Clinical Management of Hip Arthroplasty

William L. Walter · Reza Jenabzdadeh
Carina Reinhardt

Practical Guide for Handling Noises in Hard-on-Hard Bearings

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Preface

The goal of a high-quality implant is to provide patients with an appropriately functioning device in order to relieve pain and restore quality of life. Noise emission from total hip replacements can greatly influence patient satisfaction.

Noises including squeaking are not a new phenomenon but have become more prevalent with the more frequent use of hard-on-hard bearings. Emission of noise from total hip arthroplasties (THAs) is mostly considered to be benign; however, there are few cases of troublesome noises, possibly with impaired function or pain, which can influence the patient's satisfaction with their implanted device and need to be addressed accordingly.

There are several research groups dealing with this issue, firstly aiming at scientific knowledge as to what kind of noises there are and where they come from, and secondly investigating how often they occur clinically and if they can be avoided. However, there is only little information about how to actually deal with patients with noise emission. Therefore, this pocket guide is intended for all clinicians who come in contact with patients reporting noise from their total hip replacements. Since noise emission or squeaking in THA is not a very common phenomenon it may well be new to a clinician or general practitioner. This guide aims to provide a clinical algorithm of how to treat a patient with acoustic phenomena from the actual diagnosis of benign or troublesome noises to therapy and adequate management as well as monitoring and, if possible, prevention and necessary patient information.

We will give a short introduction with a concise summary of current thinking and scientific knowledge regarding noises including squeaking in hard-on-hard bearings (with references) followed by a clinical algorithm on how to treat a patient with noisy THRs. To round up the topic, two illustrated case reports show our personal experience.

Prof. William L. Walter

Author

Professor William Walter, M.B.B.S (Syd); FRACS (Orth); PhD

A/Prof William L. Walter is Chairman of the Department of Orthopaedic Surgery, at the Mater Hospital in Sydney, where he practices his orthopaedic surgery.

He is appointed as Associate Professor at the University of NSW and University of Notre Dame. Prof. William L Walter has been involved in many thousands hip and knee replacements. He completed a fellowship in Adult Reconstructive Surgery at the Hospital for Special Surgery in New York.

He currently is a member of the Australian Orthopaedic Association and a Fellow of the Royal Australian College of Surgeons. Prof Walter was also invited to become a member of the American Association of Hip & Knee Surgeons by the then President of the association, Dr William Hozack (Rothman Institute, Philadelphia). In 2012 Prof Walter was the President of the International Society for Technology in Arthroplasty and hosted the annual meeting in Sydney.

Walter has a wide range of expertise in implant design and testing and collaborated with international universities and labs in orthopaedic research on retrievals analysis and taper corrosion.

Walter has published his research in numerous international peer-reviewed orthopaedic journals. His current papers/ research includes:

Retrieval laboratory at the Mater Clinic

- 1000 hip and knee replacement retrievals
- 16 year history
- all retrievals linked to clinical database

Clinical database
- 10000 joint replacements
- 25 year history
- preoperative and postoperative clinical data collected
- radiographs scored and stored – linked to procedure

Finite Element Analysis of hip replacement
- investigating propensity for periprosthetic fracture

Acoustic analysis
- investigating propensity to squeak

Wear analysis

Large diameter bearings (CoC and MoM)
Corrosion in modular hip junctions (tapers and stems)

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1 Introduction

Total hip replacements (THRs) may occasionally produce noise, which is more prevalent with hard-on-hard bearings including ceramic-on-ceramic or metal-on-metal bearings. Different kinds of noises are reported and these have been described as "popping, snapping, clicking, clunking, knocking, crunching/grinding, and squeaking" [6][12][29]. If the THR has any distraction, for example, during a gait cycle, the relocation impact of the two surfaces could be interpreted as a click, pop, knock, or snap. Some noises may be related to soft tissue impingement or movement, for instance, snap or pop [12]. Crunching, grinding, or squeaking can indicate, for example, a mismatched wear couple, third-body particles within the bearing, bearing fracture, or edge loading [1][3][14][20][25].

Squeaking itself has been defined as a high-pitched audible sound. It is thought to be caused by a forced vibration comprising a frictional driving force (due to temporary loss of fluid film lubrication, third-body particles, mismatched bearing, etc.) and a dynamic response (resonance of the hip components at their natural frequency). The lower natural resonant frequencies of the metal components of a hip replacement are in the audible range. However, the natural resonance frequency of ceramic components is in the upper end or above the human audible range [9][28][29][31].

