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Current Controversies in Orthopaedic Surgery: The Role of Arthroscopy in the Treatment of Degenerative Joint Disease of the Knee

A Significant Role

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Introduction

The year was 1973. I was a medical student serving a clinical rotation at the Germantown Hospital. The man in the surgeon's lounge was an overwhelmingly impressive figure. A towering man with massive features, short cropped gray hair, and a low, booming voice reminiscent of an old retired marine drill sergeant. But this man was Chief of Orthopaedic Surgery and I was about to observe him perform a procedure for which he had gained an international reputation. He explained that arthroscopy, as this new procedure was called, was about to revolutionize his specialty. I had heard otherwise. Others representing the established core of orthopaedic thinking had expressed doubt and even ridicule when describing this new "fad" in Orthopaedic Surgery. What I was about to see could have convinced me that the "skeptics" were right.

The surgeon seemed to struggle with every aspect of the procedure. His prep was laborious, consisting of a typical scrub followed by a rather atypical painting with three separate solutions. I watched as he struggled with his prototypical instruments. He had difficulty entering the knee joint, a maneuver accompanied by some rather loud grunts and four letter words. There was a less than delicate forced "plunge" or two before he was finally able to visualize the articular anatomy. There was no video camera. There was no monitor. There were no motorized shavers. And once the elusive pathology was found, he struggled with his archaic instruments in his sometimes futile attempts at correction.

"How can anyone venture to introduce a luminous object into the knee-joint in an effort to look between the articular surfaces, which cannot be separated. . .? This is quite impossible. Moreover, this procedure is more dangerous than exploratory arthrotomy." A quote from Hustinx in a 1937 treatise on arthroscopy of the knee.

Years later, when I returned as an orthopaedic resident, he had made significant progress, but the struggle continued. Arthroscopy was more accepted now, but it was still in its infancy. I learned some important lessons from this man. There is value in perseverance and having the courage of your convictions when sailing in uncharted waters, even in the face of the "skeptics." Many were convinced that arthroscopy was this man's folly and were quick to criticize his dogged determination to develop a technique that, by 1990, would become the most commonly performed orthopaedic procedure in the U.S.

There are again loud and powerful voices of opposition. Insurance companies, managed care organizations, and third-party administrators all admonishing us to restrict or deny services in the name of "quality care." I dare say that were it not for these voices, the debate about this very topic might not be taking place. I am not suggesting that safety and efficacy should be ignored; they are of paramount importance, but as we shall see, our debate today will be one of degree. We will probably agree to the safety and efficacy of arthroscopic lavage and/or debridement in the treatment of degenerative joint disease for some patients despite its limitations and palliative nature. The question becomes how much pain relief and for how long a pain-free interval are we willing to support this procedure with pooled dollars.

Degenerative joint disease will afflict most of us if we live long enough. It is a diagnosis extremely familiar to orthopaedic surgeons. We are also acutely aware of the destructive potential of this ubiquitous disease. Yet, as familiar as we are with the clinical and laboratory manifestations of arthritis, we are still unable to identify the exact etiology of the disease. There have been mechanical, biochemical, as well as genetic etiologies proposed, yet the exact pathophysiology remains elusive. Treatment efficacy, therefore, also remains elusive except in terms of subjectively based outcomes criteria. What is our goal as orthopedic surgeons treating degenerative joint disease of the knee? In the young patient under 45 years of age with mechanical symptoms there is little disagreement about the therapeutic and prophylactic role of arthroscopic intervention. Most of us would also agree that the elderly patient over 65 years of age, with end-stage tricompartmental disease is unlikely to benefit from arthroscopic intervention. There is, however, a large population of patients representing a huge continuum of pathology between these two extremes. It is for this large "gray zone" population that debridement and lavage arthroscopy can provide pain relief and improved function and for whom I will argue my (their) case.

The rationale for this procedure is to debride fibrillated articular cartilage and degenerative meniscal tears, to remove loose bodies (both macroscopic and microscopic), and to lavage proteolytic enzymes. There are two basic questions we have always asked when considering the appropriateness of any surgical intervention:

1. Is it effective?
2. What are the associated risks and complications inherent in the procedure and are they outweighed by the expected benefit?

   And recently an added third question:

3. Is it cost effective?

Let us now examine the literature and current available data in an attempt to objectively address all three concerns.

