Summary

✓ Total hip replacement (arthroplasty) is a widely used procedure that alleviates pain and disability in people with hip disorders, such as osteoarthritis.

✓ Minimally invasive (MI) total hip replacement uses a smaller surgical incision than the conventional method.

✓ Possible advantages include less damage to tissue and muscle, smaller scars, less blood loss during surgery, less post-operative pain and shorter hospital stays and convalescence.

✓ Well designed, long-term studies are needed to compare patient outcomes and costs of the different types of MI hip replacement procedures.

The Technology

In minimally invasive (MI) hip replacement, surgeons make one or more small incisions, about one quarter to one half the size used in conventional hip replacement. Typically, they range from 5 cm to 12 cm.2

Some methods require one incision; others use two or three. The sites of the incisions also vary.3

Some of the MI procedures require specially designed instruments, computer-aided navigation systems and fluoroscopic guidance (X-ray) to aid visualization.4 The orthopedic implants (hip prostheses) are the same for MI and conventional procedures.

NILNAV Orthopaedics, in Australia, has commercialized a single-incision procedure and distributed it globally through NeuMedix Inc. It uses modified surgical instruments to allow the procedure to be done through a 5 cm incision. Fluoroscopy is not needed.

Zimmer Inc. (Warsaw IN) has marketed a two-incision approach called the Minimally Invasive Solutions™ (MIS™) 2-Incision™ procedure. It involves an anterior incision, 4 cm to 6 cm long, directly over the femoral neck (thigh bone) and a posterior incision, 3 cm to 4 cm in length.5 Fluoroscopy is needed, as are special surgical instruments.6 Prostheses cannot be cemented with this technique.7

Regulatory Status

MI hip replacement procedures use the various conventional hip prostheses that are licensed by Health Canada. The surgical instruments used in the procedure may require a Medical Device Licence, depending on whether they are classified as Class 1 (manual surgical instruments that are reusable) or Class II (disposable instruments or those that can be connected to an active device) medical devices (Lois Duthie, Health Canada, Ottawa: personal communication, 2004 Jun 14).

Patient Group

Total hip replacement alleviates pain and disability in individuals suffering from hip disorders such as osteoarthritis, rheumatoid arthritis or avascular necrosis.8,9 MI hip replacement may be inappropriate for patients who are obese, are overly muscular, have a recent history of blood clotting, have had the same hip replaced previously or have an unstable medical condition.8
Demand for total hip replacement is growing, with about 20,000 replacements performed in Canada in 2001-2002, up 19% from 1994-1995. An aging population and rising rates of obesity will increase the need.

**Current Practice**

Total hip replacement has been widely and successfully used for 40 years. Surgical approaches (anterior, anterolateral, direct lateral, transtrochanteric and posterior) have evolved, as have the types of prostheses (metal, plastic, ceramic or a combination) and the methods of fixation (cemented or uncemented). These variations make it difficult to compare their safety and effectiveness.

**The Evidence**

Several published studies have compared the effectiveness and safety of single-incision MI hip replacement with the conventional method (Table 1).

Other papers report similar results of single-incision MI hip replacements. Patients treated by Sherry et al. underwent single-incision MI hip replacement using NILNAV system without a navigation system. The hospital stay for these patients averaged two days.

Several authors have published case-series reports of the two-incision method.

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**Table 1: Comparative studies of single-incision minimally invasive (MI) and conventional (Con) total hip replacement**

<table>
<thead>
<tr>
<th>Study, Type, n=Number of Patients (Follow-up)</th>
<th>Operating Time (Minutes)</th>
<th>Blood Loss</th>
<th>Length of Hospital Stay (Days)</th>
<th>Functional Outcomes</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chimento et al. (also described in Sculco et al.)</td>
<td>MI n=28; Con n=32 (2 years)</td>
<td>No difference</td>
<td>MI=378 mL (total blood loss); Con=504 mL</td>
<td>No difference</td>
<td>Fewer MI patients limped at 6 weeks; no difference at 2 years</td>
</tr>
<tr>
<td>Sculco et al.</td>
<td>MI n=42; Con n=42 (2 to 5 years)</td>
<td>MI=71, range 54 to 102; Con=78, range 58 to 111</td>
<td>No difference</td>
<td>No difference</td>
<td>Harris hip scores slightly higher in MI group at 5 years*</td>
</tr>
<tr>
<td>Wenz et al.</td>
<td>MI n=111 patients (124 hips); Con n=62 (65 hips) (2 months)</td>
<td>MI 124±37; Con 164±45*</td>
<td>MI 598±325mL; Con 727±441 mL*</td>
<td>No difference</td>
<td>MI patients walked sooner and with less assistance*</td>
</tr>
<tr>
<td>Goldstein et al.</td>
<td>MI n=76 (85 hips); Con n=78 (85 hips) (2 months)</td>
<td>MI 57±8; Con 59±8</td>
<td>MI 273±102*; Con 408±173; despite reduced blood loss during MI surgery, transfusion was required by 65% of MI patients and 56% of Con patients</td>
<td>N/A</td>
<td>Patient satisfaction high in both groups (MI 96%, Con 90%); no difference in Harris hip scores at 6 and 12 weeks</td>
</tr>
<tr>
<td>Higuchi et al.</td>
<td>MI n=115 (incisions &lt;10 cm); Short n=70 (incisions 10 cm to 15 cm); Con n=27 (incisions &gt;15 cm) (2 weeks)</td>
<td>MI 69.7±15.4; Short 77.1±24.3; Con 94.9±29.8*</td>
<td>MI 668.0±317.2 g; Short 731.8±304.5 g; Con 891.5±416.6 g*</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>DiChiara et al.</td>
<td>MI n=33 patients (35 hips); Con n=33 (35 hips) (1 year)</td>
<td>MI 120; Con 100</td>
<td>MI patients received average of 0.7 (range 0 to 2) units of blood post-operatively; Con patients received average of 1.1 (range 0 to 2) units</td>
<td>MI 3.8 days; Con 3.9 days</td>
<td>Harris hip scores 3 months: MI group better* in limp and stair climbing; 6 months: MI group better* in limp, stair climbing and distance walked; and 1 year: no difference</td>
</tr>
<tr>
<td>Waldman</td>
<td>MI n=30; Con n=91 (N/A)</td>
<td>N/A</td>
<td>N/A</td>
<td>MI 2.7; Con 3.2</td>
<td>No difference between groups for limps</td>
</tr>
</tbody>
</table>

