The purpose of this study is to determine whether operative time for primary total knee arthroplasty can be decreased with the use of a continuous barbed suture. Five hundred patients were retrospectively reviewed and divided into groups based on whether incision closure utilized a continuous barbed suture or an interrupted biodegradable suture. We identified additional variables to determine their relationship to operative time, including body mass index, age, gender, and side of replacement. The results demonstrated a decrease in operative time by an average of 4 minutes (P < .001) with the use of barbed suture, without an associated increase in complications. Statistically significant relationships were found between operative time and variables such as body mass index, age, and gender, but not side of replacement.

ABSTRACT

The purpose of this study is to determine whether operative time for primary total knee arthroplasty can be decreased with the use of a continuous barbed suture. Five hundred patients were retrospectively reviewed and divided into groups based on whether incision closure utilized a continuous barbed suture or an interrupted biodegradable suture. We identified additional variables to determine their relationship to operative time, including body mass index, age, gender, and side of replacement. The results demonstrated a decrease in operative time by an average of 4 minutes (P < .001) with the use of barbed suture, without an associated increase in complications. Statistically significant relationships were found between operative time and variables such as body mass index, age, and gender, but not side of replacement.
As the demand for total knee arthroplasty rises and the need for more judicious use of health care finances increases, innovative surgical options will be utilized to help decrease operative time, which can be considered one of the most costly aspects of surgical procedures. A well-approximated closure with careful soft tissue handling is a time-intensive and essential portion of an arthroplasty procedure that is imperative to decreasing wound drainage and other postoperative complications that are predictors of major subsequent surgery. The use of continuous, bidirectional, self-retaining barbed sutures allows a knotless closure that has the proposed advantages of decreasing surgical time and the number of sutures necessary while controlling and distributing tension across the entire length of the wound. Barbed sutures may provide a method to safely decrease operating room time and thus expenses.

Barbed sutures have been utilized by other specialties to provide a cosmetic and time-efficient incision closure that has demonstrated decreased operative times without further soft tissue or wound complications. To our knowledge, no study has clinically compared knee arthroplasty closure with the use of running bidirectional barbed suture versus the more traditional interrupted suture.

The objective of this study was to compare primary total knee incision closure time with the use of continuous barbed versus biodegradable interrupted suture. We also set out to determine if additional variables such as age, gender, body mass index (BMI), and side of operation have an effect on operative time. We hypothesize that barbed suture will decrease operative time with no appreciable increase in postoperative complications and that increasing BMI will result in longer surgical procedures.

### MATERIALS AND METHODS

Institutional review board approval was obtained prior to proceeding with this study. We retrospectively reviewed 500 primary total knee procedures using the same implant performed by one fellowship trained surgeon (JP) with 10 years of experience. The first closure group began in June 2008 and consisted of 250 total knees in which #2 Quill suture (Angiotech Pharmaceuticals, Inc., Reading, PA) was utilized for closure of the medial patellar arthrotomy, the subcutaneous tissue was closed with 0 Quill suture and a running 4-0 monocryl for the final skin layer (Figs. 1 & 2). The preceding closure group consisted of 250 total knees, which were closed with interrupted biodegradable sutures consisting of #2 Ticron for the retinaculum, 0 Vicryl for the subcutaneous fat, and running 4-0 Monocryl for the skin. Operative dictations as well as anesthesia and nursing records were reviewed to determine tourniquet time as an indicator of operative time, body mass index, gender, side of operation, and
any postoperative procedures that subsequently followed the initial arthroplasty procedure. We elected to use tourniquet time to define the operative time of each case due to its reliability in being recorded at the same point of the procedure in that it is inflated just prior to incision and deflated just following skin closure and is thus a consistent time interval to measure.

RESULTS

We retrospectively reviewed 500 primary total knee procedures and divided them into 2 groups based on suture closure. The mean patient age in the barbed suture group and biodegradable interrupted suture group was 67.12 years and 65.52 years, respectively. With regard to operative time, barbed suture demonstrated a mean time of 64.3 minutes compared with 68.1 for the interrupted closure, which was found to be statistically significant ($P < 0.001$) (Figs. 3 & 4). These results were then stratified with the use of a hierarchical regression model to determine how much each factor affected operative time and showed that an additional 3.4% of the variance in operative time could be explained by adding suture type to the model.

Barbed sutures have been described in orthopaedic literature as early as the 1960s, when McKenzie studied the use of a nylon-based barbed suture in cadaver tendons that would enable repair with a minimum of suture material and surface damage with the hope of providing a strong, adhesion-free repair. Employing an animal model, he noted that the repair was “mechanically equal”
Evaluation of Primary Total Knee Arthroplasty Incision Closure with the Use of Continuous Bidirectional Barbed Suture

STEPHENS/ POLITI/ TAYLOR

Evaluation of Primary Total Knee Arthroplasty Incision Closure with the Use of Continuous Bidirectional Barbed Suture

To a repair using stainless steel. Even with promising results, interest in this suture diminished in the following decades due to the limitations in biomaterials and suture configurations.

