Ertl amputation: CASE STUDIES AND DISCUSSION

The Ertl amputation technique has become a popular procedure for lower extremity amputations in this century. In 1920, Janos Von Ertl developed an amputation technique designed to improve both functionality and comfort with regard to below-knee amputations. His bone bridge design was meant to stabilize the fibula and increase the load bearing potential of the residual limb, thereby decreasing forces on the residual limb and increasing comfort. However, the technique has been used sparingly since its introduction. Ertl’s grandsons, Jan and William, have expanded its usage and further developed its principles over the past two decades. The technique is now used for above and below-knee amputations as well as some upper extremity amputations. Because of the popularity of internet communications, those who are in need of an amputation and desire to be as active as possible often seek out those who do the Ertl amputation. The Denver Clinic for Extremities at Risk has become an “Ertl amputation center” over the past 8 years and we have developed a comprehensive team approach for all of our amputation cases.

At the Denver Clinic for Extremities at Risk our reputation was built on saving limbs, with the goal of salvaging function. There are situations where amputation can offer a higher level of activity. For these patients, the Ertl amputation may be performed. We strive to not only return the patient to his or her previous level of activity, but also to return the patient to that state of function as quickly as possible.

In this quarter’s newsletter, three case reports of patients who have undergone Ertl amputations will be described. Following the three case reports, we will provide a brief discussion regarding the evaluation of our results for the first 50 Ertl patients, the principles of Ertl amputation surgery, and the future research plans seeking to evaluate outcomes of this procedure versus standard amputations.

Case Study #1

PHYSICIANS
David Hahn, M.D., Orthopedic Surgeon
Ross Wilkins, M.D., Orthopedic Surgeon
Raymond Blum, M.D., and Rebekha Gass, M.D.
Infectious Disease Specialists

HISTORY
LL, a 59-year-old male, was injured in September 1999 when he was broadsided while riding his motorcycle. He sustained a grade 3 open fracture to the tibia (figure 1) and was treated with debridement, a hybrid external fixator, and a skin reconstruction procedure. Six months after

(figure 1) Grade 3 open fracture to the tibia.
the accident his tibia became infected with MRSA and he was referred to the Denver Clinic for Extremities at Risk for consultation and management of an infected nonunion of the tibia.

CLINICAL EXAM

On examination by Drs. Hahn and Wilkins, there was radiologic evidence for an atrophic nonunion of the mid to distal one-third of the tibia. It was determined that the best surgical approach would be debridement, followed by placement of an Ilizarov frame (Taylor spatial frame) for bone transport, and IV antibiotics to control the infection. (figure 2)

TREATMENT

LL underwent a bone transport procedure in November 1999 and progressed well despite numerous obstacles. The nonunion healed, but he continued to have difficulty with ankle and subtalar joint pain and stiffness. (figure 3) In August 2001 he presented to Dr. Hahn to discuss options to address the problems with his stiff and painful hindfoot and ankle. He was most interested in a procedure that would allow better function than an ankle fusion. LL had heard about the Ertl amputation and discussed this with Dr. Hahn. After much review by Dr. Hahn, it was determined that the Ertl procedure was appropriate for the patient's needs. The patient was adamant that the Ertl procedure be given a try and in late 2001 he became the first Ertl below-knee amputation performed at the Denver Clinic. (figure 4)

LL healed uneventfully, was ultimately fit with a below-knee prosthesis, and underwent physical therapy to regain function. In July 2010, nine years after his Ertl procedure, obtained at that time and showed solid healing of the Ertl bone bridge. (figure 6) He has been able to return to all of his regular high level activities including trail running and hiking.

(options and requested an Ertl amputation.

WT's case was discussed at length at the Denver Clinic for Extremities at Risk weekly patient conference. Reconstructive options were presented and discussed but because of the extreme stiffness of his ankle and hindfoot complex, and the patient's stated goals, the clinicians in attendance agreed that an Ertl below-knee amputation would provide the best opportunity for the patient to meet his goals.

TREATMENT

WT underwent the Ertl amputation in November 2007. The length of the residual limb was 5 inches distal to the knee joint secondary to previous soft tissue considerations and damage. Hardware was placed to hold the Ertl bone bridge in place. He did exceptionally well other than having problems with the indwelling screw that imitated the distal end of his residual limb. He asked for the screw to be surgically removed which was accomplished in September 2008 nearly 10 months following his initial amputation. In November 2008 approximately 2.5 months after the screw was removed, WT ran the New York Marathon in 4 hours 40 minutes using his Cheetham prosthesis. (figure 8) WT returned to see Dr. Hahn in October 2009 for a routine follow-up appointment. X-rays were taken which refers to re-connecting terminal limb muscles in order to re-establish muscle tension, rather than myodesis, which refers only to reconnecting the posterior group to the anterior tibial bone, has seemed to contribute to the Ertl's success, as has the careful treatment of the severed nerves, arteries, veins and skin.

The examples above illustrate some of the excellent functional results that have been achieved with his technique. However, to attribute success to this technique itself would be short sighted. There have been several developments occurring over the past century that have contributed to the Ertl success story. Use of the Internet has increased awareness of the Ertl technique, developing the amputation team concept to include surgeons who specialize in doing the Ertl amputation, improving prosthetic technology, and better management of pain as all contributing factors to the Ertl's success.

