SURGEON AGE AS THE MAJOR FACTOR IN RECOMMENDATION OF UNI-COMPARTMENTAL KNEE REPLACEMENT VERSUS HIGH TIBIAL OSTEOTOMY
A CASE STUDY IN ORTHOPAEDIC DECISION MAKING

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ABSTRACT
This case report concerns surgical decision making. The subject is a 59 year old male orthopaedic surgeon with medial compartment knee arthritis. Both high tibial valgus osteotomy and uni-compartmental knee replacement would be appropriate with similar outcomes reported in the literature. Surprisingly, almost all young surgeons recommended a uni-compartmental knee replacement and almost all older surgeons recommended a high tibial osteotomy. We discuss the reasons that surgeon age, which is clearly irrelevant to the optimal decision, is the dominant determinant of surgical recommendation for this patient.

INTRODUCTION
Little has been written on decision making in orthopaedic surgery. It is generally assumed that treatment decisions are made by the physician and a properly informed patient in consultation. The orthopaedic literature generally addresses how best to measure desirable outcomes and how specific treatments affect these outcomes. The desirable outcomes are almost always a limited number of aspects of physical functioning. There are many more general models of how to optimize medical decision making. For example, classical economic utility analysis assesses the worth of a medical procedure by attempting to ascertain what a person would give up in other goods or services for a certain amount of health, then adjusting that sum to account for the objective probability of reaching the desired outcome and for the risk proclivity of the patient and comparing that figure to the full cost of the procedure (in resources, in time, and in other health risks).1 Capability analysis emphasizes not so much how patients subjectively value, at the time they must decide what steps to take, the changes in health status they will experience as it emphasizes the need to take whatever steps maximize human potentials over a lifespan.2,3,4,5 However, all evaluation approaches include physical functioning as a major component. Therefore, it may seem that such decision making analysis is not very relevant to orthopaedic surgery in which the goal is most often to maximize physical functioning. We discuss specific decision making difficulties in a specific, common orthopaedic surgical problem.

The literature does not often address how a surgeon should decide whether to recommend to a patient one particular procedure as opposed to another designed to meet broadly similar aims. Optimally, for a specific problem in a specific patient, there exists a combination of sufficient evidence, surgeon experience and patient characteristics that allows a surgeon to recommend a single procedure as the “best” choice given typical patient desires or uncontroversial ideas about capability maximization—evidence based medicine. Many times the evidence is lacking, even when looked at for a large group of patients. Not uncommonly, too the patient has characteristics that are unusual, so that the “best” procedure for the particular patient may not be the procedure that would more typically be superior.

What we want to address here is the surgeon’s decision making biases in a specific case. Multiple biases in medical decision making have been identified.6,7,8,9 Anchoring bias (excessive reliance on one trait or piece of information)10, attribution bias (substitution of a simple characteristic(s) as representative of a complex problem10, availability bias (over estimating the likelihood of an outcome based on the vividness of examples of the outcome which make them more memorable)10 and confirmation bias (tendency to interpret data so that it confirms one’s preconceptions)31 are several that have been well described. Most of these biases have been described in the context of medical errors, most commonly misdiagnosis. The type of bias we are considering here is a bias in the statistical sense of a systematic alteration in what would be expected to be randomly distributed data or, in this case, surgical recommendations. It is not to be interpreted as a distortion due either to prejudice or to the use of a decision making procedure that always leads to systematic, unambiguous error, although those possibilities will be discussed.

The critical point we address is that the age of the surgeon making a recommendation alters the surgical
recommendation, though the surgeon’s age (though not the patient’s) is quite transparently irrelevant to the correct choice of procedure. (This would be true except in the unlikely situation, not germane here, that a surgeon’s age is a good proxy for his competence in distinct procedures: hypothetically, it might, for instance be appropriate for younger, more recently trained surgeons to recommend a recently developed operation they are more familiar with rather than an older operation that older surgeons might still feel will lead to superior outcomes should they perform the operation, given their skill with the more traditional method.)

There is no discussion in the medical literature of the effect of surgeon age on decision making of which we are aware.

We will accept that maximizing physical function is the main goal of most orthopaedic surgery and will examine a specific case in which surgeon age predicts the procedure the surgeon recommends.

We address the following questions. Does the age of the surgeon relative to the age of the patient influence or even determine his/her surgical recommendation between two essentially equivalent operations? If so, why does the age of the surgeon determine which of two operations he/she recommend? Furthermore, should a surgeon’s age affect his/her choice if his/her training is identical for all of the surgeons making the recommendation? This is a report of the effect of surgeon age and stage in career on the recommendation for either a high tibial osteotomy (HTO) or a uni-compartmental knee replacement in a specific patient.

