Histological Features of Femoral Hip Resurfacings with Neck Narrowing

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Introduction:

Narrowing of the femoral neck subsequent to metal-on-metal hip resurfacing arthroplasty (MMHRA) has been noted in 2 to 30 percent of patients (1-3). Although the etiology has yet to be fully understood, possible causes include avascular necrosis of the femoral head, remodelling secondary to stress shielding, wear debris induced osteolysis or from a wear-related or allergy induced enlarged bursa or mass. Linked to these causes have been surgical technique and approach, and cemented versus uncemented fixation. The aim of this study was to examine a group of retrieved hip resurfacing specimens with neck narrowing for the histological and clinical factors that may be associated with this process.

Materials and Methods:

A group of 17 MMHRA retrievals (15 females, 2 males) were studied. The specimens were noted by the revising surgeon to have neck narrowing by more than 10% compared to the post-op AP x-ray at the level of the component rim. With the exception of 1 femoral neck fracture, 1 femoral loosening, 1 socket loosening and 3 acetabular malpositioning cases, these were revised for unexplained pain and neck narrowing. These failed after a median of 38 months, (range 20-101) and comprised 1 ASR (DePuy), 12 BHR (Smith and Nephew), 3 Conserve Plus (Wright Medical Technology), and 1 McMinn (MMT). Femoral component sizes ranged from 38mm to 50mm (median 46mm). All 17 were cemented components inserted using the posterior surgical approach.

The wear of the femoral components was measured with a coordinate measuring machine and then they were sectioned using an EXAKT saw. The 3mm thick coronal slices were radiographed. Fixed and decalcified sections embedded in paraffin for routine sectioning and H&E staining. Sections were examined for evidence of loosening, avascular necrosis, histiocyte infiltration, and bone remodeling. Soft tissues were examined for evidence of wear debris, metal sensitivity, and necrosis. Particular attention was paid to the area of the bone that had narrowed.

A digital caliper was used to measure the inner component and femoral neck bone diameters at the component edge and the percentage of bone present was calculated using the following formula:

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\text{Percentage of bone present} = \frac{\text{Inner component diameter} - \text{femoral neck bone diameter}}{\text{Inner component diameter}} \times 100
\]

Although the starting neck diameter was not known, this number gave some indication of the degree of narrowing that may have occurred.

Results:

Retrieval analysis results allowed the 17 cases to be classified as high wear (7) (Fig 1), metal allergy (4) (Fig 2), or mechanical failure (4), while 2 cases of pain remained unexplained. Nine cases had an enlarged bursa: four of these were in the high wear cases and the tissue was grossly stained by metallosis. Three were associated with metal sensitivity, and those tissues were characterized by extensive infiltrates of lymphocytes, loss of the synovial surface and abundant fibrin.

Histologically, the bone near the narrowed portion of the neck could be roughly divided into cases which showed active remodelling, with predominantly osteoclastic activity (11) and those in which there was minimal active remodelling (6). In most cases, the cortex of the neck appeared to be thick and reinforced with new bone. Thus the necks were narrowing but not thinning. In each case, the bone at the interface on one or both sides of the stem had remodeled into a >1mm thick sclerotic line. There was little obvious proximal stress shielding but the bone on the inferior aspect was nearly always thicker than that of the superior aspect, but only the fractured case and one with femoral loosening showed marked bone remodelling inside the femoral component.

A fibrous interface membrane was a notable feature of the interface in 10 cases and 6 of these also had radiolucent lines around the stem consistent with loosening. Extensive avascular necrosis was not seen but interfacial necrosis was common underneath the cement layer which occupied from 20 to 77% of the bone area.

Assuming that the bone of the middle sections had initially contacted the cement layer at the edge of the components, the degree of narrowing appeared to range from 21 to 47%. Overall, there was no clear relationship between the degree of narrowing and the clinical, histological or retrieval findings.

Discussion:

Most radiographic studies of neck narrowing around MMHRA have noted that there have been no deleterious effects directly correlated with this relatively common phenomenon, although it has been noted that longer follow-up studies should be done in order to reinforce this notion (1). Neck fracture is rare in neck narrowing cases and the one case in this group occurred after 5 years in a small component with very high wear and active osteolysis. In most of the remainder, the neck bone appeared to be undergoing a process of reinforcement. This is also consistent in the narrowed femoral necks and it is not clear why some necks narrow and others do not. However, based on the observations from this group, neck narrowing that is progressive should be considered a sign of possible wear or allergy reaction.

References: