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Arthroplasty Versus Internal Fixation of Femoral Neck Fractures: A Clinical Decision Analysis

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SUMMARY

Background. The optimal surgical management of displaced femoral neck fractures in the elderly remains controversial. Treatment alternatives include arthroplasty and internal fixation. Options for arthroplasty include total hip arthroplasty and hemiarthroplasty, whereas options for internal fixation include multiple screws and sliding hip screws. We sought to compare arthroplasty and internal fixation alternatives and determine the key factors influencing final outcomes using a clinical decision analysis.

Material and methods. We constructed a decision analytic model representing potential outcomes after arthroplasty and internal fixation alternatives. Probabilities of events following each procedure were systematically derived from a literature review. Relative outcome preferences were estimated using health utility questionnaires with surgeons and lay persons. Sensitivity analyses determined threshold values that would alter the preferred decision.

Results. In the arthroplasty comparison, patients treated with total hip arthroplasty achieved higher expected utility values than patients treated with hemiarthroplasty (0.80 versus 0.74). In the internal fixation analysis, sliding hip screw fixation yielded higher expected utility values than multiple screws (0.76 versus 0.73). Overall, total hip arthroplasty achieved higher expected utility values than either approach to internal fixation. The superiority of arthroplasty over internal fixation was maintained over a wide range of probabilities and utilities.

Conclusions. When outcomes and their values are considered in a systematic manner, arthroplasty results in better patient outcomes when compared to internal fixation in the management of displaced hip fractures in the elderly.

BACKGROUND

Although the surgical treatment of displaced femoral neck fractures in the elderly has been well studied, optimal management remains controversial [1, 2]. Treatment alternatives include arthroplasty and internal fixation. Options for arthroplasty include total hip arthroplasty (THA) and hemiarthroplasty (HA); options for internal fixation include multiple screws (MS) and sliding hip screw (SHS) fixation. In comparison with internal fixation, arthroplasty reduces the risk of revision surgery at the cost of greater infection rates, blood loss, operative time, and possibly mortality [1].

A randomized clinical trial (RCT) provides the highest level of evidence for the effectiveness of a clinical intervention [3]. In the comparison of multiple surgical techniques and procedures, however, RCTs may be time-consuming and difficult to plan and execute. Although a number of RCTs and meta-analyses of arthroplasty and internal fixation have been performed, none have directly compared specific alternatives for each procedure. Decision analysis is a quantitative method that uses estimates of the likelihood of events (probabilities) and relative outcome preferences (health utilities) together with a Decision Tree to model a given problem and help determine the best course of action [4,5]. In the absence of valid evidence from an RCT, decision analytic models may be useful in deciding the best management of an individual patient [3]. Decision analysis allows the incorporation of available literature with physician and patient preferences for the differing characteristics and outcomes related to each procedure. We therefore sought to compare arthroplasty and internal fixation alternatives of displaced femoral neck fractures and determine key factors influencing final outcomes using a clinical decision analysis.

MATERIAL AND METHODS

Our model considered the dilemma of the optimal surgical management for an elderly (70-99 years) patient with a displaced femoral neck fracture (Garden III/IV) and no major medical comorbidities eligible for either prosthetic replacement or internal fixation. We examined the relative outcomes with arthroplasty (THA versus HA) and internal fixation (MS versus SHS).

Event Probabilities

We conducted a systematic search to identify baseline probability estimates for each chance node. A Medline search was performed to identify the highest level of evidence from primarily randomized control trials (or meta-analyses of randomized trials) related to arthroplasty and internal fixation of displaced femoral neck fractures. Reports were reviewed and selected for inclusion if their primary focus was the management of uncomplicated displaced femoral neck fractures. Reports of patients with other major medical comorbidities were excluded. Outcomes such as reoperation and the presence of major complications were recorded for each patient. Any reports that defined outcomes for the same patients were excluded. Each report meeting the inclusion criteria was subsequently reviewed to determine the characteristics of the study population. Outcomes such as reoperation and the presence of major complications were recorded for each patient. A major complication was defined as a complication that is life threatening, requires major intervention, or is associated with important long-term sequelae (Table 1) [4]. As there was no study with no reported outcomes under investigation, we pooled the proportions, weighted by sample size, to estimate the baseline risk of each event [6].

Decision Model

A decision tree depicting each of the possible surgical options and outcomes following a displaced femoral neck fracture was created using TreeAge Pro (TreeAge Software, Inc., Williamstown, MA) (Figure 1). The root node, where the initial decision is made, allows hypothetical patients and surgeons to choose between arthroplasty and internal fixation.

