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Minimally Invasive and Small Incision Joint Replacement Surgery:

What Surgeons Should Consider

Purpose

The purpose of this advisory statement is to provide information to surgeons about the emerging use of minimally invasive and small incision techniques in the practice of hip and knee joint replacement surgery. This information has been derived from a review of both the scientific literature and information presented at meetings, and is augmented by the expertise of a group of orthopaedic surgeons and researchers experienced in the use of and study of less invasive techniques.

Introduction

For decades, pioneering surgeons have experimented with less invasive joint replacement procedures involving smaller incisions and non-traditional surgical approaches. Recently, however, there has been a renewed interest by both patients and surgeons in so-called “minimally invasive and small incision surgery,” and new techniques and peri-operative protocols have been offered. Standardized nomenclature, enhanced training, and rigorous evidence-based research of these emerging techniques will continue to improve the surgical outcomes for the hundreds of thousands of patients who benefit from hip and knee arthroplasty each year.

Hip and knee replacement are among the most common and successful orthopaedic surgeries. The indications for these surgeries are well established and their overall success documented by extensive research^(1,2). Substantial pain relief and improvement in function, with longevity of 15 years or more, is expected for most patients.

Terminology and Definitions

Recent changes in total joint implant materials and design, in addition to surgical approaches, have been widely reported in the press, and are often lumped together. Such changes have been interpreted in the context of the growth of less invasive surgery in other surgical fields (which are for the most part ablative). A result is that patients and physicians expect the benefits of total joint surgery with smaller incisions and less dissection than occurs in contemporary approaches. Direct-to-consumer advertising may magnify these expectations.

Minimally invasive and small incision techniques are difficult to evaluate for a number of reasons. The variability of contemporary arthroplasty techniques confounds comparison. Incision length, for example, is not well documented in the orthopaedic literature and has not been, until recently, a major focus of concern. A surgeon’s training and individual experiences, in conjunction with surgical proficiency, affect the invasiveness of his or her approach. There is no codified way to measure incision length or soft tissue “damage” that occurs with surgery. In all implant surgery there is some trauma to the tissues.

The relative importance of any given anatomic structure's integrity, detachment and excision is often hard to know. A sharp distinction between contemporary and less invasive approaches is therefore difficult to establish. There are no commonly accepted definitions of less invasive hip and knee arthroplasty techniques. In addition, less invasive treatment of unique surgical problems (such as early avascular necrosis of the hip and isolated medial compartment knee arthritis) has been combined with less invasive total joint procedures. Finally, new anesthesia, pain management and physical therapy protocols have been introduced at the same time as less invasive surgical techniques, further confusing evaluation.

One of the deficiencies in the objective evaluation of minimally invasive and small incision surgery is a precise and universally accepted definition for these new techniques. "Less invasive surgery" is terminology that encompasses both small incision techniques and minimally invasive techniques. Small incision hip and knee replacement surgery entails performing the conventional approach through a smaller skin incision. The length of less invasive incisions may be compared to contemporary incisions (those used by most surgeons today), which are smaller than historical incisions (those used when joint replacement surgery was in its early stages of development). Minimally invasive hip and knee replacement surgery uses not only a smaller incision (or incisions) but also new exposure techniques. This is said to be less invasive to soft tissues and or bone.

In knee arthroplasty, published studies have defined incisions for less invasive surgery as approximately one-half that of contemporary incisions. These incisions are presumably measured at the time of surgery and with the knee in extension. Less invasive surgery should also involve smaller capsular incision and either a medial or lateral approach. Some espouse that a minimally invasive approach to the knee should not violate the extensor mechanism or the suprapatellar pouch.

In less invasive hip arthroplasty, reports have described both one and two incision surgeries. For single incision surgery, both components are placed through a single incision, with abbreviated but similar exposure to the traditional anterolateral and posterior hip approaches. Authors have defined incisions for less invasive surgery about one-half those of contemporary surgery. These incisions are usually linear, and are presumably measured at the time of surgery with the hip in neutral abduction. Ten centimeters has been a cut-off used in several recent publications. Other techniques utilize 2 smaller incisions – each 2 to 4 inches in length. The femoral and acetabular components are placed through two different approaches in this "two-incision" variation, and incision size depends on the surgeon's experience. Minimally invasive surgery may also involve less muscle detachment (abductors, piriformis, quadratus femoris) and smaller capsular incisions or removal.

Less invasive surgery may include unique pre- and post-operative pathways for anesthesia, nursing care and rehabilitation. Some institutions, however, may include both contemporary and less invasive surgical patients in the same pathways.

Patient Selection Criteria

Patient selection for less invasive surgery is evolving. Some surgeons define the ideal patient as young, thin, healthy, and motivated. Other surgeons, however, have offered this type of surgery to most or all of their patients. Some of these selection criteria are difficult to quantify, which further confounds evaluation of this type of surgery. The procedures are more difficult and the risk of complications appears to be more common in overweight patients, patients with marked bone or joint deformity, muscular patients, and those requiring a larger sized implants.

Less invasive surgical implants, such as unicompartmental knee arthroplasty and resurfacing hip arthroplasty, utilize alternative components and incision techniques. These surgeries should be evaluated as a separate type of less invasive surgery, so as to help clarify this technology.