*p<0.05=statistically significant difference; N/A=not available; #discrepancy between figures reported in text and table
ing it requires training and experience. Patient recovery and hospital stays are generally shorter. A radiographic follow-up by Berger of 30 patients one year later found that the alignment of the components of the inserted prostheses was excellent and equivalent to that obtained with conventional total hip replacement.6

No studies compare two-incision with single-incision or conventional hip replacement.

### Adverse Effects

Studies that compared the single-incision procedure to conventional hip replacement surgery found that complications with single-incision were not statistically significantly higher (Table 1).4,14,17,23

In his experience with a two-incision procedure, Mears reported a proximal femoral fracture rate of 2.8% (about three times higher than in conventional surgery). Most fractures occurred in the surgeons’ first attempts at the procedure.25

Zimmer reported 16 complications in over 1,300 MIS 2-Incision procedures, the most common being fracture of the femur.27

### Administration and Cost

Zimmer estimates that its two-incision procedure costs approximately US$14,000 compared to US$17,000 for conventional hip replacement surgery.27 Costs are likely lower in Canada, but there is little information available. One Ontario study from the 1990s estimated the direct cost of a hip replacement at their hospital as C$6,943, based on a seven-day hospital stay.28

Costs vary depending on the type of prosthesis used, the price paid for the prostheses by the hospital and the length of hospital stay.28 The single-incision NeuMedix NILNA system is available in Canada. No Canadian surgeons have been trained to date. The modified surgical instruments cost between C$10,000 and C$20,000 per set or they can be leased. In addition, there is a disposable item fee of between C$400 and C$600 (Phillip Thomas, NILNAV Orthopaedics Pty Ltd, Melbourne, Australia: personal communication, 2004 Mar 9).

### Concurrent Developments

Conventional total hip replacement surgery is moving towards less invasive techniques (e.g., incisions are typically smaller than those used in the past). Hospital stays for hip replacement in Canada have decreased from an average of 12.2 days in 1994-1995 to 9.7 days in 2001-2002.10 There have also been advances in anesthetics, intra-operative management and post-operative rehabilitation.29

### Rate of Technology Diffusion

Patients’ preferences will probably play a role in the diffusion of these procedures. US marketing of MI hip replacement through direct-to-consumer advertising and media coverage targeted to “aging baby boomers” will likely increase demand for these procedures.29 This surgery may be best situated at centres with high volumes of hip replacement surgery.12

The availability of training for orthopedic surgeons is another factor.8 The University of British Columbia’s Department of Orthopaedics will soon be the site of a Zimmer Institute training facility.30

### Implementation Issues

MI total hip replacement may offer advantages (reduced tissue damage, less blood loss, less scarring and less post-operative pain) over conventional methods. Cost saving may be possible through reduced hospital stays. This may help to reduce waiting lists for hip replacement surgery.33 Extensive training is needed to perform these procedures and there is a fairly steep learning curve associated with the use of MI techniques.21 The two-incision method is more difficult than the mini-anterior or mini-posterior single-incision procedure.26

More studies are needed to compare short- and long-term patient outcomes and the costs of MI procedures (single- versus two-incision,
Further study is also needed to determine how best to deliver anesthesia, prevent thromboembolism, manage pain and assist with post-operative rehabilitation. The refinement of these associated techniques may be as important as the size of the surgical incision in improving patient outcomes and reducing health care costs.

References


This brief was prepared by Zhiliu Tang, visiting medical doctor from China.

CCOHTA takes sole responsibility for this bulletin, but we appreciate comments from the following reviewers:

Paul R. Kim, MD FRCSC
University of Ottawa
Ottawa ON

Robert G McCormack, MD FRCSC
University of British Columbia
Vancouver BC

David Hailey, MSc PhD
Department of Public Health Sciences
University of Alberta
Edmonton AB

ISSN 1488-6324 (online)
ISSN 1488-6316 (print)
PUBLICATIONS MAIL AGREEMENT NO: 40026386
RETURN UNDELIVERABLE CANADIAN ADDRESSES TO:
CANADIAN COORDINATING OFFICE FOR HEALTH TECHNOLOGY ASSESSMENT
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