Tab. 1. Summary of major complications following surgical repair of hip fracture [1,2,18,19,35]

Mortality
Failure to regain mobility
Deep wound infection
Major medical complications
Hardware failure
Nonunion

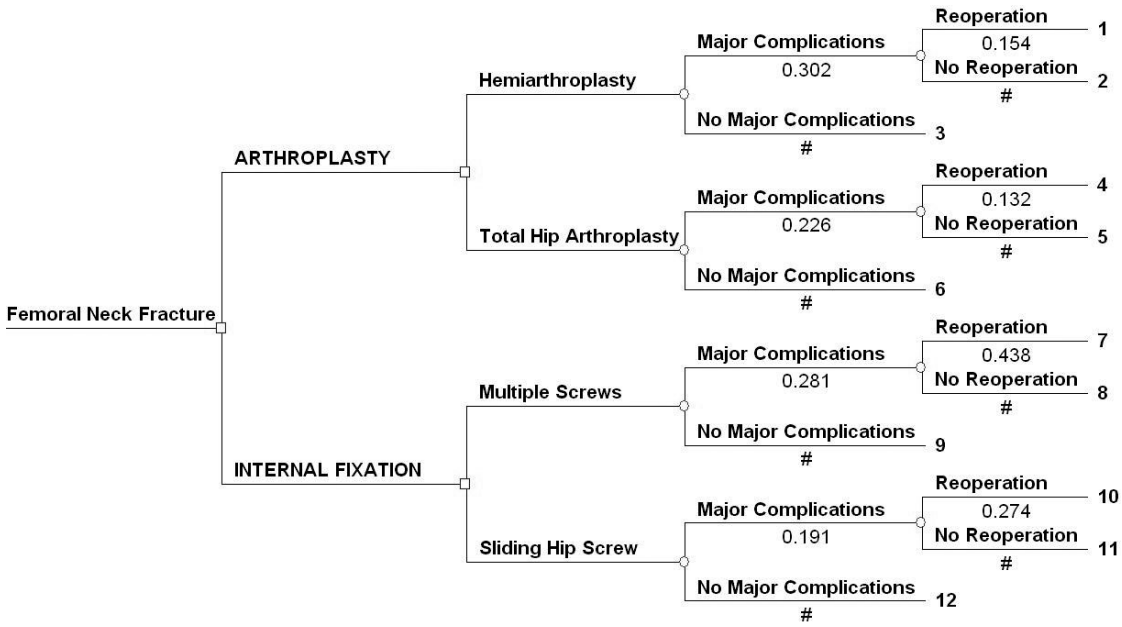

Fig. 1. Decision tree outlining management outcomes after a displaced femoral neck fracture. Squares represent decision nodes, and circles represent chance nodes. Probabilities, derived from the literature, are shown directly under the branch they represent. Hashmarks represent the remaining probability at that respective branch. Each end node has been assigned a number representing a health utility, shown in Table 3

Patients and surgeons in the arthroplasty branch then decide between THA and HA; those in the internal fixation branch decide between MS and SHS fixation. The remaining branch points, with the exception of the right-most points, called end (or terminal) nodes, are referred to as chance nodes; at chance nodes events occur with a specified probability, but are not chosen. The first chance node is related to the presence or absence of a major complication. If a major complication was attained, the next chance node refers to the need for reoperation by either arthroplasty or internal fixation.

Preferences and Health Utility

We developed a questionnaire to assess perceptions about health utilities of a series of outcomes following arthroplasty or internal fixation. A utility is a measure of relative preference or desirability for a given outcome, and is expressed as a value between 0 and 1.0, where 0 represents death and 1.0 represents perfect health [7]. All questions were related to an elderly patient with an uncomplicated displaced femoral neck fracture felt to be suitable for either arthroplasty or internal fixation.

Interviews were conducted with 43 persons, including 26 orthopaedic surgeons and 17 elderly lay persons (> 70 years old) who were deemed at risk for, but had not suffered, a hip fracture. Respondents were selected randomly and asked to rank each pathway depicted in the decision tree on a scale from 0 (death) to 100 (perfect health) representing their understanding of quality of life if faced with the clinical scenario depicted. A perfect procedure was one in which there were no major complications or reoperation. Values were then converted to a standard utility between 0 and 1.0 to be used in the decision tree.