With advances in technology, recent literature has returned to the idea of utilizing barbed suture for incision closure. Most of the current literature for the applications of this technique can be found in other specialties, such as plastic surgery, dermatology, general surgery, and urology. Warner recently reported on the use of Quill barbed suture for the closure of abdominoplasty in 58 patients. They demonstrated a marked reduction in closure time from previously stated interrupted progressive tension closures and had only one seroma that resolved uneventfully with no hematomas, skin necrosis, or revision procedures. This paper concluded that it can be used as a safe and effective way to diminish operative time.

Demyttenaere et al. evaluated a randomized control trial comparing laparoscopic barbed suturing in animals and demonstrated adhesion scores, burst strength pressures, and histology scores that were similar to controls. They concluded that barbed suture significantly reduced laparoscopic suturing time in the gastrointestinal tract.

Murtha randomized 188 patients and evaluated bidirectional barbed suture for dermal closure of Pfannenstiel incisions and demonstrated similar cosmesis, infection, dehiscence scores, and closure times. Moran demonstrated faster anastomotic times with the use of bidirectional barbed sutures in the use of robotic vesicourethral anastomoses. Barbed suture uses have even begun to emerge for minimally invasive cosmetic procedures involving facial laxity, but the data involving longevity, patient satisfaction, and potential side effects is limited.

The application of self-retaining sutures had returned to orthopaedic surgery in 2009, as Trochica compared flexor tendon repairs in cadaveric models using barbed suture versus more traditional nonabsorbable suture and noted that the barbed suture tensile load to failure was found to be equal but was not statistically significant; failure of the barbed suture occurred entirely by pullout.

A recent cadaver biomechanical study compared interrupted suture with bidirectional, barbed suture for closure of knee arthroplasty. No sutures ruptured in 2000 knee flexion cycles. The sutures were then sequentially cut, and the knee arthroplasty closed with the barbed suture survived significantly more cuts compared with the closure with interrupted sutures. They concluded that an arthroplasty closure could be maintained equally well with barbed suture through cyclic loading and that barbed running suture would tolerate greater damage than the interrupted repair. The former claim refuted some of the concerns that disruption of the barbs may diminish the effectiveness of the suture if not handled properly.

In addition to suture technique, patient factors can determine the length of an operative case. Morbidly obese patients have demonstrated increased rates of perioperative complications including problems with wound healing and infections. These patients typically need larger incisions due to a significant amount of soft tissue and the need to safely mobilize it. Wong demonstrated a linear relationship between obesity and wound complications. Obesity (BMI > 30) has been associated with increased short- and long-term wound complications as well as the necessity for alterations in operative technique for soft tissue closure and protection of medial ligament structures demonstrating the increased attention needed for closure in obese patients.

Our study demonstrated a significant decrease in surgical time with the use of continuous bidirectional barbed suture, saving approximately 4 minutes of operative time (P < .001). This supports our hypothesis that the use of bidirectional barbed suture could help decrease surgical time compared with traditional interrupted closure. Although it did not reach significance due to low power, it was also noted that there were fewer revisions and complications noted in the barbed suture group. Additionally, we demonstrated positive correlations between operative time and BMI, signifying an increased difficulty in surgical procedures involving obese patients. Other factors such as age and gender resulted in a negative correlation with younger male patients demonstrating increased operative time. The clinical implications of this are unclear and may be a result of the fact that younger male patients presenting for total knee arthroplasty as a treatment option may have more significantly advanced osteoarthritis and malalignment, which has been previously described in the literature.

Our study does offer some limitations. We are unable to determine if there is a statistical difference in postoperative complications because these events are rare and occur frequently with longer-term follow-up that was not present with the barbed suture group, which the surgeon began using in June 2008. However, it should be noted that barbed suture is biodegradable and dissolves within 3 months, and it is doubtful that it has a lasting effect on soft tissue. In addition, we were unable to consecutively record tourniquet times for patients directly preceding and following the change to this newer suture technique due to the fact that not all cases recorded tourniquet time. Decreasing the time interval during which the patient population was collected would help to eliminate the assumption that operative time was decreased as a result of increased experience by the surgeon and assisting staff, though the surgeon had been in practice a significant amount of time before this study was begun, and it is unlikely that adding patients from a few months before and after the transition to a new suture would have such a significant difference.

CONCLUSION

The results of this study demonstrate a significant decrease in operative time with the use of continuous barbed sutures, with no clear increase in postoperative complications requiring a return to surgery. Additionally, we demonstrated a positive correlation between BMI and operative time, demonstrating the need for surgeons to factor this variable into surgery time and difficulty. Bidirectional continuous barbed sutures provide an efficient and safe knee arthroplasty closure that offers a financial benefit in the form of decreased operative time and suture use. We feel barbed sutures offer an intriguing possibility for decreasing...
operative room time, but longer follow-up and prospective studies will be needed to determine the long-term efficacy and results of this closure technique.

ACKNOWLEDGEMENT

We would like to thank Dr. Darrell Spurlock for his contribution of statistical analysis to this paper.

AUTHORS’ DISCLOSURES

The authors did not receive any outside funding or grants in support of their research or preparation of this work. Neither they nor any member of their immediate families received payments or other benefits or a commitment or agreement to provide such benefits from a commercial entity.

REFERENCES