Review of the Literature

Attempts to evaluate the role of arthroscopy in the treatment of degenerative conditions of the knee date back as early as the 1930s when Burman et. al. [7] reported remarkable symptomatic relief in two patients after diagnostic arthroscopy with instruments too primitive to allow for debridement. Benefit was presumed, therefore, to be on the basis of washout alone. A potpourri of articles has followed, some prospective, most retrospective, and few looking specifically at the benefit of washout or debridement alone or in combination without associated abrasion or drilling procedures. Some could be criticized for improper patient selection, others for inadequate follow-up. A discussion of each paper and their individual merits is beyond the scope of this paper, but a summary of their results is both appropriate and necessary. Perhaps the best chronology of recent arthroscopic debridement articles is found in an article by Goldman et al. (Table 1). A copy of their summary follows:

Table 1. Recent arthroscopic debridement articles

Author	Year	Follow-up Month	Results % Good	Results % Poor
Sprague	1981	14	74	26
Shahriaree	1982	26	76	26
Jackson et al.	1986	39	68	32
Bert & Maschka	1989	60	66	34
Baumgaertner et al.	1990	33	52	48
Gross et al.	1991	24	72	28
Ogilvie-Harris & Fitsialos	1991	49	68	32
Rand	1991	60	67	33
Average		**38**	**68**	**32**

Despite the acknowledged flaws in many of the studies, one inescapable conclusion can be drawn: arthroscopic lavage and/or debridement works! It is an effective method of obtaining pain relief and improved function for the non-endstage arthritic knee patient who has failed conservative treatment, and because of age, activity level, or general medical condition, is not a candidate for more extensive surgical intervention. We may argue about duration and degree of pain relief and restored function, but it is clear from the data that both desired results are achieved.

An attempt to identify those factors that make patients more likely or less likely to benefit from treatment was nicely summarized by Baumgaertner et al. [1]. Their findings are summarized in Table 2.

Table 2. Preoperative factors affecting debridement results

	Excellent/Good	Fair/Poor
1. Duration of symptoms	<12 months	>12 months
2. X-ray changes	Mild/moderate	Severe
3. Alignment degree	Normal	Varus greaterthan equal to 1
4. Pain type	Mechanical	Load
5. Chondrocalcinosis	Present	Absent

It would be reasonable to expect that had the patients in the studies listed by Goldman been subjected to the selection criteria as defined by Baumgaertner, their results would have been significantly improved. Even without applying such selection criteria, an average of 68% of patients improved at 38 months is quite impressive assuming an acceptably low risk and complication rate. These results certainly parallel my own experience with this procedure. I should also hasten to point out that even the end-stage tricompartmental knee (with symptoms in excess of 12 months, severe X-ray changes, varus deformity, and load bearing pain) frequently experiences significant improvement in pain and function parameters; it is the degree and duration of improvement that is often shorter than desired and therefore by today's arbitrary standards classified as non-cost effective. Bear in mind that our patients may be quite thankful and pleased with a mere 3-month improvement, and, in years past, so might have the surgeon. I will later perform an economic analysis to aid us in assigning a "cost-effective" pain-free interval. This will assist us in judging objectively what duration may be reasonably assigned to the benefit of the procedure and still be "worth" the expenditure. Defining an "Acceptable Pain-Free Interval" (APFI) from the economic point of view still puts us in the unenviable position of needing to predict which patient population will reliably achieve our APFI! The majority of patients will not present with all factors associated with either excellent or poor results as defined by Baumgaertner. Most will straddle the selection criteria, owning factors belonging to both groups, and thereby making prediction of results difficult. If for now we can agree, however, that without pre-selecting our patient pool we still achieve a 68% good or better success rate that lasts at least 2 or more years, we can answer our first question in the affirmative; YES IT IS EFFECTIVE!

Let us contrast these results with the suggested alternative: the "Bad News Card" (BNC). Translated it says to our patients "You have an incurable condition, the treatment for which has been deemed non-cost effective by your third party payer. You must suffer with your pain and make the best of life working with your disabilities." Let us contrast these two options in terms of their respective "outcomes" (Table 3).

Table 3. "Outcome" comparison

	Lavage/	BNC

	Debridement	
Percent with good/excelent results	68	0
Duraton of improvement (over baseline)	38 months	0 months

In terms of pain relief and restoration of function, our alternative has an outcome of 0% compared with 68%. The duration is 0 months compared with 38 months. Which would you choose for your patient? Denial of surgical intervention is therefore associated with an unacceptably low (0%) "beneficial outcomes analysis."

We are left with our remaining two questions. Do the risks and complications warrant the potential benefit? And finally, in view of its purely palliative and non-curative nature; possibly having no effect on natural history or ultimate outcome of the disease process; is the procedure "cost effective"? Is the benefit (68% Good to Excellent results over a period of 38 months) worth the cost in dollars and cents?

Risks and Complications

In O'Connor's book "Arthroscopy" [35] he makes the following statement: "Complications during or following diagnostic surgical arthroscopy are infrequent and fortunately are usually minor. Most are preventable with good preoperative and intraoperative planning and attention to the details of basic techniques."

The Complications Committee of the Arthroscopy Association of North America reported an overall complication rate of 1.8% based on 1988 data. This rate included procedures of higher complexity such as cruciate ligament reconstruction and meniscal repairs. Articular "scuffing" was also listed as a complication as were issues associated with accessory portals and tourniquet application. All of these would be eliminated or markedly reduced had only cases of joint debridement and lavage been considered. The resultant overall complication rate of less than 0.5% is better than for any other orthopaedic surgical procedure performed today.