Data Analysis

We calculated expected values for each patient treated for hip fracture using a standard fold back approach in which the utility of each pathway is weighted by its respective probability and summed across all treatment pathways [8]. By "folding back the tree," the model expresses its conclusion in terms of a mean expected value which represents the probability-weighted average of each procedure [9]. The preferred clinical strategy can then be inferred from the decision branch that has the largest expected value [10]. Expected values using health utilities from surgeons and hypothetical patients were compared using paired t-tests.

The probabilities of major complications, reoperation, and utility values were then represented as variables in the decision tree to allow for sensitivity analyses. One-way sensitivity analyses were performed for each probability and expected utility over a range of clinically pertinent values while all other probabilities and utilities were held constant; thus the

threshold probabilities that alter the final preferred decision were determined. Threshold values represent the boundaries of the variables that indicate when one clinical strategy is more beneficial than another [10]. Two-way sensitivity analyses were then undertaken over clinically pertinent values (as derived from the literature).

RESULTS

Decision Tree

The complete decision tree, together with probabilities and utilities, is shown in Figure 1.

Event Probabilities

A total of 24 published scientific reports were selected to estimate the baseline probabilities: 20 reports focused on arthroplasty with 11 THA reports [2, 11-20] (n= 527) and 14 HA reports [11, 15, 18-29] (n= 919); 19 reports focused on internal fixation with 15 MS reports [2, 12, 14, 16, 17, 19, 21-24, 26-30] (n= 964) and 4 SHS reports [15, 31-33] (n= 391). Baseline probabilities and ranges for each probability are listed in Table 2.

Utilities

Table 3 presents utility values from surgeons and hypothetical patients, with ranges and standard devi-

Tab. 2. Probability estimates, ranges, and references used in decision tree

		Baseline Estimate	Range*	References
Total Hip Arthroplasty	Major complications	0.30	0.04-0.49	[2, 11-20]
	Reoperation	0.15	0.02-0.27	
Hemiarthroplasty	Major complications	0.23	0.07-0.58	[11, 15, 18-29]
	Reoperation	0.13	0.04-0.37	
Multiple Screw Fixation	Major complications	0.28	0.02-0.65	[2, 12, 14, 16, 17, 19, 21-24, 26-30]
	Reoperation	0.44	0.13-0.58	
Sliding Hip Screws	Major complications	0.19	0.13-0.40	[15, 31-33]
	Reoperation	0.27	0.05-0.33	

Range used in sensitivity analyses (values derived from selected literature)

Tab. 3. Estimated utilities, standard deviations (SD), and ranges used in decision tree

Outcome depicted in Figure 1	Estimated median utility ± SD from surgeons[1] (n=26)	Estimated median utility ± SD from hypothetical patients[1] (n=17)	Overall median health utility ± SD (n=43)	Range[2]
1	0.45 ± 0.24	0.50 ± 0.15	0.50 ± 0.21	0.00-0.80
2	0.60 ± 0.20	0.58 ± 0.17	0.60 ± 0.18	0.20-0.90
3	0.90 ± 0.18	0.90 ± 0.14	0.90 ± 0.16	0.40-1.00
4	0.50 ± 0.22	0.50 ± 0.14	0.50 ± 0.19	0.10-0.90
5	0.55 ± 0.19	0.58 ± 0.17	0.55 ± 0.18	0.20-0.85
6	0.80 ± 0.13	0.90 ± 0.13	0.80 ± 0.13	0.55-1.00
7	0.50 ± 0.20	0.50 ± 0.11	0.50 ± 0.17	0.20-0.90
8	0.60 ± 0.17	0.65 ± 0.16	0.60 ± 0.16	0.35-0.90
9	0.80 ± 0.18	0.80 ± 0.11	0.80 ± 0.16	0.30-1.00
10	0.50 ± 0.22	0.50 ± 0.11	0.50 ± 0.19	0.15-0.90
11	0.60 ± 0.18	0.65 ± 0.16	0.60 ± 0.17	0.20-0.85
12	0.80 ± 0.18	0.80 ± 0.11	0.80 ± 0.16	0.25-1.00

[1] Adjusted to a scale of 0 – 1.0
[2] Range used in sensitivity analyses

ations as estimated from the health utility questionnaires.

