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ORIGINAL ARTICLE

Societal costs in displaced transverse olecranon fractures: using decision analysis tools to find the most cost-effective strategy between tension band wiring and locked plating

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Background: Tension band wiring (TBW) and locked plating are common treatment options for Mayo IIA olecranon fractures. Clinical trials have shown excellent functional outcomes with both techniques. Although TBW implants are significantly less expensive than a locked olecranon plate, TBW often requires an additional operation for implant removal. To choose the most cost-effective treatment strategy, surgeons must understand how implant costs and return to the operating room influence the most cost-effective strategy. This cost-effective analysis study explored the optimal treatment strategies by using decision analysis tools.

Methods: An expected-value decision tree was constructed to estimate costs based on the 2 implant choices. Values for critical variables, such as implant removal rate, were obtained from the literature. A Monte Carlo simulation consisting of 100,000 trials was used to incorporate variability in medical costs and implant removal rates. Sensitivity analysis and strategy tables were used to show how different variables influence the most cost-effective strategy.

Results: TBW was the most cost-effective strategy, with a cost savings of approximately $1300. TBW was also the dominant strategy by being the most cost-effective solution in 63% of the Monte Carlo trials. Sensitivity analysis identified implant costs for plate fixation and surgical costs for implant removal as the most sensitive parameters influencing the cost-effective strategy. Strategy tables showed the most cost-effective solution as 2 parameters vary simultaneously.

Conclusion: TBW is the most cost-effective strategy in treating Mayo IIA olecranon fractures despite a higher rate of return to the operating room.

Level of evidence: Level I; Economic and Decision Analysis

Keywords: Olecranon fracture; cost-effective analysis; tension band; plate fixation; Mayo IIA fracture; decision analysis; cost analysis

Elbow fractures are a common orthopedic injury, accounting for 7% of adult fractures. The olecranon process is involved in 40% of these elbow fractures.[25] The Mayo Classification is useful in describing displacement, stability, and

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comminution. Mayo II fracture describes a stable elbow with a displaced olecranon fracture greater than 3 mm with or without comminution. Because these fractures are intra-articular, ideal treatment must provide anatomic alignment with rigid fixation allowing early mobilization to prevent elbow stiffness.[27] Mayo II fractures are routinely repaired with tension band wiring (TBW) or plate fixation.

TBW is a technique that converts the extensor force of the triceps into a dynamic compression force along the articular surface, allowing for primary bone healing. The TBW technique is inexpensive and requires less operative time than plate fixation.[2] Although any implant around the elbow may be symptomatic, studies have shown higher rates of implant removal for TBW compared with plate fixation.[25,26]

The plate fixation technique compresses the fracture site through the plate, allowing for primary bone healing. Newer implants are precontoured and low profile, making them less prominent in the subcutaneous tissue. Plate fixation involves more expensive implants and a longer operative time than the TBW technique.[2]

Clinical outcomes have been excellent in both fixation techniques. Studies comparing clinical and functional outcomes of TBW and plate fixation have not shown superiority of one technique over the other.[2,13,16,25,26] In a survey sent to orthopedic surgeons, 78.5% of them preferred TBW for simple displaced fractures (Mayo IIA), and 81% preferred plating for comminuted displaced fractures (Mayo IIB).[28] Plating was not the preferred choice for simple displaced fractures because surgeons felt that there was increased surgical time with this technique. They also believed they had better clinical outcomes with TBW. Seventeen percent of surgeons avoided using a plate in simple displaced fractures because they felt that it was too expensive.[28] However, some surgeons advocate using plates for all displaced olecranon fractures because the rate of additional surgery is significantly higher in TBW, resulting in potentially higher overall costs.[21,28]

Surgeons are faced with a difficult decision whether to use a more expensive fixation device (locked plate) to minimize an additional operation or to use a less expensive fixation device (TBW), which has a higher rate of return to the operating room. The purpose of this study is to guide surgeons on making the most cost-effective decision in treating Mayo IIA olecranon fractures. We used decision analysis tools to determine the most cost-effective strategy, understand the most important parameters influencing this strategy, and learn how changing these parameters alters the cost-effective strategy.

Materials and methods

Study design

The economic decision analysis was conducted according to the guidelines set forth by the Panel on Cost-Effectiveness Analysis in Health and Medicine.[24] The reference case consists of healthy individuals aged 50 to 64 years who decide to undergo operative management for a Mayo IIA olecranon fracture in an ambulatory surgical center. Societal perspectives were used to analyze costs, which includes the cost to the health care industry and the patient. The time horizon was set to 2 years, which was the mean follow-up from our literature search.

Decision model

We built a decision tree for Mayo IIA olecranon fractures, which is shown in Fig. 1. The decision options include TBW or locked plate fixation. The outcomes for each decision include successful treatment, implant removal, loss of reduction, nonunion, and infection. Successful treatment indicates completion of treatment with no additional operations. In this model, a patient who decides to undergo an additional operation for loss of reduction or nonunion would undergo locked plating.

Not all surgical site infections required operative débridement. To simplify the decision tree, we assumed that these patients were successfully treated with oral antibiotics. This occurred less than 1% of the time in both the TBW group and locked plate group. These patients were included in the success outcome group. Patients who required operative irrigation and débridement for infection were placed in observation for 24 hours for intravenous antibiotics.

To account for societal costs, we incorporated potential loss of income and leisure time for each surgical procedure. The disutility times are listed in Table I. We used the median income from the United States Bureau of Labor Statistics to estimate this cost.[6]

Model inputs

The probability of each outcome in the decision tree was calculated by compiling data from previously published trials.[1-4,10-13,15-17,20,22,23,25,26] As shown in Fig. 1, the rate of additional surgery was approximately 40% for TBW and 20% for plate fixation. Because 86% of the patients undergoing plate fixation received locked plates in the studies used to build our decision model, we assumed a locked plate was the plate fixation choice in our decision model. Fig. 1 diagrams the probability of each outcome from the initial decision. We calculated the weighted standard deviation of implant removal. This allowed us to build variability in our decision model while running Monte Carlo simulations.

Total implant costs were estimated to be $2265 for locked plating and $35 for TBW. These costs are based from the listed national prices obtained by our DePuy-Synthes vendor. The itemized implant costs are shown in Fig. 2.

To calculate surgical costs, Census Bureau data were used to find the insurance payer mix for individuals aged between 50 and 64 years.[5] We estimated that 75% of these individuals have private health insurance, 20% have public health insurance, and the remaining individuals are uninsured. Payer mix places an important role in reimbursement rates. The Centers for Medicare and Medicaid Services publishes reimbursement rates for ambulatory operations and surgeon fees.[7,8] Anesthesia costs were also calculated according to a Centers for Medicare and Medicaid Services payment formula.[9] Because plate fixation requires a longer operation, this additional cost was reflected in an increase in anesthesia costs. We assumed fixed costs for the ambulatory surgical center and no loss of opportunity cost by choosing plate fixation over TBW. In this model, patients being treated for infection were placed in observation, which has additional associated costs.