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Chapter 9

New Methods of Amputation

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Abstract

After reviewing new innovations in amputation, specifically bone anchored prostheses, we describe our experience with a new surgical dissection technique in above knee amputations. Although the technique of osseointegrated prostheses is relatively new and the results of larger clinical trials are still pending review, the concept represents a promising development in the rehabilitation of individuals with transfemoral (and potentially other forms of) amputation, resulting in improved ambulation and comfort, decreased skin problems, and an overall increase in quality of life. Furthermore, in regard to surgical dissection during amputation, muscle transection through standard electrocautery can be time consuming and bloody. Therefore, we compared electrocautery to the linear cutting stapling device (LCS) in the setting of above knee

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amputation (AKA) to see if the LCS decreases surgical time, blood loss, transfusion rates, and complications. Through retrospective review of AKA cases over a 10-year period, cases performed using electrocautery were compared to cases performed with the LCS. At a mean follow up of 45.3 months, the 11 LCS cases had decreased mean blood loss (302cc versus 510cc), decreased mean transfusion rates (1.55 units versus 2.15 units), and decreased mean surgical time (97min. versus 119min.) when compared to the 13 electrocautery cases. The differences in blood loss and surgical time trended toward, but did not achieve, statistical significance. Complications and revision surgeries were similar between the two groups. In skeletal muscle transection, the linear cutting stapler is a viable and cost effective technical alternative to electrocautery, likely resulting in less blood loss and shorter surgical time, with similar rates of complications.

Review of Osseointegrated Technology

Today the most common method of attaching an above-knee prosthesis to a residual limb is by means of a prosthetic socket, often with suspensory devices to retain the socket when not load-bearing. Although this mode of attachment has been used for over a century, problems of pain in the residual limb, increased energy expenditure with ambulation, discomfort when sitting, and skin breakdown often arise [1,2]. These sockets are hot, heavy, and can cause skin blisters. High pressure applied from the prosthetic socket to the soft tissue of a residual limb that is not adapted to tolerate this load has been suggested as the cause of pain and skin breakdown [1,2]. In addition, some residual limbs are too short to support the use of a conventional socket. Since very little force is put on the residual femur with current socket technology, the bone becomes brittle and the surrounding muscles often atrophy. In part to overcome these problems, a new surgical technique for above-knee amputations has been developed allowing a prosthesis to be directly anchored to bone via an intramedullary implant. This technique, termed “osseointegration,” has been used in dentistry for over 40 years in dental implants and fixtures [3]. It is defined by direct anchorage of an implant by the formation of bony tissue around the implant without the formation of fibrous tissue at the bone-implant interface [2,3]. Osseointegration for orthopaedic use was first developed in Sweden by Per-Ingmar Branemark in 1990 [3]. He discovered that implants made of commercially pure titanium allowed for bone ingrowth and thus stable anchorage of an implant. While the scientific basis of osseointegration is not completely understood, it has been shown that there is a relationship between pure titanium and bone that promotes activation of osteoclasts and osteoblasts resulting in bone remodeling [2,3].

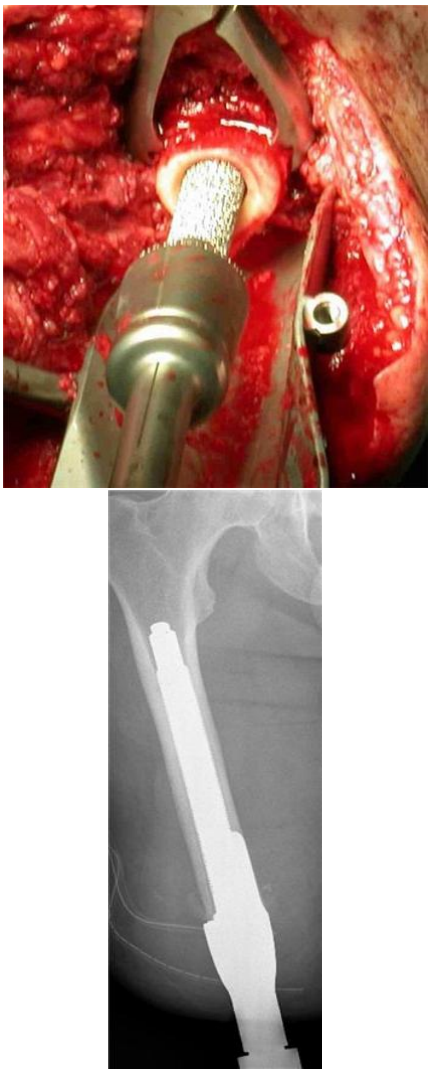

Figure 1. (a) Intramedullary component of ESKA Endo-Exo^{TM} osseointegrated above knee prosthesis (b) being implanted into femoral stump. (c) Postoperative anteroposterior radiograph of residual femoral stump with intramedullary component in place.