I have listed the surgical treatment alternatives that are commonly considered for this patient population and some of their recognized associated potential complications (Table 4).

Table 4. Surgical treatment alternatives and potential complications

High tibial osteotomy	Unicompartmental arthroplasty	Total knee arthroplasty
Non-union	Patellar impingement	Patellar impingement
Delayed union	Overcorrection	Patellar subluxation
Overcorrection	Undercorrection	"Overstuffed patella"

Undercorrection	Peroneal nerve injury	Patellar fracture
Peroneal nerve injury	Intra-articular fracture	Supracondylar fracture
Intra-articular fracture	Progressive DJD of unresurfaced compartments	Intraarticular fracture
Compartmentsyndrome	Implant loosening	Patellar clunk syndrome
Thrombophlebitis	Implant subsidence	Overcorrection
Tourniquet paresis	Improper positioning of components	Undercorrection
Pulmonary embolism	Improper alignment of components	Peroneal nerve injury
Arterial injury	Tibiofemoral subluxation	Implant loosening
Wound healing/skin slough	Implant breakage	Improper positioning of
Component	Polyethylene wear	Improper alignment of
Infection	Thrombophlebitis	Improper soft tissue balance
Component	Pulmonary embolism	Implant breakage
Arthrofibrosis	Arterial injury	Implant subsidence
Prolonged and difficult rehabilitation	Wound healing/skin slough	Polyethylene wear

Our one remaining treatment alternative is the denial of surgical intervention, the "Bad News Card." One might argue that this alternative is the only alternative with a 0% complication rate. However, if one applies the principles of modern "outcomes analysis" and considers the failure to achieve desired goals (i.e., decreased pain and improved function as a complication of a treatment plan or alternative) I would then suggest that this is the only alternative associated with an entirely unacceptable complication rate of 100%!

We have now answered our second question in the affirmative. Not only are the risks and complications commensurate with the expected results, this procedure is associated with less risk and less complications than any other procedure currently being performed by orthopaedic surgeons nationwide and perhaps worldwide! This in contradistinction to the BNC, which carries with it a 100% complication rate in terms of achieving therapeutic benefit!

Cost Analysis

Workers' compensation and occupational medicine have been a focus of my organization as well as my orthopaedic practice for the past 15 years. I have experienced repeated modifications in the health care delivery system in the

name of "cost containment." Some have been modestly effective; most have failed in accomplishing true reductions in health care spending but rather have cost-shifted the dollars among the various interested parties, including Third-party administrators (TPA's) and insurance carriers. All have been politically motivated. Careful objective financial analysis will help us avoid decisions that appear at first glance logical and attractive, but under closer scrutiny demonstrate antonymous effects.

A seemingly logical decision from the financial standpoint to reduce costs by denying care will only succeed if the resultant Total Overall Intensity of Utilization (Surgical and Non-Surgical) is reduced. In the simple equation: *A + B = C,* one can logically assume that any decrease in *A* or *B* will result in a proportional decrease in *C*. In health care delivery systems however, *A* and *B* are not independent variables. They are intimately linked by complex factors and sub-formulas where a particular decrease in *A* could result in a marked INCREASE in *B* thereby causing a "paradoxical" increase in the resultant *C*! For instance, let us assume *A* represents costs associated with a particular surgical procedure and B represents the costs of non-surgical alternatives to procedure *A. C* is our Total Cost of care for given diagnosis *X*. If a choice not to perform procedure *A* is associated with a simultaneous increase in the intensity of non-surgical care *B*, then our Total Cost *C* may increase despite a decrease or elimination of cost *A*.

Let us now analyze Debridement Arthoscopy for the two major populations of patients likely to be candidates; those who are still working and fall under the Workers' Compensation system and those that are retired or unemployed and fall under Medicare (Table 5).

Table 5. Workers' compensation costs

Treatment	
Surgical fee	$1200
Facility and supplies	$3500
Physical therapy	$0000
Total	$4700
Indemnity (average annual wage of $35,000)	
80% wage replacement dictated by Workers Compensation Act	
0.8 × 35,000 = 28,000/12 = $2333/month	
Cost of lost productivity and/or replacement worker greaterthen equal to the cost of original wage	
35,000/12 = $2917/month	
Total indemnity costs/month of disability:	
$2333 + $2917 = $5250	

Workers' Compensation

Under Workers' Compensation, physical therapy would be a critical component of both surgical and non-surgical treatment protocols. Any PT cost in this scenario would be mirrored in the indemnity scenario in Table 5,

effectively canceling each other out (unlike Medicare!)

Our "break even" point or APFI can now be defined as the time it would take to recoup our "investment." The total cost of investment---$4700.

At a cost of $5,250 per month of disability we would need only 4700/5250 or 0.9 months to make our procedure worthwhile: APFI = 0.9 months to break even for this population.