Possible advantages

Acknowledging that there are contradictions as well as weaknesses in the literature published to date on less invasive arthroplasty techniques, proponents have pointed out several advantages. The reported advantages of less invasive surgery occur in the first few weeks or months after surgery. Minimally invasive and small incision techniques are reported to decrease immediate post-operative pain, shorten length of hospital stay and rehabilitation, allow earlier return to work, decrease blood loss and fewer transfusions, improve cosmesis, preserve normal tissue intervals and decrease scarring / muscle damage, and have high patient satisfaction. A lower overall complication rate and earlier weight bearing have also been reported. If image intensification and / or surgical navigation are used in conjunction with less invasive surgery, component positioning may be improved compared with traditional techniques without such guidance.

Possible disadvantages

Potential disadvantages of less invasive joint replacement have also been reported, and relate to the difficulty of performing surgery within a restricted visual field as well as issues related to learning a new exposure technique. Various authors and presenters have pointed out that there may be an increased overall complication rate because of poor visualization of landmarks and vital structures. This may lead to fracture, malposition and neurovascular injury, although these complications are by no means limited to less invasive techniques. Injury to skin and soft tissues can occur by excessive retraction of skin, and most proponents recommend the use of specialized instruments. Length of surgery may be increased, and this may lead to a higher rate of thromboembolism or infection. Cost may be increased with longer operating times, need for specialized equipment, and the use of image intensification or navigation systems. With techniques espoused by certain implant manufacturers, only specific prostheses are suggested for minimally invasive surgery, limiting surgeon choice of fixation type, degree and prosthesis geometry. Damage to prosthetic bearing surfaces may occur at the time of implantation or relocation in cases where the joint is not well visualized.

A major potential disadvantage of these techniques is that one or more of the aforementioned issues may have a negative effect on the otherwise positive long-term results and durability that our patients and we have come to expect from total joint replacement surgery.

Unknown surgical technique related factors

Several factors are not yet thoroughly understood when comparing contemporary and less invasive hip and knee replacement surgery. Contradictory or inconclusive results, or lack of sufficient follow-up in currently available studies leave these areas open to debate in the discussion regarding the risks and benefits of less invasive surgery. These factors will be the object of ongoing research, and include:

- Long-term durability of the joint reconstruction
- Long term pain relief, motion and function
- Implant positioning
- Infection rate
- Incidence of thromboembolism
- Incidence of neurovascular injury
- Joint stability and dislocation rate
- Reoperation rate
- Need for specialized instruments or implants
- Relative safety and efficacy of individual techniques

Safety/Ethical Considerations

Patient safety is a major concern for any new and emerging technique. Many surgical landmarks and vital structures may not be visualized, are poorly visualized, or may be located solely by imaging techniques in less invasive surgery. Anatomic relationships may be different than with more traditional

techniques as vital structures and soft tissues may move less freely. Complications appear more likely, particularly during the so-called “learning curve” for surgeons. Surgeons who have performed few of this type of procedure may have an increased complication rate. Learning some of these techniques may be least difficult for those surgeons who have the greatest joint arthroplasty experience. The operative time for less invasive techniques will not only be longer during their early application, and also may be longer even when the surgeon becomes proficient. Longer surgical times may translate to higher direct cost, in addition to complications such as infection and deep vein thrombosis.

The protection of surgeon and operating room personnel should be considered if fluoroscopy is used, and appropriate safety measures and monitoring employed.

The ethical considerations for the introduction of a new procedure are myriad, and many are new to the current generation of orthopaedic surgeons.

Future implications/research opportunities

Any new medical technology, surgical approach or treatment protocol should be compared to pre-existing or conventional methods. Factors such as safety, efficacy, cost effectiveness, clinical advantages and patient outcomes should be evaluated before new approaches are accepted. Durability is of paramount importance in joint replacement surgery and thus studies must address both short-term and long-term results. Surgeons who choose to offer these emerging techniques to their patients are encouraged to collect and compare the clinical outcomes of the two types of surgery in their own practice.

On a larger scale, we suggest that any new techniques should be scientifically compared with contemporary conventional methods. If possible, a single variable should be changed in any given assessment and both accepted evaluation processes and sufficient statistical power should be utilized. The gold standard for objective evaluation is a randomized prospective comparison—only then will the risks, benefits and costs of new techniques be made clear to patients and physicians.

Understanding the application of a new technique is the final challenge. If proven to be beneficial, determining who should perform the technique and under what conditions is mandatory for successful outcomes.

Conclusion

Less invasive hip and knee replacement surgery is of great interest to patients, joint replacement surgeons, and third party payers. Much of this interest is based on the promise of same or better long-term results, with shorter and less painful recovery. This set of outcomes has not been validated and there is not a great deal of scientific proof to support it at this time. The most positive results have been demonstrated by a small number of high volume total joint centers and surgeons in selected patient

As surgeons, we need to critically evaluate these emerging techniques. Scientific evidence and rigorous evaluation of minimally invasive total joint arthroplasty techniques are needed before these techniques are recommended for more widespread clinical practice.

Credentialing

Surgeons who are engaged in new techniques are responsible to be competent, proficient and qualified to perform these new approaches. The surgeon should discuss any additional risks associated with these approaches as well as their own experience and qualifications in performing any surgical procedure in the informed consent process.

The AAHKS, through its educational endeavors, attempts to educate orthopaedic surgeons and other practitioners about new and existing technology and techniques. However, the AAHKS does not certify the competence of an individual for clinical use of a new technique or provide any credentials.

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