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Infected total hip arthroplasty – the value of intraoperative histology

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Abstract Intraoperative histology showed a sensitivity of 100% and a specificity of 98%. These results were better than those observed for the other tests evaluated. Our data provide evidence that intraoperative histology is useful tool in the diagnosis of infected total hip arthroplasty.

Résumé Afin de choisir le type de traitement, il est important de distinguer entre l'infection et le descellement aseptique, des échecs arthroplastiques; cependant, les tests préopératoires utilisés, ne sont pas habituellement concluants. Le rôle de l'histologie peropératoire du tissu articulaire dans le diagnostic d'infection, en comparaison avec des autres tests plus utilisés: l'histoire dernière et l'examen clinique, V.S., scintigraphie, et aspiration articulaire. Le score standard pour définir une infection est fondé sur les résultats de l'examen histologique et microbiologique. L'étude a compris 83 patients. L'histologie peropératoire a montré une sensibilité de 100% et une spécificité du 98%. Ces résultats sont supérieurs à ceux observés dans les autres tests évalués. Cette étude a mis en évidence que l'histologie Peropératoire peut être un instrument utile dans le diagnostic d'infection de prothèse d'hanche et appuie l'inclusion de l'histologie peropératoire dans les protocoles de révision d'arthroplastie.

Introduction

The diagnosis of an infected total hip arthroplasty (THA) may be difficult in spite of technological advances. Intraoperative histological examination (IH) can be used to distinguish septic from aseptic loosening. It may especially be helpful when the results of clinical examination and preoperative tests are not sufficiently unequivocal [1, 2, 14, 16, 17, 23, 24, 28]. A prospective study was performed to compare the sensitivity and the specificity of IH with other tests in diagnosing the presence of infection in THA.

Materials and methods

Between January 1990 and December 1992 THA revision was performed in 83 patients. All patients underwent a clinical examination, scintigraphy and joint aspiration prior to the operative revision.

The *clinical examination* included interview using a structured questionnaire and the examination was carried out by the same person (M.P.). The questionnaire recorded the presence of pain at the time of the interview, chronic pain, and a previous episode of drainage or fever for more than 48 h in the first month after primary operation. A positive answer for one or more of these questions were considered diagnostic of infection.

Scintigraphy was performed with technetium-99m methylene diphosphonate (Tc-99m MDP) and with Tc-99 hexamethylpropylene-amineoxine-labelled cells (HmPAO white blood cells). The result of scintigraphy was considered positive, when the areas of increased isotope uptake for Tc were congruent with high levels of white blood cell labelled with Tc.

Joint aspiration was performed under fluoroscopy with a sterile technique. A 20-G spinal needle was inserted without local anaesthetics perpendicular to the skin and advanced to the neck of the femoral component. The aspirated specimens were processed immediately and inoculated in blood agar, chocolate agar, Wilkins Chalgren agar, McConkey agar, Sabouraud agar and thioglycolate broth. The duration of inoculation was 48 h for agar plates, 72 h for blood agar and chocolate agar and 5 days for thioglycolate agar with blinding inoculation. Conventional methods were used for identification and study of antimicrobial susceptibility. For coagulase-negative *Staphylococcus* species identification was accomplished using API-STAPH bioMerieux, antimicrobial susceptibility by the disk diffusion technique, MICs determination by mi-

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crodilution method and slime production by the Christensen method [7]. Joint aspiration was recorded as positive when any microorganism was isolated on the specimens cultured.

Intraoperative histology

Joint synovial samples were sent for immediate IH examination after surgical opening of the hip capsule. In case of unsatisfactory sampling further samples were sent for histological examination. Synovial tissues were frozen in liquid nitrogen at -190°C and sections of $5\text{ }\mu\text{m}$ were prepared with a cryostat at minus 22°C . The specimens were stained with hematoxylin and eosin.

Intraoperative histology was interpreted according to the criteria of Mirra. The diagnosis of infection was considered positive when more than five polymorphonuclear leucocytes (PMNs) per high-power field were found [22, 24]. The pathologist evaluating the intraoperative samples was not aware of the clinical aspects nor the preoperative findings in the individual case.

The diagnosis of infection was based on the histological examination and microbiology of the joint tissue obtained at operation. It was found positive if acute inflammation in the histological specimens was found in minimum three samples together with positive cultures in more than half the samples taken.

Data were analysed using the SPSS statistical package. The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of the study tests for the definitive diagnosis of infection, as defined above, were determined. The PPV is the ratio of the positive results of each test to the number of hips in which infection was actually determined. The NPV is the ratio of the negative results of each test to the number of hips in which absence of infection was determined.