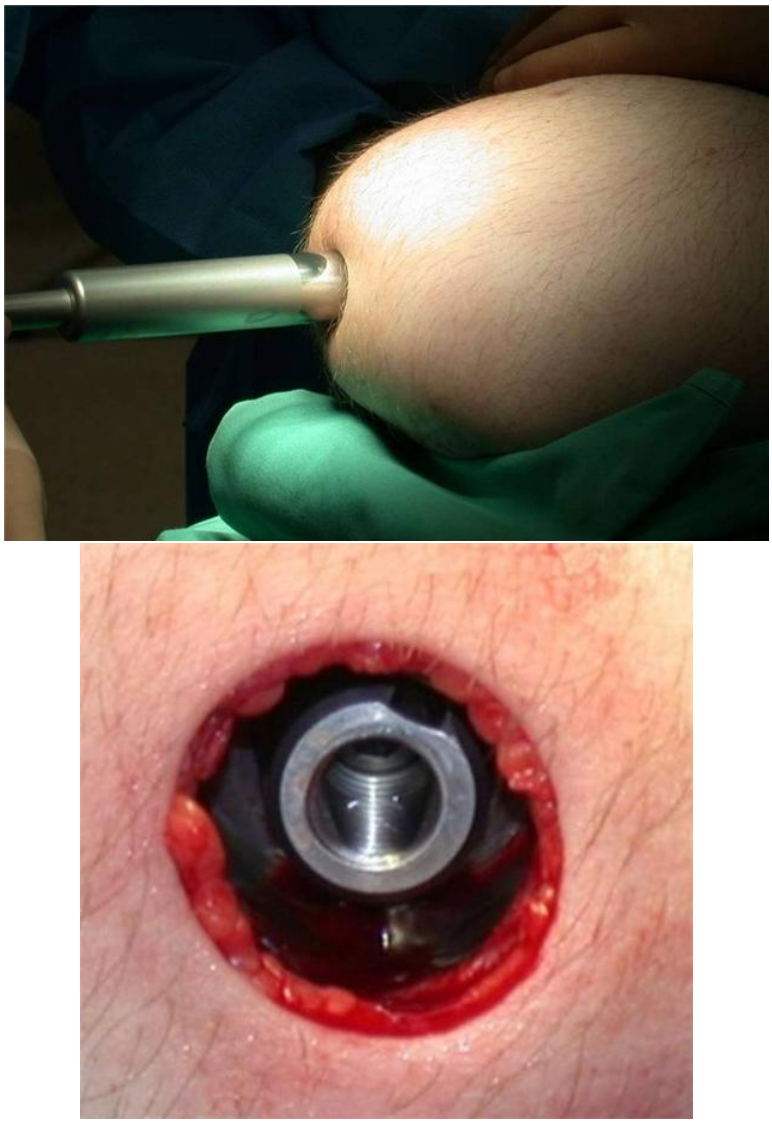

Figure 2. (a) A punch device is used in the second surgery to (b) expose the intramedullary component after 8-10 weeks of healing.

The surgical procedure for the osseointegrated prosthesis is performed over the course of two operations. During the initial stage, the femur is prepared with reamers and a press-fit intramedullary titanium stem is implanted directly into the residual femoral stump (Figure 1). A minimum length of 16 cm of femoral stump is required. A support sleeve is used to strengthen the lower end of the femoral stem depending on the weight and degree of activity of the patient. For activities such as riding, skiing, and weight training (bodybuilding) a support sleeve with flap is highly recommended as supplemental support. After the implant has been inserted, the wound is closed and a growing-in phase of approximately 8-10 weeks follows during which the patient only has restricted use of his/her existing external prosthesis. A second surgery is then performed in which a special device is used to punch through the skin of the stump in order to create an opening directly under the medullary canal where the

first device was implanted (Figure 2). A coupling device (abutment) is attached to the intramedullary implant and its distal end protrudes through the soft tissue of the stump to provide for attachment of the external prosthesis (Figure 3). The abutment is then linked to an adapter consisting of a conic sleeve and rotation disk allowing any standard knee-lower leg prosthesis system to be connected to the internal device (Figure 4).