We can see that the costs of treatment quickly become overshadowed by the costs of an employee staying out of work. If we use a conservative figure of only 18--24 months (rather than the full 36 months suggested in our literature) as an expected post-surgical pain-free interval, our savings of having that employee back to work would be $94,500--$126,000. A cost of approximately $5000 for a benefit of approximately $100,000 should make sense from any point of view!

Medicare

We cannot assume that a simple denial or withholding of care under whatever pretense will result in a commensurate cost savings (Table 6).

Table 6. Medicare costs

Arthroscopic Debridement	
Surgical fee	$ 900*
Facility and supplies	$3500
Physical therapy	$0000**
Total	**$4400**

*This figure is decreasing rapidly.
**PT is rarely used in post-op period for this age group.

This could only be true if patients did not seek alternative treatment for their symptoms. Be assured that a patient in pain and given a "BNC" will seek any and all alternatives available to find relief, even if only on a temporary basis. It is also na|$$|Adive to assume that alternative treatments like acupuncture and chiropractic, that have been embraced by managed care consortiums as approved modalities in a proactive preventative health plan, would be denied as therapeutic modalities for accepted degenerative disease diagnoses. Let us now explore some of the traditional as well as some of the more non-traditional or "alternative" treatments currently available to our patients who have been told that palliative arthroscopic surgery is not available to them: Arthrocentesis (4/yr @ $120) = $480; Office Visits (4 in addition to above @ $80) = $320; Medications (NSAID @ $15/month) = $180. Total---$980. But our costs do NOT end here: Physical therapy @ Medicare maximum = $ 900+ (Medicare caps PT costs at $900/year).

Although Medicare has capped physical therapy at $900 per subscriber annually, this applies only to therapy done outside of the physician's office. Many family practitioners and orthopaedists have therapy as part of their practices and therefore are not restricted by the $900-limit. Many patients will also have accessory medical policies that will allow continuation of covered services when the Medicare allowances are exceeded. The insured patient will also have the option of seeking "alternative" treatments once a traditional physical therapy allowance has expired. Because reimbursement rates are most often related to Medicare fee schedules, these alternative treatments are offered at similar rates to traditional physical therapy. At a conservative estimate of $30 per PT treatment, three times a week, our cost of $90/week will exhaust the Medicare allowance in 10 weeks. Between chiropractic, acupuncture, and hyaluronidase injections there are plenty of treatment alternatives available to continue the "drain" on resources at the physical therapy rate of $90/week throughout the year. It is therefore reasonable to assume that a patient in pain will continue treatment intensity at a level of at least $90/week representing an annual cost of $4680!! Let us also assume that holidays, transportation issues, missed appointments, and intermittent pain-free intervals will reduce this treatment intensity by 30%. We are left with an annual average expense of: $4680 - 30% = $3276**.** When we add back our $980 from above we are up to $4256 before consideration of issues like home health care, lost time from work for family care-givers, etc. These "ancillary" costs are real and will substantially increase our "hard" costs (Table 7).

Table 7. Menu of alternative care

Chiropractic	$90/week
Acupuncture	$90/week
"Hylan" or "Synvisc" injection series	$1000/3 injection series*
Home health care	$????
Family lost work time	$????
Transportation (ambulance/family member/etc.)	$????
Adverse psychological and physical effects	$????
Total	**$4256****

*Reimbursement recenty approved by Medicare.
**Annual minimum.

Assuming the same conservative 18--24 month post surgical pain-free interval the minimum cost of denying surgery during that period would be $6384--$8512 without adding any "ancillary" costs! At a full 38-month pain-free interval we would realize a cost of $13,477 by denying surgery! Total cost of investment = $4400; monthly cost of BNC = $4256/12 = $355/month; APFI = 4400/355 = 12.4 months to break even.

Any additional pain free interval is at zero ($000.00) cost as compared with

BNC (denial of surgery)! We need, therefore, an average 1-year pain-free interval to justify our costs to the insurance industry. Any patient who remains pain-free longer is "profitable" to the insurance carrier! Remember that these are conservative estimates that do NOT include any of the ancillary costs, many of which are also borne by the insurance industry and certainly by society as a whole. One could effectively argue that these added costs would bring our APFI or break-even point closer to 6 months.

Therefore, the cost of denying surgical treatment in face of the anticipated benefits proven by the studies to date, results in MORE not less total health care dollars spent in the management of degenerative disease of the knee after 6--12 months. Denying surgical intervention and its admitted temporary improvement (38 months on average as per our literature, but all we need is 6--12!) results in a higher utilization of health care resources and a concomitant increased dollar expenditure.

