

**JOIN THE
ARTAS GENERATION™**

A robotic revolution in speed, precision and accuracy.

ARTAS™
HAIR RESTORATION REDEFINED

A NEW GENERATION OF PERFORMANCE



The ARTAS® System enables physicians to harvest healthy follicular units in a minimally invasive procedure. Using sophisticated imaging technology and precision robotics, the ARTAS System dissects follicular units accurately and consistently, thousands of times in a single session. A proprietary dissection system and intelligent algorithms help physicians retain the natural appearance of the patient's donor area. The ARTAS System has received FDA 510(k) clearance and CE Marking certification.*

INNOVATIVE TECHNOLOGIES FOR THE RESULTS YOU EXPECT



High-resolution digital imaging
rapid, micron-level targeting accuracy



Image-guided robotic alignment
speed and precision beyond manual techniques



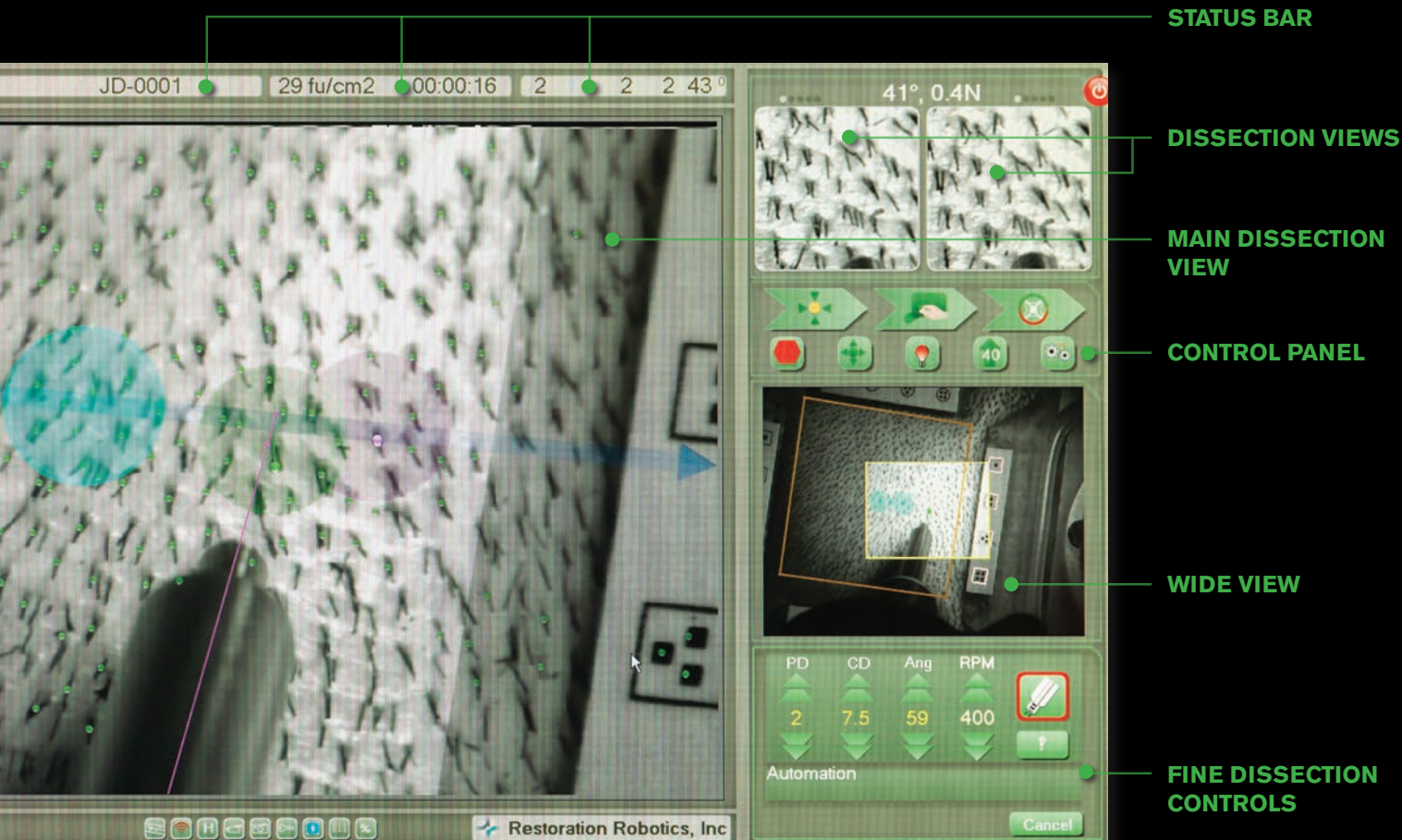
Minimally invasive dissection
delivers healthy, intact grafts with less visible harvest sites



Intuitive controls
shortens the learning curve and makes the procedure easier to perform

*Additional international regulatory clearances received or pending.

HIGH-RESOLUTION DIGITAL IMAGING



Main view displays hundreds of follicular units, tracking previous, current and next dissections.

- Visualizes the surface of the scalp in three dimensions with micron-level precision
- Maps coordinates, angle, orientation, and direction for each follicular unit
- Determines the density and distribution of follicular units
- Monitors and updates distinct parameters of each follicular unit 50 times per second

INTUITIVE CONTROLS



Physicians have a shorter learning curve and are in control at all times with the ARTAS® System's easy-to-use controls.