Squeaking of hard-on-hard bearings is multifactorial, requiring a certain combination of patient, implant, and surgical factors [11][29]. Squeaking has been associated with younger, taller, heavier, and more active patients [2][8][27][29] as well as with specific THR systems [9][12][15][23]. Aspects of stem design, such as the material, weight, and geometry of the components, may affect the ability of the stem to resonate [5][11][29]. The surgical technique including the component orientation can directly influence the chance of squeaking [8][20][29]. Generally, factors that increase the mechanical forces across the hip joint and factors that increase the risk of neck-to-rim impingement and edge loading are those that predispose a THR to squeaking. However, one should note that squeaking can also occur with correctly positioned implants and in the absence of neck-to-rim impingement [29].

The implications of squeaking are not yet fully understood but evidence to date suggests that it is a largely benign phenomenon that can be considered "normal" just like a clicking knee. Most patients with squeaking hips have no pain and no deficiency of hip function. In fact, squeaking more commonly occurs in high-function hips. For the vast majority of patients with squeaking hips, surgical intervention is not required. However, if the noise is persistent and troublesome for the patient, revision surgery may be indicated.

In this booklet you will find recommendations for the clinical assessment of noisy THRs, from diagnostics to therapy and adequate management, as well as monitoring, possible prevention, and patient information. A clinical algorithm in the form of a flowchart and two clinical cases as an example are also included.

Take-Home Message

- There are different kinds of noises in THR, for example:
  - Click, knock → e.g., joint laxity
  - Snap, pop → e.g., soft tissue impingement/movement
  - Crunch, grind → e.g., third-body particles
  - Squeak → forced vibration of implant system (loss of fluid film)
- Squeaking is mostly benign
  - Requiring a certain combination of patient, implant, and surgical factors
- If noise is troublesome, surgical intervention might be required

2 Clinical Assessment of a Noisy THR

2.1 Diagnostics

- Take the patient's medical history
- Important questions to be asked:
  1. What kind of noise is it (squeaking, clicking, snapping, popping, crunching, etc.)?
  2. When does the noise occur (specific movement, e.g., squatting, walking, etc.)?
  3. How often does the noise occur (persistent, occasional, etc.)?
  4. Is the noise reproducible?
  5. When did the noises start (time since surgery, precipitating factors)?
  6. Is there any associated pain?
- Implant components (surgery report, etc.)
  1. Exclude incompatibility issues of the implant components based on the documentation (different manufacturers or designs, mismatched bearing, etc.)
- Physical examination of the patient
  1. Inspection and palpation for groin or buttock mass
  2. Range of motion (clicking at the extremes of motion may indicate neck-to-rim impingement or relocation clunk, grinding may indicate edge loading or ceramic breakage)
  3. Walking and chair-rise function of hip
- Medical imaging: ultrasound, X-ray, computed tomography (CT), magnetic resonance imaging (MRI) endoscopy
  1. Exclusion of mechanical failure of the THR (ceramic fracture, dislocation, loosening, etc.) using X-ray (overexposure using image intensification may be necessary to identify subtle fractures) [22] or CT
  2. Assessment of implant positioning (malpositioning?) using X-ray or CT. Using CT, implant position can be assessed more accurately

- Laboratory diagnostics (blood, urine, synovia, etc.)
  1. Metal ions, ceramic particles, etc. → indication of wear of bearing partners or taper junction or ceramic fracture (needle aspiration [24])
- Histology and/or cytology

Take-Home Message

- Find out nature of noise (what, when, how often, reproducibility)
- Exclude component failure or mismatch issues

2.2 Therapy and Adequate Management

If noises are infrequent and function is not impaired, surgical intervention is not required.

1. Reassure and counsel patient on activity modification and monitor closely (e.g., squeaking while bending down and weight bearing might be avoided by rotating foot externally while bending down and weight bearing [11])

If noises are severe and troublesome, revision may be required. Indications for revision are:

1. Severe malpositioning of implant components
2. Failed implant components (ceramic breakage)
3. Impingement and subluxation
4. Persistent pain
5. Elevated levels of metal ions (unilateral hip above 7 µg/l for chromium and 7 µg/l for cobalt [4][26]) → may indicate metal wear of metal-on-metal bearing, or taper junction wear/corrosion
6. Ceramic particles in needle aspirate (>5 µm [24]) → indication of ceramic fracture

At time of revision surgery component malposition and soft tissue or bony impingement must be corrected and soft tissue tension can be optimized. If necessary the bearing can be changed for another ceramic-on-ceramic or ceramic–on-polyethylene bearing.