Summary

Arthroscopic alternatives for degenerative joint disease of the knee include aggressive treatments such as abrasion arthroplasty, microfracture, and multiple drilling. Less aggressive procedures include partial/sub-total menisectomy of degenerative meniscal tears, debridement/chondoplasty and lavage. The literature clearly indicates that our attempts to become aggressive in the treatment of the degenerative knee have been generally unsuccessful with the exception of microfracture for which there are currently no long-term follow-up studies. If, however, we limit our interventions to procedures designed to palliate and address mechanical issues related to intraarticular debris, rather than the restoration or regrowth of healthy cartilage our results improve dramatically.

Is it effective?

By a careful review of all the literature available to date. . . YES.

For the non-endstage patient who has failed the routine course of conservative treatment including NSAID medication, intra-articular injection, assistive devices, activity modification, and who has continued pain and impaired function, arthroscopic lavage and/or debridement offers an effective palliative solution that may differ per patient in degree and duration.

Do the benefits outweigh the risks?

Even before selecting out the more complex procedures, arthroscopic surgery represents one of the LEAST risky things we routinely do as orthopaedic surgeons. Arthroscopic debridement of the degenerative knee is statistically one of the safest procedures we perform. The answer again is a resounding YES.

Is it cost effective?

Workers' Compensation: $5000 versus $100,000. . . . YES!!!; Medicare: $4400 versus $6384+++. . . .YES!!!

Conclusion

Arthroscopic debridement and lavage for the treatment of degenerative joint disease of the knee represents a cost-effective, low-risk, beneficial procedure in terms of pain relief and functional improvement that is associated with an extraordinarily low complication rate. In fact, from the purely economic point of view, it may represent a very cost-effective treatment modality even for endstage disease given a break-even point (APFI) of only 6--12 months.

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A Limited Role

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At the Veterans' Hospital in Houston, Moseley and colleagues examined the role of arthroscopy for treating the arthritic knee [17]. They conducted a randomized, blinded, controlled clinical trial. In their study, one group of patients had a formal debridement of the joint surface. This group had a good clinical result and were satisfied with their surgery. A second group of patients underwent an arthroscopic lavage only. They also did well. The fascinating aspect of this study was the presence of a third group that received sham surgery. This sham operation consisted of sedation, local anesthesia and incision of the skin---nothing more. *No surgical violation of the knee joint itself occurred.* No irregular joint surfaces were shaved. No meniscal tears were excised. No healing was promoted. No degenerative enzymes were flushed from the joint. Indeed, nothing was done. Nonetheless, patients in this group were satisfied with their treatment.

Granted, this was a small study, with perhaps atypical subjects. But consider it: arthroscopy may function as a placebo. All surgical procedures must offer more than a placebo effect to justify placing patients at risk or incurring more than trivial costs.

Risks of Arthoscopy

The first question to address, therefore, is whether arthroscopy places the patient at risk. Although precise data are not available, most estimates place the rate of complications in the range of 2% [21]. Furthermore, as Jackson [13] noted, the patient undergoing arthroscopy for articular degeneration is probably at higher than average risk, by dint of either previous steroid injections or decreased immune function on the basis of age. Although a 2% rate may seem reasonable, it loses its veneer of benignity when seen from a

wider perspective: if the complication rate is 2%, it is probable that a surgeon will have a complication if he performs as few as 35 procedures. (The probability of having at least one complication after *n* procedures is given by the equation $(1 - (1 - [\text{complication rate}])^n$.) Stated another way, if a surgeon performs 35 unnecessary arthroscopic procedures in a year, it is likely that he will hurt at least one patient without helping anyone.

Other data to consider relate to the individual procedures. Each of these operations is discussed and summarized in Table 1.

Procedure	Limitations
Arthroscopic lavage	• Benefits may be attainable without surgery • Benefits may be transient
Arthroscopic debridement	• Benefits may be merely on the basis of lavage (see above) • Remaining cartilage is not normal • No repair tissue is formed
Partial menisectomy	• Meniscal tears (which are very common in older people) may not be responsible for the patient's pain • Results bad if there are chondral defects • Benefits may be short lived
Abrasion chondroplasty	• "Repair" tissue is not hyaline cartilage • Fibrocartilage is less well suited to withstanding loads • Temporary benefits • Patients can be made worse
Cartilage (bone plug) graphting	• No published results • Cartilage does not (necessarily) heal side-to-side on the joint surface • Donor site morbidity--where is there cartilage to spare? • Technical difficulties
Chondrocyte transplant surgery (Genzyme carticel procedure)	• Two surgeries required; one open procedure • Expensive • Addresses isolated defect only • Long term data not yet available

Keep in mind that none of the studies that support the use of arthroscopy followed a double-blind, randomized controlled protocol. Such a design

becomes all the more necessary in light of the sham surgery study.

Arthroscopic Lavage

Although osteoarthritis is not categorized as an inflammatory condition, Smith [22] et al. have found that cytokines are produced in the degenerative knee. Lysosomal enzyme production is also increased [4]. Arthroscopic lavage may remove these chemicals. The evacuation of these mediators may decrease pain and limit synovitis. In addition, removal of small, irritating pieces of particulate matter may break the self-reinforcing cycle of joint destruction. Thus, in terms of aims and methods, arthroscopic lavage makes sense. Furthermore, as shown by Livesley [14] et al., this procedure seems to make patients feel better.