To date, there are over 80 transfemoral amputees world-wide who have been fitted with transfemoral osseointegrated fixation and efforts are underway to expand the use of this device to the U.S. [3,6,7]. In addition to alleviating the skin problems and residual limb pain, studies have shown that amputees using transfemoral osseointegrated prostheses have greater range of hip motion and better sitting comfort compared to those using a socket-type prosthesis [4,5]. They can walk further and be more active than when using a conventional prosthesis and have improved sensory feedback through "osseoperception" [4,6]. This leads to a better result with respect to load transfer and guidance of the prosthesis. External components of the prosthesis can be attached and detached from the abutment easily and the alignment is preserved. Factors such as steroid medication or anti-tumor chemotherapy which may interfere with bone healing; heavy smoking or diabetes which may increase risk of bone sepsis; and body weight in excess of 100 kilograms have been suggested as relative contraindications to the fitting of lower-limb osseointegrated prostheses [6].

As this method is very new, there are few studies in the current literature. Osseointegration has been used in Europe since 1990 and all studies reviewing this technique are from the United Kingdom, Germany, and Sweden. The group in Germany evaluated their results of 30 cases that were operated between 1999 and 2008 with the ESKA Endo-Exo™ implant (ESKA America, Braselton, GA) which consists of an intramedullary femur prosthesis with a Spongiosa™ metal-configurated relief surface which when implanted cementless, allows for bone ingrowth and enables secure osseointegration allowing direct transmission of muscle power to the lower leg prosthesis. They showed that a minimum length of 16-18 cm and sufficient soft tissue coverage of the femur stump is needed. Drainage at the perforation point of the implant through the soft tissue sleeve was noted in some patients, but these problems were easily handled nonoperatively and did not necessarily provoke an intramedullary infection. This problem was avoided in the majority of patients. In terms of function, patients were more satisfied and had less complications in the longer term with the osseointegrated prosthesis [7,8].

This technique has also been used at the University of Gothenburg in Sweden by Dr. Branemark and colleagues who report the results of their first 18 consecutively treated patients (8 male/10 female, mean age 45 years) in a clinical investigation with amputations mainly caused by trauma and tumor [9]. At inclusion the mean time since amputation was 15 years (10 months - 33 years). Two self-report questionnaires were answered preoperatively and at follow-up: the SF-36 Health Survey (SF-36) and the Questionnaire for persons with a Transfemoral Amputation (Q-TFA). At follow-up, 17 of 18 patients used the osseointegration prosthesis; one patient did not respond due to pain and loosening of the implant. Four of the scales of the SF-36 (Physical Functioning, Role Functioning Physical, Bodily Pain and Physical Component Score) and all four scores of Q-TFA (Prosthetic Use, Prosthetic Mobility, Problems and Global Health) were statistically significantly improved showing superior general physical health, increased prosthetic use, better prosthetic mobility, fewer problems, and a better global amputation situation in the osseiointegrative group. In a later study in which this group reviewed their first 39 patients with osseointegrated implants for

infectious complications, they found an overall 18% infection rate at a mean followup of 56 months [10]. Most implant infections had low infectious activity and in the majority of patients prosthetic use was not affected. Despite frequent colonization around the skin-implant interface the titanium implant system for bone-anchored prostheses caused few infections leading to disability or implant removal [10].

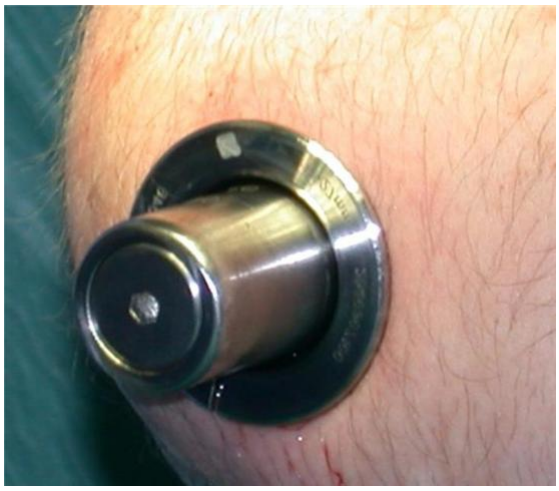

Figure 3. Abutment placed into intramedullary component which will link to external prosthesis.