Decision Analysis

After the initial decision analysis using health utilities from surgeons was complete, final values favored arthroplasty with an expected value of 0.80 (THA 0.80; HA 0.74) compared with 0.76 for internal fixation (MS 0.73; SHS 0.76). Results using health utilities from hypothetical patients were similar, with an expected value of 0.80 for arthroplasty (THA 0.80; HA 0.78) and 0.77 for internal fixation (MS 0.74; SHS 0.77). When health utilities incorporated values from surgeons and hypothetical patients, final values favored arthroplasty with an expected value of 0.80 (THA 0.80; HA 0.74) compared with 0.76 for internal fixation (MS 0.73; SHS 0.76). No significant difference was found between utility values from surgeons and hypothetical patients ($p>0.1$). These values are depicted in Figure 2.

Sensitivity Analyses

One-way sensitivity analyses showed that changing the probability of reoperation had little impact in altering the preferred decision to favor HA over THA or MS over SHS; reoperation did, however, play a role in an overall comparison of arthroplasty to internal fixation. The most significant factors in altering the preferred decision were the rates of major complications and health utilities (Table 4). Two-way sensitivity analysis on rates of morbidity for arthroplasty and internal fixation showed that even if rates of morbidity after arthroplasty were relatively high, arthroplasty is still favored over internal fixation over a notably wide range of values (Figure 3). The effects of varying health utilities showed similar findings (Figure 4).

DISCUSSION

Decision analysis favored arthroplasty over internal fixation in the treatment of displaced femoral neck fractures over a wide range of clinically plausible scenarios. Although arthroplasty may be associated with greater complication rates and perioperative morbidity, decreased reoperation rates and greater health utility make it preferable to internal fixation. These findings were consistent across health utilities from both surgeons and hypothetical patients.

Sensitivity analyses demonstrated that in order for internal fixation to be favored over arthroplasty, either the probability of morbidity and reoperation would have to be significantly higher for arthroplasty, significantly lower for internal fixation, or a combination of both. Morbidity rates are the most important variable in determining the procedure of choice, followed by utilities and rates of reoperation.

Decision Analysis

Decision analysis is most usefully applied in clinical decisions where there is uncertainty regarding

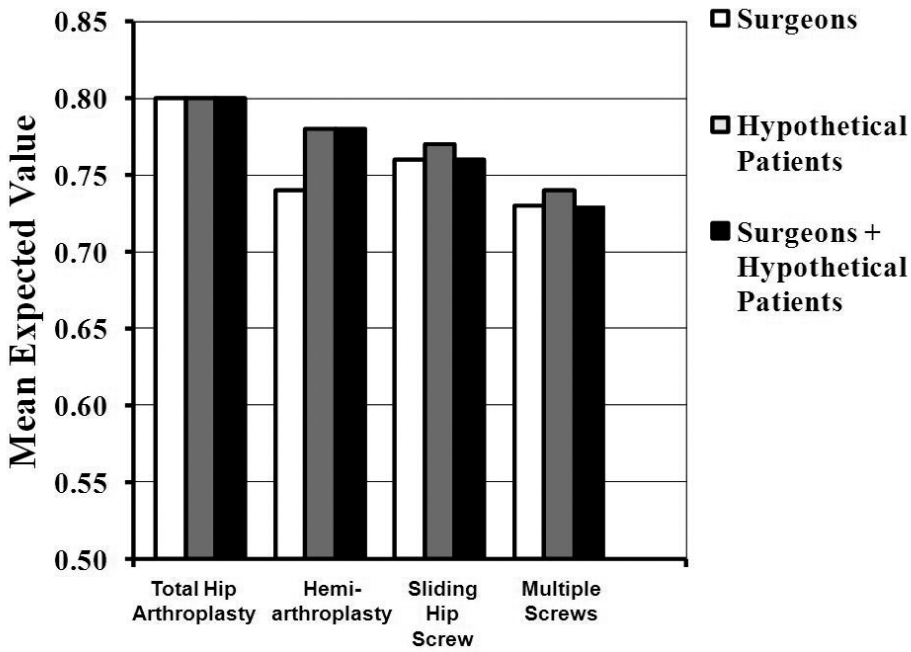

Fig. 2. Final expected values after decision analysis using health utilities for surgeons (n=26), hypothetical patients (n=17), and both surgeons and hypothetical patients (n=43). No significant difference between values from surgeons and hypothetical patients was found ($p>0.1$)