My cavil against this procedure is not that it doesn't work. It does. On the other hand, it is probable that its benefits can be attained with less cost, less risk and less discomfort by using a simple needle lavage system, as opposed to a formal arthroscopy. Chang [7] et al., for example, have found that at 1-year follow up, there was no difference between those patients randomized to have mere irrigation of the joint versus those who had formal arthroscopy. Edelson [9] et al., likewise, found short-term improvement among patients who had lavage alone.

Arthroscopic Debridement

Debridement is performed to decrease the friction between opposing joint surfaces and to promote uniform pressure distribution within the knee [23]. The original debridement procedure, as described by Magnuson, consisted of an arthrotomy and the removal of synovium, osteophytes and diseased cartilage. All of these goals can be achieved arthroscopically. Baumgaertner et al. [2] performed a retrospective review, which suggested that symptom abatement typically follows this procedure. (One must consider, of course, that the benefit seen was a product of lavage and not the debridement itself.)

Although arthroscopic debridement has intuitive appeal---the gross appearance of the knee following debridement is nearly normal---our knowledge of the microscopic anatomy of the articular surface tells us that debridement does not create a normal healthy joint. Articular cartilage has an organized, polar micro-anatomy [16]. At the joint surface, the lamina splendans and tangential zone have horizontally oriented fibrous structures to resist shear forces and protect the deeper layers. Because of this organization, if one debrides the upper surface of the cartilage one is left with not only less cartilage, but worse cartilage. When the "skin" of the lamina splendans is lost, recrudescence of irregular surfaces is inevitable.

To my knowledge, there is no proven theory as to what causes the pain in osteoarthritis, especially in its early phases. Perhaps fibrillated cartilage contributes to the production of pain. Accordingly, even though debridement does not restore the joint surface, it may help patients. Indeed, a laborer, 2 years from retirement and symptomatic at work only can be perhaps "cured" by debridement. For him, temporary relief until activity modification is

possible may obviate the need for major surgery. In general, though, debridement is, at best, a "temporizing procedure."

Partial Menisectomy

Torn menisci, sports medicine doctors will tell you, are painful and should be removed or repaired. Among patients typically treated by sports medicine doctors---young and acutely injured---that is no doubt true. I am less certain that such an approach applies to patients with degeneration. Meniscal tears are very common in older people, and presumably not causing pain in every instance. Among autopsy subjects with an average age of 65, Noble [18] found a horizontal meniscal tear in 60%; and among autopsy subjects under the age of 55, meniscal abnormalities were present in one third. He suggested, thus, "the pathological significance of [meniscal tears is] open to question."

Matsusue and Thomson [15] studied the effects of arthroscopic partial menisectomy in patients with an average age of about 50. They followed these patients for an average of nearly 8 years, and discovered that nearly all (87%) had an excellent result *provided that the patient did not have any articular degeneration.* Among those not so fortunate (the patients with grade III or IV changes) only 1 of 15 patients had an excellent result, and four had a poor result.

Before you conclude that it is proper to perform arthroscopic partial menisectomy as long as the patient does not have chondral damage, recall that it is supremely difficult pre-operatively to guarantee that such damage is not present. (Normal X-rays are insufficient; and MRI is still a crude evaluator of the articular surface.)

Arthroscopic partial menisectomy has been touted as a valid treatment for a torn meniscus in the degenerative knee if the patients had "mechanical symptoms," such as locking or catching. This has never been proven, but is not unreasonable. Still, it would be wise, given the findings of Matsusue and Thomson, to counsel the patient that the outcome after surgery depends in large part on what is found at the time of surgery.

Abrasion Chondroplasty

This operation is a variant of the open one described originally by Pridie [11]. The goal of this operation is not only to remove the damaged surface, but to stimulate repair. Pridie found that by drilling holes into the subchondral bone and allowing marrow stem cells to reach the joint surface, fibrous cartilage would grow to cover the exposed bone. The long-term value of this cartilage is dubious [3]. Laboratory studies have shown that this repair tissue---histologically distinct from the normal hyaline articular cartilage---cannot endure for long. Indeed, Dandy, as quoted by Shahriaree [20], stated that "to suggest that buzzing a powered burr over dead bone could make entirely normal hyaline cartilage grow in the wasteland of an osteoarthritic knee is about as sensible as stating that a new limb will grow after amputation."

Normal hyaline cartilage contains a large amount of proteoglycan, which in turn attracts a large amount of water. Without these proteoglycans, the repair cartilage is less hydrated, and thus less adapted to withstand loading forces. Also, fibrocartilage is rich in type I (not type II) collagen and is therefore less able to withstand compressive forces on that basis as well [6].

