best-case scenario'' and the utility of routine Gram staining would perform even worse among all revision spine cases.

—The Editors

Materials and methods

Data collection

After approval of the institutional review board, we retrospectively reviewed the records of 595 consecutive revision spine surgeries performed by four senior surgeons between 2008 and 2013. All revision cases including cervical, thoracic, and lumbar fusion and non-fusion, with and without instrumentation were included. Demographic data including age, time between index and revision surgeries, sex, history of diabetes mellitus, smoking, spinal injections, obesity, Medicare status, surgical region (eg, cervical, thoracic, lumbar), instrumentation, and revision surgical diagnosis were collected.

Operative cultures were obtained in 129 of 595 (21.7%) cases based on the individual preoperative and intraoperative clinical judgment of the senior surgeon and were included in the study. Routine preoperative evaluation of each of these patients included clinical examination, radiographs, and advanced imaging including computed tomography and magnetic resonance imaging. In cases where an infection was suspected, preoperative measurement of serum white blood cell count, erythrocyte sedimentation rate, and C-reactive protein was obtained, as well as an aspiration if indicated. Intraoperative cultures were obtained in all the reviewed cases and were sent for aerobic and anaerobic culture, tuberculosis, and fungus. Gram stain requisitions were sent along with the cultures at the discretion of the surgeon, and the results were documented. Operative cultures were incubated for 14 days postoperatively per hospital protocol. Culture results, including their documented medium and number of positive specimens, were recorded. For the purposes of analysis, the perioperative microbiology culture was considered the gold standard against which Gram stain results were compared.

Gram staining was performed in 98 (76.6%) specimens at the discretion of the treating surgeon, and results were