At the Denver Clinic for Extremities at Risk we have now completed more than 50 such Ertl amputations. We started by doing only a very few patients who were healthy and active and who had requested the Ertl procedure. As we saw the excellent results and very satisfied patients, we began doing more Ertls so that now routinely patients needing a below-knee amputation because of failed reconstruction are offered an Ertl type of amputation. A series of clinical research studies is presently being planned in concert with both the University of Northern Colorado as well as the University of Colorado Medical Center in order to more precisely evaluate the results of Ertl amputations versus standard limb amputations to hopefully continue to improve amputation outcomes.

Discussion:

Although limb amputations have been performed for centuries, surgeons are continually seeking to improve patient function and comfort. As discussed earlier, Dr. Janos Van Ertl created the Ertl technique for this reason. His osteomyplastic principles of creating a bone bridge to stabilize the fibula and sealing the end of the tibia have created an end-bearing residual limb that can handle a prosthesis with more comfort and efficiency. The use of myodesis, which refers to re-connecting terminal limb muscles in order to re-establish muscle tension, rather than myodesis, which refers only to reconnecting the posterior group to the anterior tibial bone, has seemed to contribute to the Ertl's success, as has the careful treatment of the severed nerves, arteries, veins and skin.

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LL healed uneventfully, was ultimately fit with a below-knee prosthesis, and underwent physical therapy to regain function. In July 2007, nine years after his Ertl procedure, he was able to run with minimal pain when using his Cheetah prosthesis. Even though the patient received a chronic pain specialist, preoperatively to manage his pain issues are all contributing factors to the Ertl success. At the Denver Clinic for Extremities at Risk we have now completed more than 50 Ertl amputations to hopefully continue to improve outcomes. A series of clinical research studies is presently being planned in concert with both the University of Northern Colorado as well as the University of Colorado Medical Center in order to more precisely evaluate the results of Ertl amputations versus standard limb amputations to hopefully continue to improve outcomes.

**Case Study #3**

PHYSICIANS
David Hahn, M.D., Orthopedic Surgeon
Giancarlo Barolat, M.D., Neurosurgeon
Kevin Smith, M.D. Anesthesiologist
Conrad Tire, M.D. Plastic Surgeon

HISTORY
OE, a 40-year-old male, was injured by an EID in Iraq in May 2008. He sustained severe injuries to his sciatic nerve just proximal to the knee joint. The injury left him with limited lower extremity function and significant pain. He was permitted by the US Army to be treated by the DCER while on convalescent leave in September 2008.

CLINICAL EXAM
After discussing surgical options with Dr. Hahn, OE felt an amputation would give him the most function and allow him to return to active military duty. Significant surgical reconstruction options were discussed and not felt to be reasonable as far as the patient and other consultants were concerned. The consensus among the clinicians at the weekly Denver Clinic for Extremities at Risk patient conference was that an Ertl below-knee amputation with sciatic nerve grafting would provide the patient with the function he would require to return to active duty. The nerve grafting would provide sensation to the residual limb, allowing for safer prosthetic wear. The group also recommended that the patient consult with Dr. Giancarlo Barolat, a chronic pain specialist, preoperatively to determine if a spinal cord stimulator would help control his pre and postoperative pain. The IED injury to his sciatic nerve was producing severe neuropathic pain.

After consultation with Dr. Barolat, OE felt it was a trial stimulator would be of benefit to minimize phantom limb pain following the surgery. Dr. Kevin Smith would place the trial stimulator and Dr. Barolat would place the permanent one if the patient required this to continue his pain management.

TREATMENT
OE underwent the Ertl amputation procedure in November 2008. The residual limb was 6 inches distal to the knee joint secondary to previous soft tissue considerations and damage. Hardware was placed to hold the Ertl bone bridge in place. He did exceptionally well other than having problems with the indwelling screw that inititated the distal end of his residual limb. He asked for the screw to be surgically removed which was accomplished in September 2008 nearly 10 months following his initial amputation. In November 2008 approximately 2.5 months after the screw was removed, OE ran the New York Marathon in 4 hours 40 minutes using his Cheetah prosthesis. (figure 8)

At his 3-month follow-up visit, he reported being able to run with minimal pain when using his prosthesis. Even though the patient received significant pain relief with the stimulator, he decided against a permanent implant since he was able to manage his pain quite easily. A CT scan was obtained at that time to see how much healing of the Ertl bone bridge had occurred and 75% healing was noted. (figure 7) He then took in the office also confirmed the healing and good screw position. (figure 8)

OE has continued to do well. He has no difficulty with pain and had special prosthetics made so that he could participate in running, volleyball, and other competitive sports. At his 6-month follow-up in May 2009, he reported he had made the US military Para Olympic volleyball team, and by recent phone conversation continues to be actively employed by the US Army as a high ranking sergeant with minimal discomfort.

**Discussion:**
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Many patients experience pain after amputation surgery that may not diminish over time. Mechanical, phantom, residual limb and bodily pain is not uncommon after surgery. Ideally, the pain can be controlled and eliminated with oral medication. However, sometimes it is not enough and the patient continues to experience pain. Therefore, the Denver Clinic for Extremities at Risk has developed a prospective IRB-approved study to determine if spinal cord stimulation is a viable method of pain control for lower-extremity amputees who have failed conventional pain management. The study consists of a three week trial with a spinal cord stimulator. If the patient, in conjunction with their physician, determines that the spinal cord stimulator trial was successful at eliminating their pain, they may move forward with a permanent stimulator. For information about this study contact Katherine Pavlovsky, Clinical Research Coordinator, at 303-839-6294 or Katherine.pavlovsky@healthonecares.com.