Figure 4. Patient with osseointegrated prosthesis and external prosthesis.

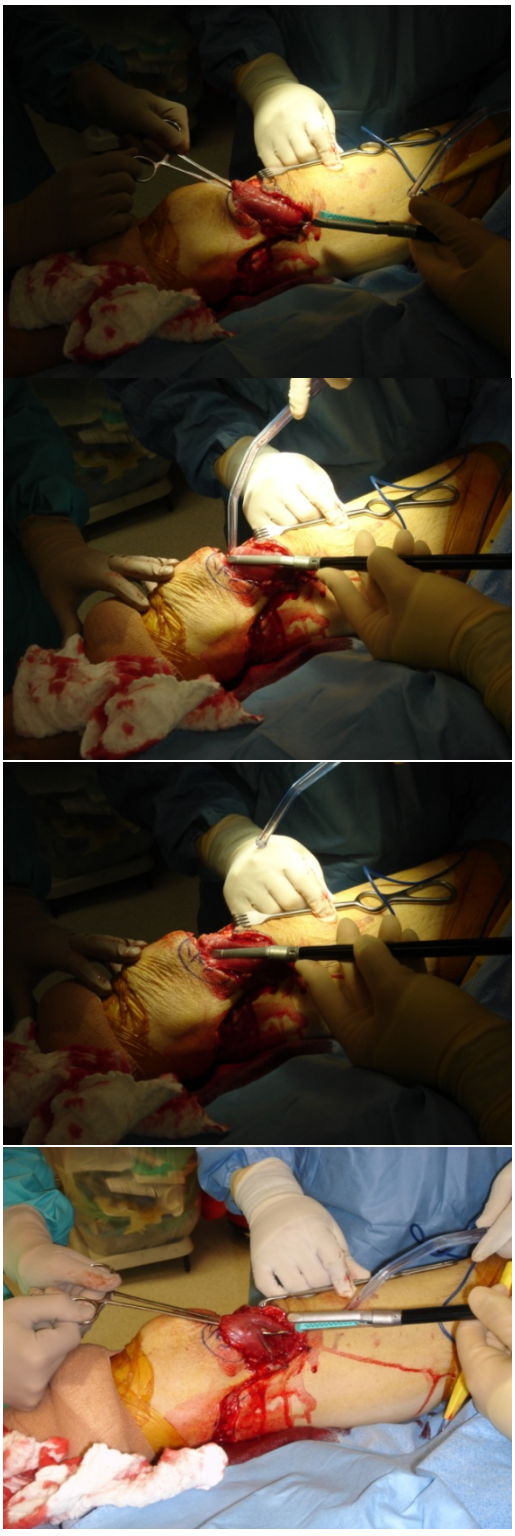

Figure 5. These pictures illustrate the linear cutting stapler technique (a, b, c, d).

Muscle Dissection in above Knee Amputation

Skeletal muscle is a dense soft tissue that is so vascular that it is often transferred to vitalize areas of poor blood supply [12]. Traditional techniques of muscle dissection include sharp dissection with scalpel or scissors, blunt dissection with spreading instruments, and electrosurgical dissection. Advantages of sharp and blunt dissection include speed and accuracy, at the expense of lack of hemostasis and tissue damage. The Bovie may also be accurate, but is time consuming, poorly hemostatic, and causes local tissue damage, necrosis, and delayed wound healing as confirmed by light microscopy [21,22].

