ured has not been consistent. Some authors have considered one positive culture as indicating infection, others have required additional factors or have used the MSIS criteria [7] Other studies have recognized that long-term clinical follow-up may be needed to define clinically relevant periprosthetic infections, especially those involving organisms of low-virulence [23].

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QUESTION 7: What is the role of specific granulocyte counting methods and new immunohistologic staining techniques in diagnosing periprosthetic joint infection (PJI)?

RECOMMENDATION: The role of specific granulocyte counting methods and new immunohistologic staining techniques is to support the diagnosis of infection when diagnosis is uncertain. The recommended threshold is 5 or more polymorphonuclear leukocytes (PMNs) per field in each of 5 high power (400x objective) magnification fields. The stains reported-to-date can only be performed on sections of formalin-fixed, paraffin embedded tissue. Therefore, they are not available for use on frozen sections obtained during an operation.

LEVEL OF EVIDENCE: Moderate

DELEGATE VOTE: Agree: 85%, Disagree: 4%, Abstain: 11% (Super Majority, Strong Consensus)

RATIONALE

Currently, histology has been considered as one of the variables for PJI diagnosis [1]. Literature has reported on tissue reaction associated with implant failure and its relationship with infection [2]. It has been seen that an increase of PMNs correlates with the presence of an active infection [3,4]. New methods have been introduced to increase diagnostic performance. A literature search of PubMed, Ovid, Embase and the Cochrane Library was performed to include studies that evaluated the role of granulocyte counting methods and/or evaluating new immunohistologic staining techniques. The following types of studies were excluded:

1. Studies with histology metrics were used as the gold standard to test the results of other tests.
2. Studies involving primarily sites other than hip or knee (for example, shoulder operations are excluded).
3. Reviewed articles and case reports.
4. Articles published in languages other than English.

5. Articles with only limited data available such that one cannot calculate the sensitivity, specificity or predictive value of histology.
6. Studies which analyze different aspects of inflammation and therefore have no focus on the diagnostic quantification of granulocytes.

For each, it was attempted to define the results of histology and the influence of special or immunohistochemical stains with respect to true positives, false positives, true negatives and false negatives to calculate sensitivity, specificity, predictive value and accuracy. If that data was unavailable, the values reported by the authors were recorded. The threshold used for interpreting histology as favoring infection, the reference standard and other clinical metrics were also recorded.

Results

The initial search yielded 287 articles, 41 of which were automatically excluded as duplicates. The titles and abstracts of the remaining 246 articles were reviewed and 233 excluded. The remaining 13 articles, reviewed in their entirety, and 9 publications for excluded for the following reasons: 3 were not in English, 3 related to aseptic loosening (not infection), 1 did not involve the use of special stains and 2 had an inappropriate study design. The remaining three [5–7] studies were included in our review:

1. Kashima TG, Inagaki Y, Grammatopoulos G, Athanasou NA. Use of chloroacetate esterase staining for the histological diagnosis of prosthetic joint infection. Virchows Arch. 2015;466:595–601. doi:10.1007/s00428-015-1722-y.
2. Krenn VT, Liebisch M, Kölbel B, Renz N, Gehrke T, Huber M, et al. CD15 focus score: Infection diagnosis and stratification into low-virulence and high-virulence microbial pathogens in periprosthetic joint infection. Pathol Res Pract. 2017;213:541–547. doi:10.1016/j.prp.2017.01.002.
3. Munemoto M, Inagaki Y, Tanaka Y, Grammatopoulos G, Athanasou NA. Quantification of neutrophil polymorphs in infected and noninfected second-stage revision hip arthroplasties. Hip Int. 2016;26:327–330. doi:10.5301/hipint.5000365.

Based on the review of the literature, it is recommended that neutrophil counting methods be included when diagnosis is uncertain. In general, we recommend that 5 or more PMNs per field in each of 5 high power (400 X objective) magnification fields be used as the threshold to support the diagnosis of infection. Additional studies are needed to determine the optimum use of special stains. Although the literature supports the use of special stains for neutrophils to increase sensitivity, the stains reported to date can only be performed on sections of formalin-fixed, paraffin embedded tissue. Therefore, these stains are not available for use on frozen sections obtained during an operation. There is some evidence that findings derived from special stains can also correlate with the virulence of the pathogens involved in the infection.

The above recommendations are based on the review of three studies, one of which is high quality. Based on the range of sensitivity and specificity, the strength of the 5 PMNs threshold is strong, while the advocacy of special stains on permanent sections is moderate.

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2.4. DIAGNOSIS: PATHOGEN ISOLATION, CUTURE RELATED

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QUESTION 1: Should intraoperative cultures be taken during every revision total joint arthroplasty (RTJA)? If so, how many?

RECOMMENDATION: Yes, routine cultures should be taken during every RTJA. At least three intraoperative culture samples should be obtained.

LEVEL OF EVIDENCE: Moderate

DELEGATE VOTE: Agree: 87%, Disagree: 12%, Abstain: 1% (Super Majority, Strong Consensus)

RATIONALE

Using the following search terms and words (revision and joint infection; joint arthroplasty; aseptic loosening and culture), a total of 1,772 results were generated from PubMed, Ovid and Google Scholar. Sixty-five studies were found to have met the inclusion criteria. Publications that did not relate to the topic, case reports and those describing technical details of revision arthroplasty were all excluded. Furthermore, registry studies, articles with inadequate description of tissue sample methodology and studies with few patient numbers were