CASE REPORT

The patient is a 59 and ½ year old male orthopaedic surgeon with a chief complaint of left medial knee pain.

Present Illness

The knee pain came on relatively acutely after playing 5 hours of tennis one day. Swelling was present the next day, but resolved rapidly. Activity related pain at the medial joint line persisted. The pain has been present for 8 months. The patient is unable to run. The pain is present with every step—usually mild when walking and severe with attempted running. No pain at rest. The knee pain is localized to the medial joint line and has not improved with PT, rest, NSAID’s, lidocaine/corticosteroid joint injection (although this temporarily completely relieved the symptoms.) He is somewhat better with an “un-loader” brace when walking, but it does little for running symptoms. He is very sore after standing for a day in the operating room. He wishes to remain active.

Past Medical History

He has had previous bone-patellar tendon-bone ACL grafts in both knees and both knees have had one or two meniscal partial resections for symptomatic tears. These resulted from sports injuries. He has mild/moderate hypertension and elevated cholesterol that are well controlled medically.

Physical Examination

He is moderately overweight. He has mild varus alignment of the legs. He has a stable knee to examination.

Imaging

Anterior-posterior lower extremity alignment films show mild varus (Fig. 1).

Posterior-anterior flexion radiograph shows loss of medial joint space (Fig 2).

MRI shows loss of medial joint cartilage (Fig 3).

Valgus stress anterior-posterior radiograph showed a normal lateral joint space.

Impression

Medial joint osteoarthritis in a stable knee in a nearly 60 year old physically active man; unresponsive to conservative measures.

Recommendation

High tibial osteotomy (HTO) or uni-compartmental knee replacement.

CAVEATS

At the University of Iowa, where the patient sought treatment, orthopaedic residents are taught that the literature does not show a clear difference in outcomes between these two procedures in patients of this age. Although individual faculty has opinions as to which procedure is better, they are not presented as evidence based. Furthermore, at this institution, all HTO’s are done as opening wedge procedures whereas most of the literature deals with closing wedge osteotomies. All the uni-compartmental knee replacements at this institution are Oxford Partial Knee Replacement, though the literature includes other uni-compartmental knee replacement devices. This allows speculation that between opening wedge HTO and Oxford uni-compartmental replacements there may in fact be a significantly better choice. But no compelling comparison of these two specific options has been done. If relying on the existing literature, a surgeon should be expected to be at equipoise with respect to the two operations. In practice surgeons may have opinions about which procedure is preferable due to an imperfect literature.

METHODS

The above history and physical and imaging studies were sent to all the resident/fellow orthopaedic surgeons and faculty orthopaedic surgeons by the patient in what he thought would be an interesting educational exercise. He asked them to make a recommendation for his surgery between these two procedures. Some
Figure 1. Bilateral antero-posterior full leg radiograph showing varus alignment and interference screws from prior patellar bone-tendon-bone ACL reconstructions.

Figure 2. Posterior-anterior flexed knee radiograph showing medial joint space narrowing.

Figure 3. MRI STIR sagittal image of medial knee showing absent articular cartilage.
faculty recused themselves due to lack of familiarity with the treatment issues of medial knee joint compartment osteoarthritis in late middle age/early elderly patients. No hand surgeons offered an opinion, for example. Some residents did not answer, either because they were too junior to have been exposed to all the issues or for other reasons. What is critical to note is that if residents (younger) differed from faculty (older) in their recommendations, it was not because they had been trained by people who may have different beliefs about the superiority of one procedure to the other for patients of this age, given this set of indications. They had all been trained by the faculty whose opinions were also being solicited. If residents are making different recommendations from faculty, they are certainly not simply doing so because they were instructed to believe something different than the faculty believed about appropriate treatment.

RESULTS
The total possible response groups include 29 residents and fellows (interns were excluded) and 22 clinically active faculty. Thirteen residents/fellows responded (45%) and 12 faculty responded (50%).

Of the residents and fellows, eleven recommended uni-compartmental knee replacement and two recommended HTO. Of the faculty, nine recommended HTO and three recommended uni-compartmental knee replacement. The difference between resident/fellow and faculty recommendations was assessed by Fisher exact test and was significantly different with a P value=0.0048. Faculty age averaged 49 years and 3 months (range 33-70 years). Resident/fellow age averaged 31 years and 4 months (range 29-36 years). The youngest faculty member, 33 years of age, recommended a uni-compartmental and the oldest resident/fellow at 36 years old recommended an HTO.

DISCUSSION
Why did the residents/fellows and faculty choose different operations for this patient? Looking at the existing literature, it would appear that either option seems reasonable for patients from approximately age 55-65. One could reasonably expect all surgeons to be at equipoise with respect to the two options. Nearly all of the respondents would recommend an HTO for a 30 year old active person, since a uni-compartmental replacement would not be expected to last his lifetime. Similarly, all would recommend a uni-compartmental knee (some a TKR) for medial knee arthritis in a 75 year old as it can be anticipated to be a definitive procedure with more rapid recovery than an HTO.