The thigh contains more skeletal muscle mass per cross sectional area than any other segment of the body [19]; therefore, above knee amputation (AKA) represents an ideal surgery through which to analyze methods of skeletal muscle transection. AKA remains the salvage procedure for surgeons dealing severe or intractable cases of vascular disease, trauma, infection, and malignancy. Over 60,000 major lower limb amputations are performed in each year in the United States [15]. Speed of procedure remains an important variable in any surgery, and in the Civil War, well trained surgeons could perform lower extremity amputations in under ten minutes—often at the expense of blood loss, wound healing, infection, and a mortality rate of 28-52% [14]. Today, in academic centers and in the community, amputations are performed with similar goals of expedition, but with a greater eye toward control of blood loss, soft tissue preservation, and uneventful wound healing. Increased surgical times are associated with costs over 60 dollars per minute [18]. Contamination rates of open surgical trays have been shown in increase significantly in at least 15 minute intervals [13]. Blood loss is associated with significant financial cost, as well as medical risks of transfusion reaction, increased intensive care unit and hospital stays, increased infection rates, and a 1.2:100,000 chance of hepatitis C viral transmission [16,20,24].

Therefore, a new technique serves to improve the blood and time consuming problems associated with traditional muscle dissection. The linear cutting stapler (LCS), traditionally used for visceral transection and anastamoses, clamps soft tissue and sharply cuts while ligating the margins with small, fine staples. The LCS can transect large areas of muscle with speed and near complete hemostasis. Disadvantages of this technique include decreased accuracy of dissection, need for technical expertise, and inaccessibility in tight areas. A thorough literature search revealed only two articles regarding the use of the LCS for muscle dissection—both of which focused on technique, not comparisons with current technique or outcome. They anecdotally state that this LCS technique for muscle transection is feasible, reduces operative time, and does not increase complications, but give no real data [17,23].

We are the first to investigate the use of the LCS as the primary means of muscle transection in direct comparison to standard electrocautery. We ask if the LCS technique reduces surgical time and blood loss in this regard. We also ask if the LCS has an effect on transfusion rates and overall complications.

Table 1. Patient Characteristics and Data

Age / Sex	Diagnosis	Comorbidities	Surgical Time (min)	EBL	Units PRBC	Complications	Revision Surgeries
Bovie							
83 M	Tibia Osteomyelitis --> Squamous Cell Carcinoma	DM, HTN	100	75	2	Phantom Limb Pain (PLP)	None
87 F	Soft Tissue Sarcoma	PVD, HTN	105	112.5	0	None	Recurrence
64 F	Soft Tissue Sarcoma	DM, T4	75	350	2	Wound drainage	I&D & Revision AKA
67 F	Total Knee Arthroplasty Infection	None	115	137.5	2	None	None
71 F	Soft Tissue Sarcoma	None	105	500	0	Femoral Stump Metastasis	Hip Disarticula-tion
29 M	Knee Endoprosthesis Infection	None	224	3000	15	PLP, Stump Overgrowth	Bone Revision
44 M	Tibia Osteomyelitis	DM	153	400	2	None	None
24 M	Knee Endoprosthesis Infection	None	82	500	2	PLP	None
26 F	Knee Endoprosthesis Failure	HTN	80	100	0	None	None
64 M	Soft Tissue Sarcoma	None	72	100	0	None	None
75 M	PVNS + Total Knee Arthoplasty Infection	None	207	310	0	Severe PLP	PVNS Excision
48 M	Soft Tissue Sarcoma	None	82	350	0	Severe PLP/Neuroma	Neuroma Excision
51 M	Distal Femur Osteomyelitis	HTN	144	700	3	None	None
LCS							
72 F	Soft Tissue Sarcoma	HTN, CAD, PPD+	88	250	1	PLP	None
32 M	Soft Tissue Sarcoma	?	120	550	1	PLP	None
82 F	Lymphoma + Distal Femur Osteomyelitis	CAD, HTN, HCE, T4	96	150	0	Infection	I&D & Revision AKA
62 M	Osteosarcoma	HTN, HCE, gastritis	77	150	2	None	None
51 F	Soft Tissue Sarcoma	HTN, asthma, migraines	95	250	2	Deep Infection, PLP	I&D & Revision AKA
48 F	Squamous Cell Carcinoma	Obesity	94	450	5	Wound Necrosis	Hip Disarticulat ion
47 M	Tibia Osteomyelitis	None	90	100	0	None	None
67 F	Total Knee Arthroplasty Infection	ESRD, HTN, CAD, DM, obesity	92	500	2	Mild PLP	None

Table 1. (Continued)