Tab. 4. Difference in baseline values required to alter the preferred decision

		Probability		Utility
		Major complications	Reoperation*	
Arthroplasty	THA	+ 0.20	-	- 0.14
	HA	-	-	+ 0.03
Internal Fixation	MS	- 0.08	-	+ 0.04
	SHS	+ 0.11	-	- 0.07
	Arthroplasty[1]	+ 0.10	-	- 0.13
	Internal Fixation[1]	- 0.14[2]	- 0.22[2]	+ 0.06

* Hashes indicate that no value will alter preferred decision
[1] In best case scenario
[2] Both required for internal fixation to be favored over arthroplasty

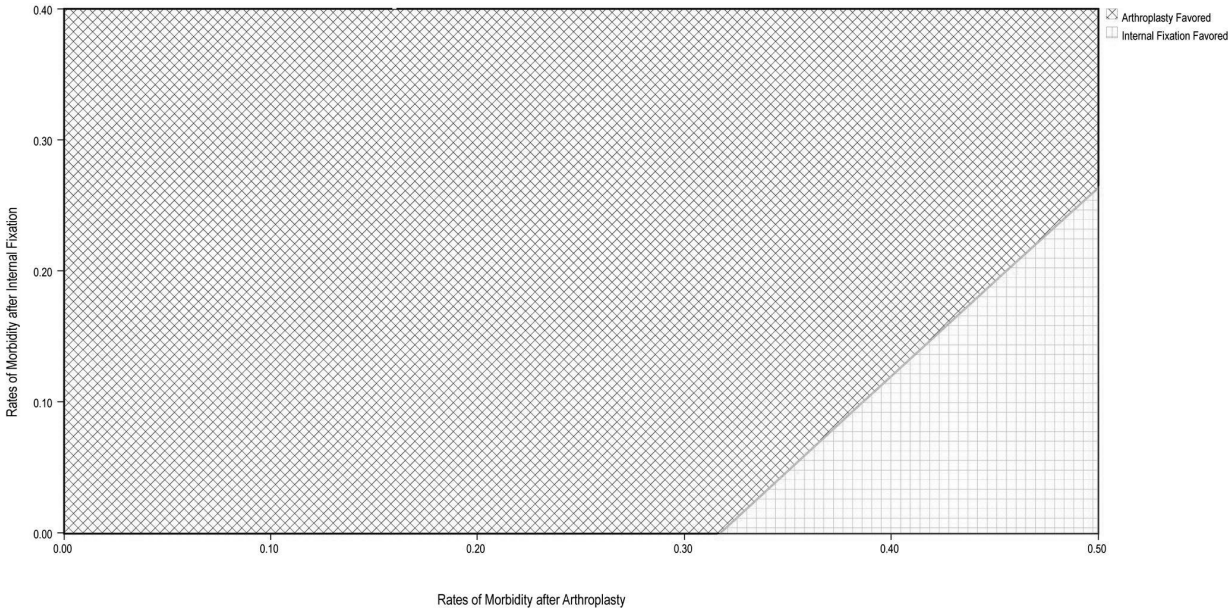

Fig. 3. Two-way sensitivity analysis on rates of morbidity for internal fixation and arthroplasty. The boundary displays threshold values for each variable

appropriate clinical strategy and when a meaningful tradeoff of advantages and disadvantages is present in the clinical problem [5]. Surgical options, which tend to involve concrete treatment options and relatively discrete outcomes, are aptly suited for decision analysis [10]. Sensitivity analysis allows options to be analyzed in the face of uncertainty, allowing decision analysts to examine what the effects of variability on risks, benefits, and values have on expected clinical outcomes [9]. Decision analysis has been applied to a number of clinical scenarios including the management of ventricular septal defects [4], screening for prostate cancer [34], and the treatment of early osteoarthritis of the wrist [3]. Furthermore, decision analytic studies may be valuable in their ability to guide clinical policy in a group of patients with a given condition, thus guiding strategies for the care of populations [3].