Nonetheless, all the respondents did have a preference. None said, “I really can’t make a recommendation; the patient should decide.” This might be because all respondents were very familiar with the particular patient and were asked to pick a single choice. But even in a more typical clinical setting, the response to a statement that there are two equivalent operations for a problem by most patients would be “what would you do?” so it is likely that the recommendations elicited here mirror those that would be elicited in a more typical setting.

For a few respondents, obvious sources of bias can be identified. One faculty recommending the HTO is a sports medicine physician who only does HTO’s. The 2 faculty who recommended uni-compartmental knee replacement are both joint arthroplasty surgeons who do not perform HTO’s. However, excluding the responders with a clear bias based on their familiarity with only one procedure in their practice would only increase the statistical significance of the distinction in responses between faculty and residents. The one faculty member, who performs both HTO and uni-compartmental in his practice, recommended HTO. Both residents recommending HTO have played sports with the patient. But several resident/fellows who played sports with the patient recommended uni-compartmental knee replacement.

Perhaps a single strong faculty personality has convinced the residents/fellows that uni-compartmental is the best option? This seems implausible because only one junior arthroplasty surgeon performs uni-compartmental knee replacements regularly and the head of sports medicine service is a strong advocate of HTO.

A parsimonious explanation for the results may be that both groups of surgeons are, in the first instance, using a heuristic, attending only to a single, readily processed cue (patient age), to circumvent the need to make a complex judgment that accounts for a multitude of potentially relevant traits. Heuristics users typically make decisions lexically – that is, if one choice is superior to another along a single most significant dimension, they make that choice and attend to a second differentiating factor only if there is a tie along the first dimension, and to a third only if there are ties along the first two etc. (Think about comparing the size of numbers, which we do lexically: 812 is a larger number than 798 because the “8” in the hundreds column is bigger than the “7,” and we need not compare differences in the tens and ones.) Those using conventional, non-heuristic based rational choice methods typically process cues in a what is generally dubbed a compensatory fashion, balancing virtues (of greater or lesser magnitude) in some domains against flaws (of greater or lesser magnitude) along others.

Thus, a heuristic user may only note that a patient is above or below some threshold of “old” rather than attending to a host of other variables that would seem to affect the decision, such as the patient’s activity level, life expectancy, probability of experiencing distinct complications associated with each procedure, desire with
respect to recovery time, and anticipation of surgery for another joint. Essentially this heuristic substitutes a simple question for a complex question. Instead of asking “what is the better of two similar procedures for this particular complex human being?” one substitutes the question “is he old?” This bias is a type called “attribution substitution”. Attribution substitution is attending to an easily processed cue as a substitute for considering more complex information. It is common to observe this sort of heuristic decision making process. When people engage in “stereotyping,” another common form of attribute substitution, they use an easily processed cue – age, gender, race – as a proxy for more complex traits that are actually of interest (vulnerability to disease, trustworthiness, stamina, etc.). We can readily imagine how using the attribution substitution heuristic was adaptive in an evolutionary sense if the error costs of use were lower than the costs of obtaining and processing greater amounts of information. Using the heuristic can misfire when the single attribute selected is poorly representative of the individual or group at issue.

But the question that remains, if all surgeons recommend HTO for the “young” and replacement surgery for the “old,” is why residents/fellows see a 60 year old man as being old, with limited life expectancy and limited physical capacity, while faculty sees the patient as not-old, with a lot of good life left and plenty of physical capacity. It would have been possible to find that patient age is the only cue that surgeons attend to in deciding between these procedures, but that they all agree that when a patient reaches a particular chronological age, he is now “old enough” that replacement is appropriate, and not until then. Instead, what we observe is the use of what seems like a second-order heuristic to implement the heuristic that assigns one procedure to the old and a different one to the young. At this second level, the residents/fellows might “stereotype” all people “roughly” 30 or more years older than they are as old and the faculty may “stereotype” people “near” their own age as not old. Perhaps only one group of respondents is using a stereotyping heuristic. The faculty may have a more accurate view of the life of a 60 year old, and this is not “stereotyping.” Alternatively, the residents may more accurately understand the remaining years and quality of physical activity of a 60 year old and the faculty are engaging in a form of denial—“no one my age should have an elderly person’s operation.” What is curious, though, is that the use of a “relative age” heuristic to determine whether a patient “is” old does not serve information-economizing functions: chronological age is just as immediately perceived and easily processed as relative age. So if the surgeons are using some sort of “relative age” heuristic, it is not one readily explained in the most conventional terms (as a strategy to make use of readily available and easily recognized information to make a judgment that typically meets the subject’s ends.)