Results

A total of 83 THA revisions (in 30 men and 53 women) were initially included in the study; 3 cases were excluded because two or more of the methods studied were lacking which left 80 patients. The mean age was 65 years (range 37–86 years). Fifty of the primary THA operations had been performed in our hospital, and 30 in three other centres. The average interval from the primary to the revision procedure was 4.0 years (range, 10 weeks to 15 years). Past history and clinical examination data were available for all patients. Scintigraphy was performed in 78 cases. Successful preoperative joint aspiration was carried out in 79 cases. IH results were satisfactorily obtained in all 80 patients.

Results on the PPV and NPV of the diagnostic methods evaluated are shown in Table 1. The highest sensitivity (100%) was observed for IH: all 16 cases of confirmed infection were also positive for IH. However, the remaining four tests evaluated showed lower sensitivities, ranging from 56% to 63%. Specificity was higher than 90% in all study tests. Again, the PPV of IH (94%) was the highest for all the tests evaluated. Clinical exam-

ination also had a high PPV (91%), but the values observed for aspiration (83%) and scintigraphy (60%) were markedly lower. Finally, the NPV was about 90% for all methods except IH, which predicted the absence of infection in all noninfected cases evaluated, giving an NPV of 100%.

Discussion

The presence of infection is important both for the choice of surgical management (one- or two-stage replacement), and for the prediction of outcome [3, 4, 9, 12, 13, 15, 20]. It is not uncommon for preoperative tests to yield inconclusive information that does not make it possible to distinguish a septic from an aseptic loosening in a painful arthroplasty. The role of IH of the joint tissue in the diagnosis of infection remains controversial. Our results provide evidence that IH may be of clinical value in the diagnosis of an infected THA [1, 6, 13, 20, 22–24].

As previously reported and confirmed by our results, other diagnostic methods commonly used in clinical practice have important limitations in predicting infection [2, 5, 9, 10, 14–17, 20, 27–29]. Past history and clinical examination may be conclusive in some cases, but in many others may be nonspecific, and similar for septic and aseptic loosening [3, 4, 9, 10, 15, 20]. In the detection of infection, different studies have shown sensitivities ranging from 54% to 94% [5, 9, 17]. Scintigraphic examination with Tc-99 MDP has been commonly recognized as having a low specificity [3, 4, 9] in diagnosing infection, owing to unspecific increased uptake in noninfected arthroplasties more than 6 months after surgery. Scintigraphy with $^{111}\text{-indium}$ oxine-labelled cells and with Tc-99 HmPAC white blood cells seemed to be good diagnostic tests [12, 15, 17, 21, 25, 26], although other authors have reported a limited role for them in the detection of infection in a THA [14, 29]. Joint aspiration is not exempt from problems, such as pain and risk of infection [2, 9, 10]. There are also diagnostic problems when contaminant or unspecific microbiological species are isolated. Some authors recommend this practice only in selected patients and not routinely. The reported sensitivity for the diagnosis of infection ranges from 65% to 95% [2–4, 9, 10, 15, 17–19, 27, 28]. In summary, the ability to predict infection found in our patients with these diagnostic methods lies within previously reported ranges, supporting the concept that a poor clinical value is expected when any of them is used as the only diagnostic tool.

Table 1 Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of study tests for the diagnosis of infection. Results are expressed as percentages (proportions of all cases)

	Sensitivity	Specificity	PPV	NPV
History	62.5 (10/16)	98 (63/64)	90 (10/11)	91 (63/69)
Scintigraphy	60 (9/15)	90 (57/63)	60 (9/15)	91 (57/63)
Aspiration	62 (10/16)	96 (61/63)	83 (10/12)	91 (61/67)
Intraoperative histology	100 (16/16)	98 (63/64)	94 (16/17)	100 (63/63)

We found a high sensitivity and specificity of IH in detecting the presence of infection in our patients. The technique of using frozen sections as an intraoperative test for infection was first described by Charosky et al. [6]. Mirra et al. reported a close correlation between the presence of five polymorphonuclear leucocytes per high-power field and infection in their study on the pathology of the joint tissues and its clinical relevance in prosthetic failure [22–24]. This method was also used by Feldman et al. [11] in a retrospective study, with similar results to those obtained in this study. However, other authors have reported conflicting results. Brause [3, 4] found a sensitivity of only 55%. More recently, Fehring and McAlister [10] described a sensitivity of 18% and a specificity of 90%. It is of note that, in these studies, the standard used to define infection was based exclusively on microbiological culture results. However, as previously demonstrated, microbiological findings can result in high false-positive and false-negative rates if they are used as the only method of diagnosing the presence of infection [8]. In our study, the presence of acute inflammation, as assessed by complete histological examination, and positive microbiological cultures were both required to establish the definitive diagnosis of infection. In summary, this study supports previous findings on the clinical value of IH in detecting the presence of infection. IH is a simple and rapid test, and relatively inexpensive; it may provide essential information when the results of other diagnostic methods are limited or conflicting, and help to ensure appropriate management in cases, such as those in our study.

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