Take-Home Message

- Benign noise: reassure and counsel patient
  - May be avoided by changing foot/leg position during movement
- Severe and troublesome noise: revision may be required
- Optimize implant position during revision

2.3 Monitoring

The patients should be monitored on a regular basis; yearly initially and then every 2–5 years.

2.4 Prevention (for Primary and Revision Surgery) and Patient Information

The risk of squeaking can be minimized by:

- Correct component positioning
  - Avoid impingement
  - Ensure concentric loading
- Correct soft tissue balancing
  - Optimize soft tissue tension
  - Avoid soft tissue impingement
- Only using correctly assembled and undamaged implant components
- Appropriate implant selection (implant selection will also influence squeaking risk: e.g. larger-diameter femoral ball heads or thin more flexible femoral components are more likely to squeak [13])
- Follow instructions for use (IFU) of the implant components

Patient informed consent must include risk of noise.

3 Clinical Cases

3.1 Case 1

A 63-year-old woman had a ceramic-on-ceramic hip replacement (40-mm bearing, Biolox®delta, CeramTec, Plochingen) with a cup size of 52 mm 1 year earlier. At the 1-year follow-up she was doing well, being free of pain and managing all her activities of daily living. She was very pleased with the hip but mentioned that she noticed an occasional "squeak" from her hip on certain movements. She asked if this was something to worry about.

Case Solution

Clinical examination showed a good range of motion in the hip with no impingement. Radiographs and a CT scan were obtained to exclude component malpositioning (cup position: inclination 50° and anteversion 25°) or ceramic fracture (Fig. 1, Fig. 2). There was no radiological abnormality on imaging. As her symptoms were intermittent, not troublesome, not causing any pain, and not affecting any of her activities, she was diagnosed as having a "benign squeaking." Management of her case included patient counseling, reassurance, and careful follow-up. The patient felt reassured and very happy with her THR.

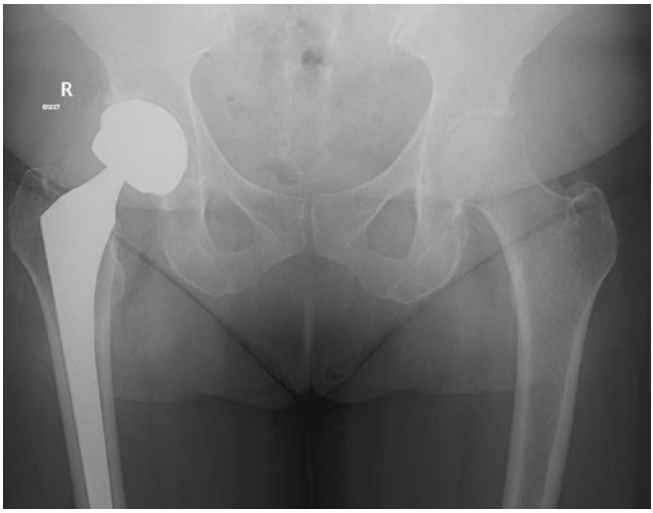

Fig. 1 Anteroposterior radiograph of case 1 showing well fixed and well positioned implants.

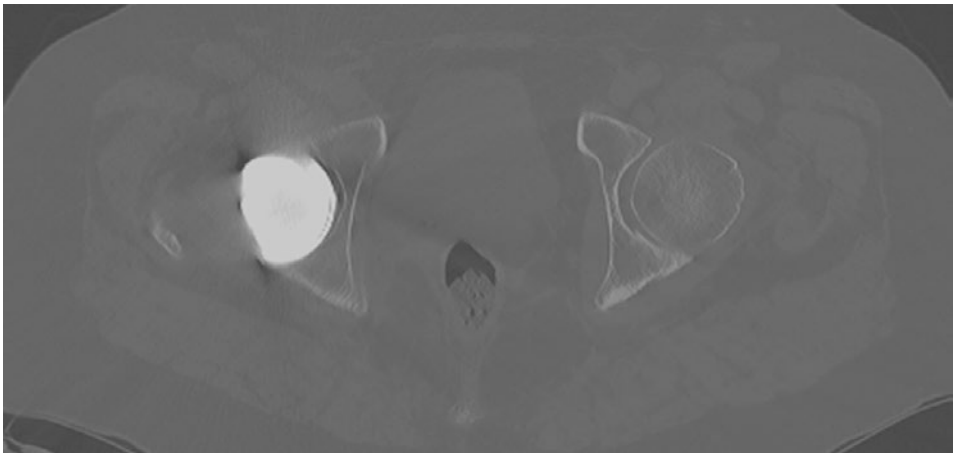

Fig. 2 Computer tomographic scan of the hip in case one to measure acetabular component anteversion and to exclude ceramic liner breakage.