Thus, what we seem to have observed is something like a physician/patient relative age evaluative bias. This bias has not been discussed to our knowledge in medical decision making but the psychological underpinnings of this bias are well studied. Humans value years in the future differently based on their present age. Simply stated, the years from 70 to 80 are more highly valued by a 50 year old than a 30 year old. This has been demonstrated, for example, by asking people how many years of life they would exchange for something else, such as a painless death or a disability free elderly period. The older one is, the more one values the remaining years.

It is also possible that humans intuitively, and much more effortlessly, perceive age in relative, not absolute terms. People are indeed quickly classified as “old” or “young” based on relative age because only those relative judgments typically matter—whether in terms of evolutionary imperatives or for more immediate functional reasons that have little bearing on inclusive fitness. A person we see is too old (or young) to mate with; old enough to be owed deference in hierarchical communities or young enough to be owed protection or guidance, etc. Of course, even if it is generally appropriate to make quick judgments of age based on relative age, it may well be inapt in this setting: the young surgeon is not being asked to judge whether the patient is an apt mate, for instance, and if the surgeon is using an age judgment metric designed for that task, rather than for the task of evaluating which operation is apt, he will be displaying a bias in the pejorative sense of the word.

Physician/patient relative age bias is type of intertemporal bias. This may be relevant for many orthopaedic decisions. For example, there may be a major difference in how a 16 year old with aseptic necrosis of the hip values the hip mobility and relatively normal function for the next 10 to 20 years of their life compared to a 50 year old surgeon’s assessment of the importance of those years. The surgeon may be concerned about the inability to replant a multiply replanted or infected total hip replacement as the patient ages and recommend a hip arthrodesis to be converted to a total hip replacement when the patient is older. The teenager, though, might reasonably contend that the years from 15 to 30 are critical in establishing career and mate and status and that having a visible disability might compromise his ability to optimize along these dimensions. The surgeon can reasonably contend that there is a long full life after fifty that might be compromised by an unstable, un-re-implantable failed total hip. It seems clear that there is not a technical or literature based way to adjudicate between these opinions.
The question remains whether surgeons would make more similar recommendations – and perhaps more defensible ones – if they were to take a more nuanced history and perform a more patient specific evaluation, rather than relying on a “patient age” heuristic. What factors might be left out if doctors attend only to chronological age? The life expectancy for a patient born in 1951? The particular patient’s expectation of longevity? The patient’s expectations about his level of continued physical activity? The patient’s risk averseness to certain types of complications, e.g. artificial joint infection vs. HTO non-union? Patient’s beliefs concerning ease of revision to TKR if needed? Other limiting musculoskeletal issues, particularly this patient’s expectations for his multiply operated contralateral knee? Does it matter that the patient recently took up triathlons? Does it matter that the patient still hopes to play softball on the departmental team and expects to do well in his age group at USTA tennis tournaments? These are factors that might allow a more nuanced recommendation by the surgeon and choice by the patient. They are often unstated. A checklist of such factors—expected longevity, activity level, etc.—might result in more reasoned judgments, though the general literature on heuristics shows many instances in which efforts to make people consider additional factors simply fail. Certainly, though, the surgeon’s age is irrelevant to the choice.

Whether it is ultimately sensible or not, rather than merely economical in terms of decision-making resources, to use patient age lexically, rather than attempt to assess each particular patient’s needs and condition with greater particularity is a question we won’t really address. (It is worth noting, though, that there are psychologists, associated with what is generally dubbed the “fast and frugal heuristics” school12,13, who believe that lexical methods, or decision making procedures that rely on a very small number of cues if not a single differentiating one, are often superior, in the medical context, to multi-factor balancing tests, without regard to information-processing costs; and others, associated with the “heuristics and biases” school, e.g. Tversky and Kahneman, who sharply criticize these claims, but this dispute is outside the bounds of this paper (For a fuller discussion of the dispute, see reference 14). It is certainly possible that at the first level recommending between uni-compartmental knee replacement and HTO based simply on age might be a “good enough” heuristic. Nuances of health, activity level, expected longevity might augment the decision making process, but age is the single most important variable.

Should surgeons be aware of their changing biases as they age? If so, who is right—the young or the old surgeons? What can or should a surgeon do about this bias? Since the operations’ outcomes are nearly equivalent, does it even matter? We think it is possible that being aware of potential stereotyping might prompt a surgeon to take a more nuanced history and explore with the particular patient of his/her expectation in determining the choice between two operations with similar outcomes in more general populations. Simply being aware of potential biases might then help the surgeon give better advice.

REFERENCES