Age / Sex	Diagnosis	Comorbidities	Surgical Time (min)	EBL	Units PRBC	Complications	Revision Surgeries
36 M	Soft Tissue Sarcoma	None	126	400	0	Severe PLP, Neuroma	Neuroma Excision
70 F	Soft Tissue Sarcoma	Bleeding D/O, Breast Ca, HCE	77	125	0	Mild PLP	None
48 F	Knee Endoprosthesis Infection	Morbid Obesity	110	400	4	Wound Dehiscence	I&D & Wound Vacuum

Abbreviation footnote:

Bovie = electrocautery, LCS = linear cutting stapler, PVNS = pigmented villonodular synovitis, DM = diabetes mellitus, HTN = hypertension, PVD = peripheral vascular disease, T4 = hypothyroidism, CAD = coronary artery disease, HCE = hypercholesterolemia, ESRD = end stage renal disease, PLP = phantom limb pain, I&D = incision and drainage, AKA = above knee amputation

Materials and Methods

We retrospectively reviewed above knee amputation cases over a ten year period and compared two groups: one group in which muscle dissection was performed primarily with electrocautery and another group in which muscle was dissected primarily with the LCS. We compared the two groups in regard to surgical time, blood loss, transfusions, and complications. No power analysis was performed initially (see discussion for the posthoc power analysis). We reviewed all consecutive surgical cases performed by a single musculoskeletal oncologist, at a single hospital, between August 14th, 1998 and August 6th 2007. Cases in which AKA was performed were included in the study; we excluded cases in which other time or blood consuming procedures were concurrently performed. The indications for AKA included malignancy, intractable infection, and failure of previous limb sparing procedure. Contraindications included patient refusal and ability to perform limb salvage. Of 30 consecutive AKA cases that met the inclusion criteria, 6 were excluded because other time or blood consuming procedures were concurrently performed. A total of 24 cases constituted the study, 13 performed with electrocautery and 11 with the LCS. Age, gender, reason for amputation, and medical comorbidities were similar between the two groups (Table 1). Average follow up was 45.3 months, 71.3 months for the electrocautery group (range 14 to 112 months) and 14.6 months for the LCS group (range 4 to 33 months). No patients were lost to follow up. The study was approved by our institution's Investigational Review Board.

The AKA procedure was performed without tourniquet. A scalpel was used to incise the skin in a "fish mouth" fashion with equal anterior and posterior flaps at the appropriate level in regard to local soft tissue viability and the level of necessary osteotomy. Subcutaneous tissues and underlying fascia were dissected in line with the skin incision with electrocautery. Muscle was transected from anterior to posterior as it was encountered. In the electrocautery group, muscle was transected using electrocautery in both cut and coagulation modes. In the LCS group, muscle was transected primarily using the EZ-45 Gastrointestinal Anastamosis (GIA) stapler (Ethicon Endo-surgery, Cincinnati, OH) as shown (Figures 1A, 1B, 1C, 1D). The superficial femoral artery and vein were ligated with suture ligatures, stick ties, and

hemo-clips. The bone was osteotomized with an oscillating saw. The sciatic nerve was tied off with a suture ligature as proximally as possible and then transected sharply at this level. Adductor myodesis was routinely performed. Bone wax was placed over the distal femoral canal, and a drain was placed, with overlying layered closure of the fascia, subcutaneous tissue, and skin. The wound was dressed and wrapped with a compressive dressing. Postoperatively, physical therapy was initiated on postoperative day 1 for mobilization and prone rests to prevent hip flexion contracture. Patients were followed in clinic on weeks 1, 2, 6, 12, and then every three months for the first two years.

The data was collected in regard to surgical time, blood loss, transfusions, and complications (Table 1). Surgical time was determined by subtracting the time "surgery end" from "surgery start" (skin-to-skin time) as recorded by the anesthesiologist in the anesthesia record. Blood loss was determined as an average of the surgeon's and anesthesiologist's estimate of blood loss: the surgeon's estimate of blood loss was taken from the dictated operative note, and the anesthesiologist's estimate of blood loss was taken from the transcribed anesthesia record. The anesthesia record and hospital chart were reviewed for blood transfusions given during the surgery and associated inpatient stay. Complications were determined by a thorough review and the hospital chart for intra-operative and acute postoperative complications and the clinic chart for delayed postoperative complications. Complications were defined as adverse events requiring surgical intervention.