Abrasion chondroplasty may offer initial relief by relieving what Arnold [1] et al. termed "intra-osseous hypertension." That venous stasis may contribute to the pain of osteoarthritis, especially the pain felt at rest, is a clever hypothesis and may be true. But as Shahriaree notes, there is nothing to indicate that the holes made by chondroplasty to relieve that pressure will remain open and allow the effect to be more than transient.

Chondrocyte Transplant Surgery

The autologous chondroctye transplantation procedure [5] (Carticel) is only partially an arthroscopic procedure; and indeed, diffuse osteoarthritis is a contra-indication. Thus it is not correctly categorized as "arthroscopy for the degenerative knee." Still, because the technical aspects of the surgery may one day allow for a purely arthroscopic procedure, and because the clinical indications may one day go beyond the isolated cartilage defect, I would like to address this topic here. Autologous chondrocyte transplantation is a two-stage procedure, the first of which is an arthroscopic harvest of cartilage. The chondrocytes in the sample are isolated, expanded in culture, and then re-implanted under a periosteal flap. Early results suggest that hyaline cartilage grows to fill the defect.

The main limitation of the procedure, to many, is the cost. The implanted cells are expensive---over $10,000 per implant---and surgeons must attend a course to learn the technique. And cost is not the only issue. Clinical questions, enumerated by Jackson and Simon [12], center on issues of safety and long-term clinical efficacy. For example, given that the chondrocytes are allowed to multiply in culture, do they retain sufficient power to multiply once they are implanted? Is the liquid medium the correct one to ensure that useful cartilage matrix will be deposited? Are we certain that only chondrocytes, and not undifferentiated cells, are implanted? Jackson and Simon also note that there may be allergic reactions to the bovine serum used in culture, and the malignant potential of expanded cells has not been ruled out.

The Carticel procedure has been granted a biologics license by the Food and Drug Administration (FDA) [19]. Still, the FDA notes that no internal control groups were used in the studies, and mandated that such studies be carried out before full approval. Dr. Marvin Steinberg has long taught: Don't be the first to do a procedure; and don't be the last. This teaching is relevant here. Autologous chondrocyte transplantation may be an important remedy for the isolated chondral defect, and in the future may be part of our armamentarium against osteoarthritis. As of now, though, it has no role in the treatment of the degenerative knee.

Osteochondral Grafting

Osteochondral Grafting, like Carticel, is indicated for the isolated cartilage lesion. But unlike Carticel, it can be performed arthroscopically, and in one sitting. The gist of this procedure is that cartilage is "borrowed" from areas where it is less important, and transferred to symptomatic regions. Hyaline cartilage and the underlying bone are harvested *en masse* as a plug. The recipient area is then drilled to accommodate the impacted plug.

One major limitation of this procedure may be the paucity of donor material. Some believe that there is indeed *no* valid donor material. This argument (suggested to me by Dr. John Gregg) holds that because cartilage forms in the embryo only where there is articulation, if a region of the femur is covered with cartilage it must, perforce, articulate with either the patella or the tibia. (Dr. Gregg says that pediatric patients with joint contractures have smaller articular surfaces.) In addition, simple geometry will show that it is impossible to harvest more than one graft per portal that is perfectly perpendicular to the joint surface.

Those are the technical details. Consider, too, the science: cartilage grafting relies not only the plugs themselves, but on fibrocartilage formation as well, to fill the space between the graft plugs. This weak link may be the point of failure. As noted above, fibrocartilage is mechanically inferior to hyaline cartilage and lacks a lamina splendans. This lack of tangentially oriented collagen may subject the graft plugs to shear wear. Accordingly, the cautious surgeon views this procedure as nothing more than a fancy version of the old fashioned chondroplasty with possible donor site morbidity.

Conclusion

Patients with moderate joint degeneration---too much to be managed medically, but not enough to warrant joint replacement surgery---can be frustrating for clinicians: there are no excellent treatment options. It is tempting to offer such patients an arthroscopic procedure, even with poor odds for success, merely because of the absence of alternatives.

The absence of alternatives, though, is not enough. Managed care companies will remind us that resources are finite, and to consume them in one place is to deny their use in another instance. Perhaps each unnecessary arthroscopy supplants a valid one. It is not enough, under those conditions, to argue that arthroscopy provides some relief. It must also provide the best return on its costs, compared with other options. Each health care dollar must, in the language of Mill, provide the greatest good for the greatest number.

The evidence I have considered suggests that for treating degenerative arthritis of the knee, appropriately selected patients *may* benefit from arthroscopy, as a palliative procedure, in the short run. Much, however, is unknown. The simple fact is that we have not yet identified the appropriate patients; selected the best surgical procedure; delineated the expected benefits; articulated the costs; or estimated the duration of those beneficial effects with necessary precision or scientific certainty. Until then, arthroscopy for the degenerative knee must be viewed with appropriate skepticism.