Fig. 3 Anteroposterior radiograph of the hip in case 2 showing a fragment of the rim of the ceramic acetabular insert that has fractured.

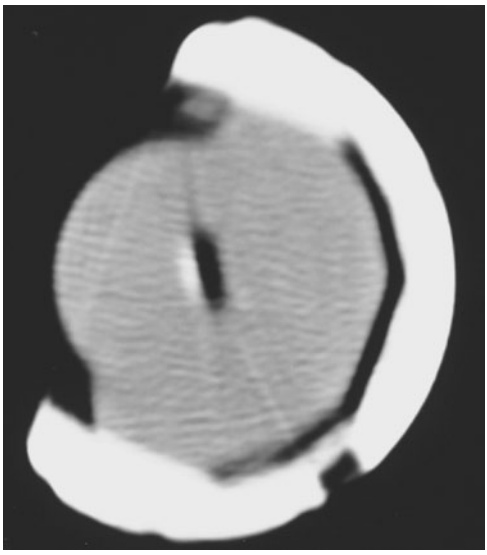

Fig. 4 Axial computer tomogram of the ceramic insert in case 2 showing rim fracture.

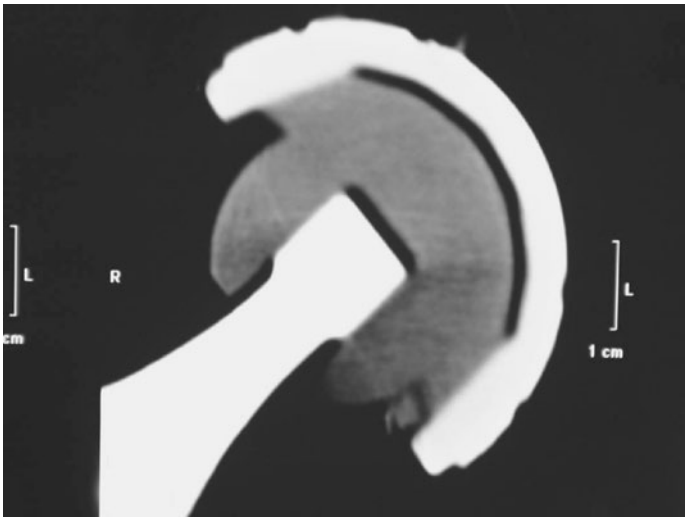

Fig. 5 Coronal computer tomogram of the ceramic insert in case 2 showing rim fracture.

3.2 Case 2

A 64-year-old woman had a ceramic-on-ceramic hip replacement (36-mm bearing, Biolox®forte, CeramTec, Plochingen) 3 years earlier. She had been doing well until she noticed an intermittent "crunching and grating" noise in her hip with no specific activity. The noise then started occurring with any movement of the hip but was not accompanied by pain. Check-up radiographs and CT scans showed a fracture in the rim of the ceramic liner (Fig. 3, Fig. 4, Fig. 5).

Case Solution

Revision surgery was undertaken showing some metallosis and ceramic fragments in the joint. A complete synovectomy was performed and the acetabular shell, ceramic liner, and femoral ball head were changed. After a thorough inspection of the stem taper, it was found to be undamaged so it remained in situ. For revision, a 36-mm Biolox®delta ceramic-on-ceramic bearing was used. The patient was doing well after revision and was very satisfied with the outcome.