The outcome variables were entered into an Excel (Microsoft Corporation, Redmond, WA) spreadsheet, where means and standard deviations were calculated. The average surgical time, blood loss, transfusions, and complications of each group were then analyzed with the two group t-test to determine statistical differences between them. Rates of major complications between groups were compared by t-test and chi-square test. All statistical tests were two-sided and statistical significance was defined as $p \leq 0.05$. Statistical software SAS (SAS Institute INC., Cary, NC, USA) and MedCalc (MedCalc Software, Broekstraat 52, Belgium) was used for the data analysis.

Table 2. Results Summary

Outcome Measure	Bovie Group	LCS Group	Difference with LCS (%)	p-value
Mean EBL (cc)	510.4	302.3	-208.1 (-40.8%)	0.39
Mean Surgical Time (minutes)	118.8	96.8	-22 (-18.5%)	0.18
Mean Transfusions (units)	2.15	1.55	-0.6 (-28.0%)	0.65
Complications	6/13	5/11	~ (-0.7%)	0.98

Abbreviation Footnote:
EBL = estimated blood loss, cc = cubic centimeter, Bovie = electrocautery, LCS = linear cutting stapler

Results

With current documenting techniques, "skin to skin" surgical times as documented on the anesthesia record are a reliable method of calculating surgical times. Averaging the surgeons's and anesthesiologist's estimate of blood loss helps to obtain a standardized as well as accurate measure. Transfusion needs are the final common denominator of blood loss, and are easily quantified through chart review. Complications requiring surgical intervention represent a clinically important outcome and also can be quantified with diligent chart review.

The mean surgical time for the electrocautery group was 119 minutes; the mean surgical time for the LCS group was 97 minutes. The LCS group had an average of 22 minutes (18.5%) decreased mean surgical time when compared to electrocautery (p=0.18). The mean estimated blood loss for the electrocautery group was 510.4cc; while for the LCS group, the mean was 302.3cc. Use of the LCS resulted in an average of 208.1cc (40.8%) less blood loss (p = 0.39) (Table 2).

The average units of blood transfused for the electrocautery group was 2.15 units, while for the LCS group, this average was 1.55 units. The LCS group had an average 0.6 unit (28.0%) reduction in transfusion when compared to the Bovie group (p = 0.65). We were unable to find a difference in the number of major complications between the two groups (p = 0.98). The electrocautery group had a mean major complication rate of 0.462 (6/13) and the LCS group's mean was 0.456 (5/11) (Table 2).

In addition to absolute number, the nature of these complications was similar between the two groups. In the electrocautery group, one patient developed wound drainage and was treated with incision and drainage and revision AKA, and two patients developed stump problems which required revision surgery (hip disarticulation and revision AKA). Five patients in this electrocautery group developed phantom limb pain, 2 of which were treated with revision surgery. One patient in this electrocautery group developed local recurrence which was treated with revision AKA and inguinal lymph node dissection. In the LCS group, two patients developed wound necrosis and dehiscence, both of whom were treated with revision surgeries (hip disarticulation and revision AKA). Also in this LCS group, two patients developed deep infection, both resolving after incision and drainage with revision AKA. Five patients in the LCS group developed phantom limb pain, one of whom required neuroma excision. All instances of phantom limb pain in each group resolved or were well controlled with medication or surgery (Table 1).

Discussion

We investigated a new technique for muscle dissection that may improve the problems of prolonged operative time and increased blood loss associated with traditional methods. In comparing the new LCS to the standard electrocautery, we looked for differences in outcomes of surgical time, blood loss, transfusions, and complications. In addition to statistical analysis of significance, we should also assign *clinically significant* values in regard to these outcomes. In regard to surgical time, we know that financial costs per minute are excessive, and contamination on surgical tables increases in at least 15 minute intervals [13,18]. The 22 minute (18.5%) difference is clinically significant in this regard. The Advanced Trauma and

Life Support guidelines categorize hemorrhagic shock according to amount of blood loss (Classes I –IV) [11]. In a 70 kg patient, 750cc represents the difference between the 4 classes of shock. One can then assume that an increment of 750cc of blood loss is clinically significant. Furthermore, in the case of a procedure with close to this amount of blood loss (510.4cc for the electrocautery group), any reduction that takes this blood loss safely out of this 750cc range can also be considered to be clinically significant; for example, a 250cc (50%) reduction in this case, which is very close to our 208.1cc (40.8%) difference in means. Since risks and costs associated with transfusion increase with each unit transfused, one can safely assume that 1 unit is a clinically significant increment, which is also close to the 0.6 unit difference found in our study. Our complications were defined as any adverse event requiring a surgical intervention, and as such, each unit of complication (a surgical intervention) can be deemed significant [16,20,24]. The mean differences in complications did not come close to one unit in our study, and therefore were both clinically, as well as statistically, insignificant.