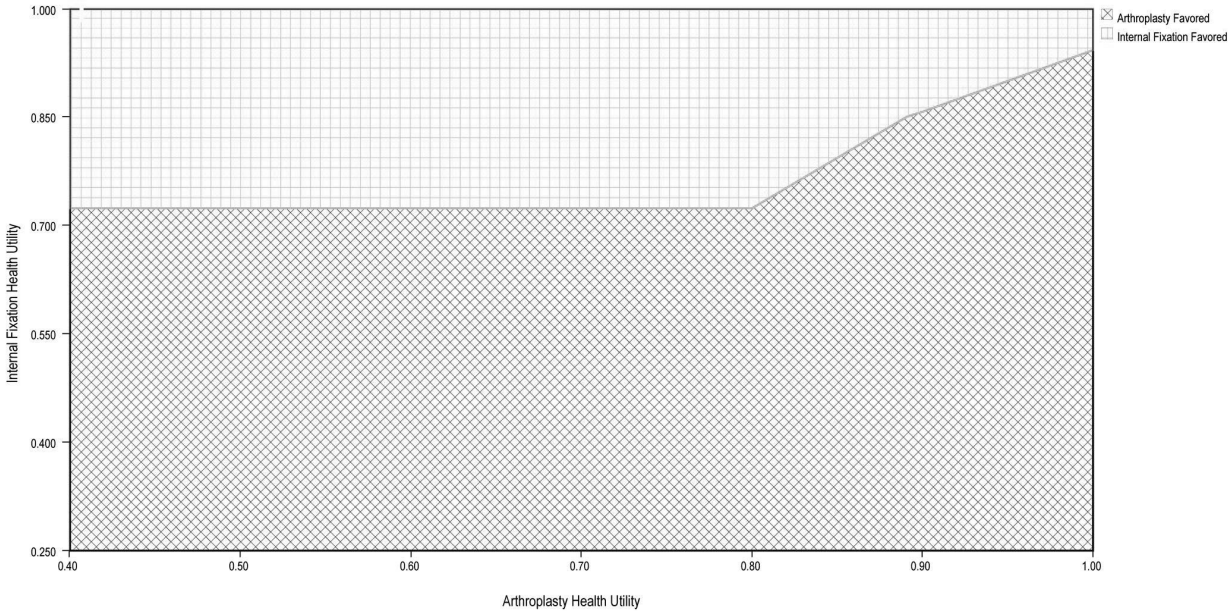

Fig. 4 Two-way sensitivity analysis on health utilities for internal fixation and arthroplasty. The boundary displays threshold values for each variable

Strengths and Limitations of the Investigation

Decision analysis is a tool that allows users to apply evidence-based medicine to make informed clinical decisions. Like any other study design, however, decision analysis does not guarantee a correct answer; its validity and application depends entirely on the specific clinical scenario, the availability of data, and the strength and inclusion criteria of the selected literature. When interpreting a decision analysis, surgeons must look at how closely their particular clinical situation resembles that of the analysis, the strength and reliability of the estimated probabilities and utilities, as well as the results of the sensitivity analyses. It is possible that in some settings the probabilities of events differ from those that were incorporated in this model.

The present study shows an application of decision analysis to the treatment of hip fractures. It should be noted that the rates of complications and reoperation vary significantly depending on the prosthesis and technique used, as well as the morphology of the hip fracture and expected end results. Additionally, published evidence is often inaccurate, and important variables are highly varied. For example, quality of bone in patients with hip fractures was not available from the randomized trials that were reviewed. It is possible that management decisions may change for patients based on bone quality. To account for this, however, we undertook sensitivity analyses over a broad range of clinically pertinent values to determine the threshold probabilities that would alter the preferred decision. For simplicity, the present model does not consider the incidence or impact of minor complications or comorbidities on clinical outcomes. This includes post-operative events that are not immediately life threatening, self-limited, resolved with minimal intervention, and associated with no residual sequlae [4]. Finally, the technique of reoperation in terms of arthroplasty or internal fixation was not taken into consideration. It is possible that these factors may have altered expected clinical outcomes.

To avoid potential confusion and possible psychological distress induced by the health utility survey, respondents in our study were not patients with hip fractures. Consequently, we included a sample of elderly persons at risk for hip fractures and asked respondents to consider questions as realistically as possible. It is possible, however, that responses do not accurately reflect the responses of patients with hip fracture, and that patients with hip fractures may have an inherent preference for one procedure over another. We also did not take into consideration surgeon seniority, and it is possible that health preferences from senior surgeons may differ from those of more junior surgeons.

CONCLUSION

In summary, our model suggests that when outcomes and their values are taken into account in a systematic manner, arthroplasty results in better patient outcomes when compared to internal fixation in the management of displaced hip fractures over

a wide range of clinically plausible scenarios. The most important influencing variables are rates of morbidity, utility preferences, and reoperation rates. Health utility questionnaires showed that surgeons and patients' perceptions of health utility following various outcomes in hip fracture treatment are generally compatible. These findings can be used by surgeons to confirm the choice of arthroplasty over internal fixation in elderly patients with displaced femoral neck fractures. Furthermore, surgeons can relay the findings of the decision tree as incorporating both evidence from randomized trials as well as preferences of individuals similar to the patient population at risk for hip fractures. Before deciding on a definitive management plan, however, surgeons must look at their individual patient population and take into consideration multiple factors including health status of patients, age, bone quality, and individual patient goals and expectations. The findings of this study should ideally be confirmed in one or more large, methodologically rigorous randomized controlled trials. Until that time, surgeons should carefully discuss the many surgical options available with their patients, and the relative benefits and risks of each.