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Guest Editorial Comments

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The role of arthroscopy in the management of arthritic syndromes is still evolving. Unfortunately, the absence of adequate prospective, randomized studies in this area renders the debate frustrating to the clinician and patient alike. Ultimately, the orthopaedic surgeon must rely on his or her judgment and clinical experience in the utilization of arthroscopic options to manage arthritis of the knee.

Judicious selection of patients is critical to the successful outcome of arthroscopic treatment of patients with non-inflammatory arthritis of the knee. It has been suggested that diagnostic arthroscopy may aid treatment for the osteoarthritic knee in five situations: a painful, swollen knee with normal radiographs and non-inflammatory fluid; clinical and radiographic osteoarthritis with pain out of proportion to radiographic findings and refractory to conventional medical therapy; chronic, stable (radiographic) osteoarthritis with sudden, profound worsening of symptoms; osteoarthritis with primarily "mechanical symptoms"; and osteoarthritis with unexpected synovial fluid characteristics [5]. However, it seems that the enthusiasm of the surgeon for debridement of articular cartilage or meniscal lesions must be tempered by careful preoperative and intra-operative evaluation.

It is clear that simple saline irrigation of the joint (which is part of the arthroscopic procedure) may in and of itself, produce significant clinical improvement. A study by Chang et al. [4], which randomly compared arthroscopic surgery versus closed needle joint lavage in patients with osteoarthritis of the knee concluded that overall, there was no significant difference 1 year after the procedure between those patients who had undergone the surgical procedure versus those who had simply undergone irrigation of the joint [4]. However, it was observed that patients with meniscal tears had a higher probability of improvement after arthroscopic surgery than did those patients with articular cartilage lesions who had undergone debridement. Merchan and Galindo [6] concluded in their prospective study of arthroscopic debridement of the arthritic knee versus non-operative conservative treatment that surgically debrided patients had significant improvement compared with those patients conservatively managed. Their conclusions suggested that patients with a normal femoral-tibial mechanical axis, with sudden onset of knee pain were the best candidates for arthroscopic debridement [6]. This is similar to the

conclusions of Baumgartner et al. [2], who, in a retrospective review of patients with osteoarthritis of the knee, found that symptoms of long duration, and more advanced arthritic severity as evidenced by loss of the normal valgus femoral tibial alignment were more likely to produce poor outcomes of arthroscopic debridement. The review by Rand confirms the efficacy of debridement of degenerative meniscal tears in patients with degenerative arthritis of the knee as long as preoperative X-rays do not demonstrate subchondral sclerosis or osteophyte formation in the involved hemi-joint [8]. Other reported series confirm these results [1,7]. Overall, approximately two-thirds of patients will express improvement and satisfaction with an arthroscopic debridement between 1 and 4 years after such a procedure. But, as questioned by one of the authors in the previous articles, it is unclear whether this represents a placebo effect, the effect of irrigation of the joint, or actual therapeutic benefit of the arthroscopic debridement.

The treatment of articular cartilage lesions with arthroscopic debridement is more controversial than the simple resection of degenerative meniscal tears in the setting of osteoarthritis of the knee. Debridement of articular cartilage lesions is variously referred to as "chondroplasty," "abrasion chondroplasty," "subchondral drilling," or "subchondral picking." These procedures are all designed to attempt to stimulate resurfacing of a denuded area of subchondral bone by fibrocartilage. However, the functional outcome of these procedures does not clearly seem to benefit the patient. A study by Bert and Maschaka retrospectively reviewed the outcome of abrasion arthroplasty and debridement versus debridement alone. Among 126 patients followed-up an average of 5 years with unicompartmental osteoarthritis, those patients who underwent arthroscopic debridement alone had a better outcome than those who underwent an abrasion chondroplasty and arthroscopic debridement simultaneously [3]. The conclusion of these authors is that abrasion arthroplasty may not produce as good a result as simple arthroscopic debridement of degenerative lesions of both articular cartilage and menisci.

In general, the "ideal" patient for an arthroscopic evaluation in the setting of non-inflammatory knee arthritis would be that patient with a near-normal femoral tibial alignment, without significant osteophyte formation or subchondral sclerosis. Patients with degenerative tears of menisci generally have better outcomes than those with degenerative meniscal tears plus lesions of the articular cartilage. It does not seem that abrasion arthroplasty offers significant improvement in the outcome of arthroscopic interventions.

The economics of arthroscopic treatment of the degenerative knee are debatable, and the reader is cautioned that the opinion expressed regarding the positive cost-benefit analysis of the procedure should be accepted with skepticism. Equally worrisome is the eager acceptance of new and unproved technologies such as autologous chondrocyte transplantation and osteochondral plug grafting of degenerative lesions. Long-term follow-up, preferably as part of prospective, randomized, single-blind clinical studies, will be necessary to place the arthroscope and its related technologies in proper perspective.

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