The limitations of this study begin with the sample size. The elevated p-values associated with the large mean differences found in this study are likely due to limited numbers. Therefore, a posthoc power analysis was performed to determine the sample size needed to determine statistical differences / equivalences between the mean values of outcomes of these two groups. Set to an alpha level of 0.05 and a beta level of 0.20, the sample size needed to confidently assume our differences in surgical time and blood loss were not due to chance are 45 patients per group and 114 patients per group, respectively. Because of fervent attempts at limb salvage, AKA has become a procedure of last resort; therefore, fortunately, the cases at a single institution are limited. Finding a more common procedure with extensive muscle dissection or reproducing a multi-center study would increase the statistical power. The outcomes measured have inherent limitations. Recorded surgical times may be skewed by intraoperative delays that have nothing to do with the procedure itself (i.e., waiting for personnel, searching for equipment). Surgeons' and anesthesiologists' estimates of blood loss may be subjective and biased. The retrospective nature of the study also poses limitations. Though there was no loss to follow up or missing data, data recorded in the chart may not have been detailed or complete in regard to complications; moreover, retrospective studies, by nature, yield less control over outcome variables.

Only two articles regarding the LCS for muscle dissection were discovered through a thorough literature search. One article described the technique in the setting of radical neck dissection. This article did not follow a specific series of patients, but it did describe "no complications related to the stapler and reduced operative time" anecdotally in "approximately 150 cases [17]." The second article described use of the LCS in free muscle transfer to the face. The authors primarily describe technique, and briefly describe five cases which resulted in 100% flap survival and "non-problematic" staples at ten month follow up [23].

Our study similarly showed that use of LCS for muscle transection in AKA is a feasible technique. Unlike the previous studies, we supply data to support our conclusions of decreased surgical time and blood loss. The difference in mean surgical time was 22 minutes (18.5%) and in mean blood loss was 208.1cc (40.8%) in favor of the LCS. These differences in means are clinically significant and certainly trend toward statistical significance ($p = 0.18$, $p = 0.39$, respectively). The other studies did not comment on transfusion rates, and our clinically significant difference in transfusion rate of 0.6 u (28. 0%) in favor of the LCS

would likely be statistically supported by an increased sample size. In concurrence with the previous studies, the current study demonstrates no increase rate of complications in both t-test and chi-square analysis. The previous studies do not explore financial factors associated with the use of this new technology; and, in addition to the risks, the gains achieved with using the LCS must be weighed against the costs. Using the LCS as the primary means for muscle transection in AKA costs an estimated $1,000 to $2,000 in stapler and cartridge reloads. This cost must, in turn, be measured against the potential savings in decreased operating room time and blood loss. Given the assumption surgical time costs at least $63.39 per minute [18], 22 minutes of decreased surgical time saves $1,394.58 per case. The complications associated with increased blood loss and transfusion rates, such as increased ICU stays, hospital stays, infections, and complications, have additional economic value [16,20,24]. We must also consider that increased use of the LCS in extra-abdominal general and orthopedic surgeries will result in decreased cost of the device through economies of scale.

Conclusion

Of the new methods of surgical amputation , the most promising advances involve osseointegrative technology and new methods in the surgical transection of muscle. Although the technique of osseointegrated prostheses is relatively new and the results of larger clinical trials are still pending review, the concept represents a promising development in the rehabilitation of individuals with transfemoral (and potentially other forms of) amputation, resulting in improved ambulation and comfort, decreased skin problems, and an overall increase in quality of life [9]. In regard to muscle transection in amputation, the use of the linear cutting stapler is feasible and cost effective, likely resulting in decreased surgical time and blood loss, with no increase in complications.

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