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REFERENCES

1. Bhandari, M, Devereaux, PJ, Swiontkowski, MF, et al. Internal fixation compared with arthroplasty for displaced fractures of the femoral neck. A meta-analysis. J Bone Joint Surg Am 2003; 85-A: 1673.
2. Blomfeldt, R, Tornkvist, H, Ponzer, S, et al. Comparison of internal fixation with total hip replacement for displaced femoral neck fractures. Randomized, controlled trial performed at four years. J Bone Joint Surg Am 2005; 87: 1680.
3. Graham, B, Detsky, AS. The application of decision analysis to the surgical treatment of early osteoarthritis of the wrist. J Bone Joint Surg Br 2001; 83: 650.
4. Aleem, IS, Karamlou, T, Benson, LN, McCrindle, BW. Transcatheter device versus surgical closure of ventricular septal defects: a clinical decision analysis. Catheter Cardiovasc Interv 2006; 67: 630.
5. Detsky, AS, Naglie, G, Krahn, MD, et al. Primer on medical decision analysis: Part 1 -Getting started. Med Decis Making 1997; 17: 123.
6. Audige, L, Bhandari, M, Griffin, D, et al. Systematic reviews of nonrandomized clinical studies in the orthopaedic literature. Clin Orthop Relat Res 2004; 14: 249.
7. Naglie, G, Krahn, MD, Naimark, D, et al. Primer on medical decision analysis: Part 3--Estimating probabilities and utilities. Med Decis Making 1997; 17: 136.
8. Karanicolas, PJ, Smith, SE, Inculet, RI, et al. The cost of laparoscopic myotomy versus pneumatic dilatation for esophageal achalasia. Surg Endosc 2007; 21: 1198.
9. Krahn, MD, Naglie, G, Naimark, D, et al. Primer on medical decision analysis: Part 4--Analyzing the model and interpreting the results. Med Decis Making 1997; 17: 142.
10. Schultz, WR, Weinstein, JN, Weinstein, SL, Smith, BG. Prophylactic pinning of the contralateral hip in slipped capital femoral epiphysis: evaluation of long-term outcome for the contralateral hip with use of decision analysis. J Bone Joint Surg Am 2002; 84-A: 1305.
11. Blomfeldt, R, Tornkvist, H, Eriksson, K, et al. A randomised controlled trial comparing bipolar hemiarthroplasty with total hip replacement for displaced intracapsular fractures of the femoral neck in elderly patients. J Bone Joint Surg Br 2007; 89: 160.
12. Johansson, T, Jacobsson, SA, Ivarsson, I, et al. Internal fixation versus total hip arthroplasty in the treatment of displaced femoral neck fractures: a prospective randomized study of 100 hips. Acta Orthop Scand 2000; 71: 597.
13. Jonsson, B, Sernbo, I, Carlsson, A, et al. Social function after cervical hip fracture. A comparison of hook-pins and total hip replacement in 47 patients. Acta Orthop Scand 1996; 67: 431.
14. Neander, G, Adolphson, P, von Sivers, K, et al. Bone and muscle mass after femoral neck fracture. A controlled quantitative computed tomography study of osteosynthesis versus primary total hip arthroplasty. Arch Orthop Trauma Surg 1997; 116: 470.
15. Ravikumar, KJ, Marsh, G. Internal fixation versus hemiarthroplasty versus total hip arthroplasty for displaced subcapital fractures of femur--13 year results of a prospective randomised study. Injury 2000; 31: 793.
16. Svenningsen, S, Benum, P, Nesse, O, Furset, OI. [Femoral neck fractures in the elderly--a comparison of 3 treatment methods]. Nord Med 1985; 100: 256.
17. Tidermark, J, Ponzer, S, Svensson, O, et al. Internal fixation compared with total hip replacement for displaced femoral neck fractures in the elderly. A randomised, controlled trial. J Bone Joint Surg Br 2003; 85: 380.
18. Baker, RP, Squires, B, Gargan, MF, Bannister, GC. Total hip arthroplasty and hemiarthroplasty in mobile, independent patients with a displaced intracapsular fracture of the femoral neck. A randomized, controlled trial. J Bone Joint Surg Am 2006; 88: 2583.
19. Blomfeldt, R, Tornkvist, H, Ponzer, S, et al. Internal fixation versus hemiarthroplasty for displaced fractures of the femoral neck in elderly patients with severe cognitive impairment. J Bone Joint Surg Br 2005; 87: 523.