4 Clinical Algorithm

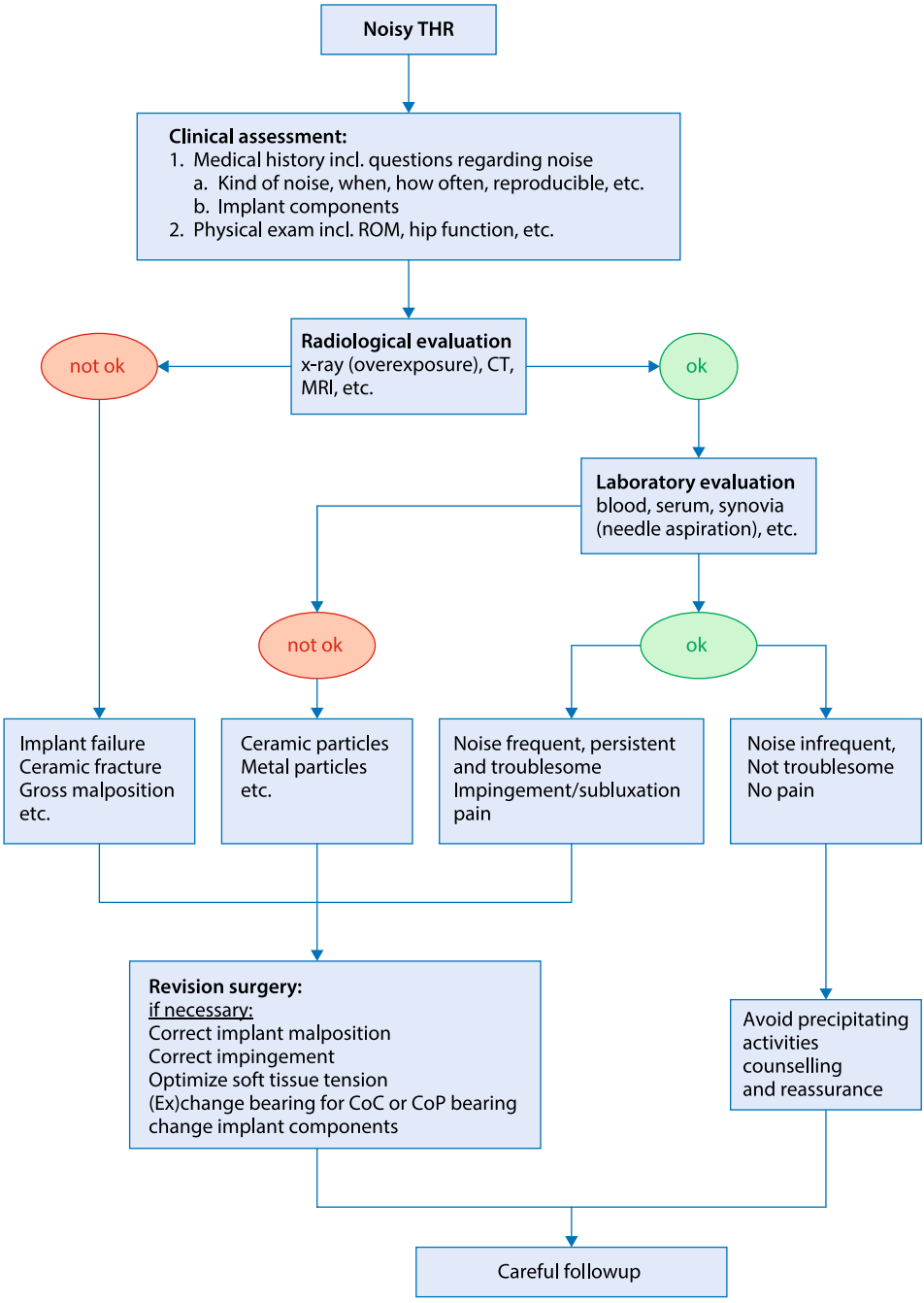

Fig. 6 Flowchart: Clinical algorithm according to W. L. Walter for handling noise in total hip replacements.

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The volumes of the Clinical Management Guide series are directed at orthopaedic surgeons who want to acquire information rapidly while saving as much time as possible. As a helpful advisory tool, this Pocket Guide concisely and clearly imparts the current state of knowledge on selected issues of everyday clinical practice and, in doing so, concentrates purely on the essential.

In addition, it also addresses medical practitioners and scientists of adjacent specialist disciplines who are not confronted on a daily basis with problems regarding endoprosthetics but, when required, would like to access important information on a specific topic.

Practical Guide for Handling Noises in Hard-on-Hard Bearings

This book provides recommendations and a clinical algorithm for the assessment of noise in total hip arthroplasties with hard-on-hard bearings. It covers everything from diagnostics to therapy and adequate management, as well as monitoring, possible prevention, and patient information.

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