20. El-Abed, K, McGuinness, A, Brunner, J, et al. Comparison of outcomes following uncemented hemiarthroplasty and dynamic hip screw in the treatment of displaced subcapital hip fractures in patients aged greater than 70 years. Acta Orthop Belg 2005; 71: 48.
21. Jensen, JS, Rasmussen, T, Christensen, S, et al. Internal Fixation or Prosthetic Replacement in Fresh Femoral Neck Fractures. Acta Orthop Scand 1984; 55: 432.
22. Parker, MJ, Khan, RJ, Crawford, J, Pryor, GA. Hemiarthroplasty versus internal fixation for displaced intracapsular hip fractures in the elderly. A randomised trial of 455 patients. J Bone Joint Surg Br 2002; 84: 1150.
23. Puolakka, TJ, Laine, HJ, Tarvainen, T, Aho, H. Thompson hemiarthroplasty is superior to Ullevaal screws in treating displaced femoral neck fractures in patients over 75 years. A prospective randomized study with two-year follow-up. Ann Chir Gynaecol 2001; 90: 225.
24. Roden, M, Schon, M, Fredin, H. Treatment of displaced femoral neck fractures: a randomized minimum 5-year follow-up study of screws and bipolar hemiprostheses in 100 patients. Acta Orthop Scand 2003; 74: 42.
25. Sikorski, JM, Barrington, R. Internal fixation versus hemiarthroplasty for the displaced subcapital fracture of the femur. A prospective randomised study. J Bone Joint Surg Br 1981; 63-B: 357.
26. Soreide, O, Molster, A, Raugstad, TS. Internal fixation versus primary prosthetic replacement in acute femoral neck fractures: a prospective, randomized clinical study. Br J Surg 1979; 66: 56.
27. van Dortmont, LM, Douw, CM, van Breukelen, AM, et al. Cannulated screws versus hemiarthroplasty for displaced intracapsular femoral neck fractures in demented patients. Ann Chir Gynaecol 2000; 89: 132.
28. van Vugt, AB, Oosterwijk, WM, Goris, RJ. Osteosynthesis versus endoprosthesis in the treatment of unstable intracapsular hip fractures in the elderly. A randomised clinical trial. Arch Orthop Trauma Surg 1993; 113: 39.
29. Parker, MJ, Gurusamy, K. Internal fixation versus arthroplasty for intracapsular proximal femoral fractures in adults. Cochrane Database Syst Rev 2006: CD001708.
30. Rogmark, C, Carlsson, A, Johnell, O, Sernbo, I. A prospective randomised trial of internal fixation versus arthroplasty for displaced fractures of the neck of the femur. Functional outcome for 450 patients at two years. J Bone Joint Surg Br 2002; 84: 183.
31. Benterud, JG, Husby, T, Nordsletten, L, Alho, A. Fixation of displaced femoral neck fractures with a sliding screw plate and a cancellous screw or two Olmed screws. A prospective, randomized study of 225 elderly patients with a 3-year follow-up. Ann Chir Gynaecol 1997; 86: 338.
32. Elmerson, S, Sjostedt, A, Zetterberg, C. Fixation of femoral neck fracture. A randomized 2-year follow-up study of hook pins and sliding screw plate in 222 patients. Acta Orthop Scand 1995; 66: 507.
33. Nordkild, P, Sonne-Holm, S, Jensen, JS. Femoral neck fracture: sliding screw plate versus sliding nail plate – a randomized trial. Injury 1985; 16: 449.
34. Krahn, MD, Mahoney, JE, Eckman, MH, et al. Screening for prostate cancer. A decision analytic view. Jama 1994; 272: 773.
35. Blomfeldt, R, Tornkvist, H, Ponzer, S, et al. Displaced femoral neck fracture: comparison of primary total hip replacement with secondary replacement after failed internal fixation: a 2-year follow-up of 84 patients. Acta Orthop 2006; 77: 638.

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