- Easy-to-control key parameters including puncture depth, coring depth, angle and speed
- Control via keyboard or patient-side pendant

IMAGE-GUIDED ROBOTIC ALIGNMENT



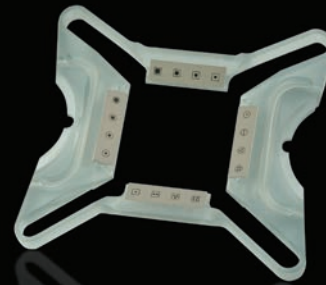
- High resolution visualization cameras provide input to dynamically maneuver the robotic arm
- Robotic arm can approach follicular unit at virtually any angle to control the needle alignment with micron-level precision
- Visual servoing dynamically compensates for patient movement
- Intelligent algorithms target follicular units to create natural-looking donor areas

MINIMALLY INVASIVE DISSECTION



TWO NEEDLE SYSTEM

- Consists of a sharp, bi-beveled inner needle nested inside an outer blunt dissection punch
- Inner needle scores the skin, then dissecting punch separates the follicular unit from the remaining tissue
- Delivers a healthy, intact graft with harvest site limited to size of the inner needle



SKIN TENSIONER

- Enhances dissection through uniform skin tension
- Fiducials define boundary of the surgical field

QUALITY, INTACT GRAFTS

- Low transection rate
- Generous amount of tissue around each follicular unit

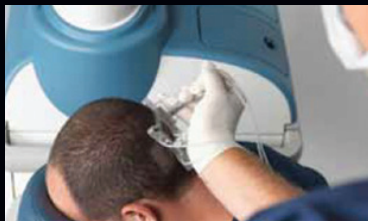


Actual harvested grafts

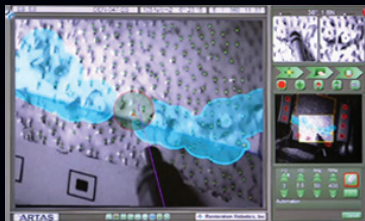


STEPS OF THE ARTAS® PROCEDURE

- Skin tensioner is placed on the trimmed donor area to keep the area taut
- High resolution visualization identifies follicular units on the surface of the patient's skin and targets them for harvesting
- Image-guided robotic arm maneuvers and deploys the two-needle system, compensating for patient movement
- Gentle suction lifts the dissected graft partially out of the scalp, so technician can remove using forceps
- Grafts are manually transplanted in the desired scalp areas



Tensioner is applied to scalp



System targets follicular unit at the appropriate angle



Two-needle system dissects a healthy, intact graft

EXPAND YOUR PRACTICE BY MEETING PATIENT DEMAND

Nearly 35 million men* are potential candidates for hair restoration in the United States alone.

THE ARTAS SYSTEM ENABLES YOU TO OFFER YOUR PATIENTS:

- Minimally invasive procedure
- Reduced treatment times
- Fast recovery
- Less discomfort
- Nearly undetectable donor area
- No linear scar
- Consistent and safe results



Donor Area - 7 days post treatment

*International Society of Hair Restoration Surgery

BEFORE AND AFTER

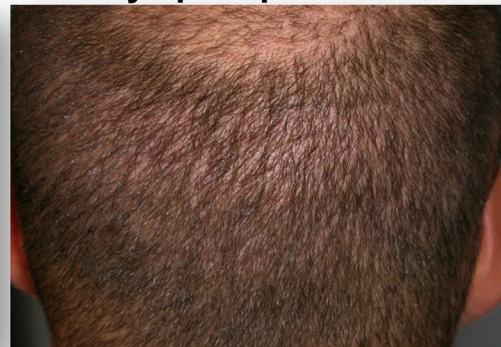
Pre-procedure



1 day post procedure



7 days post procedure



898 ARTAS grafts, 9 months post-procedure



Before



After

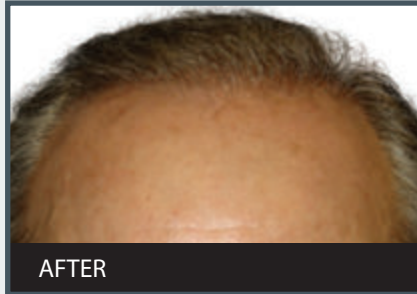


RESTORATION[™]
ROBOTICS

Patient Results



BEFORE



AFTER

**Larry – 10 months after,
3244 grafts, Norwood 6**



BEFORE

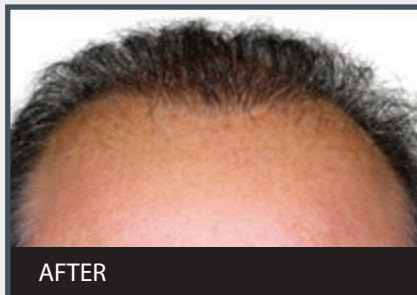


AFTER

**Jeff – 9 months after,
1066 grafts, Norwood 3A**

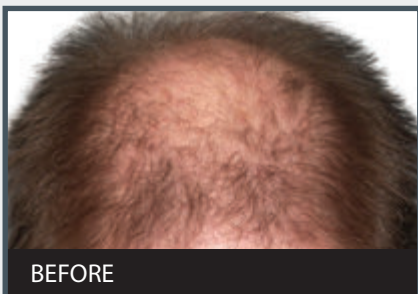


BEFORE

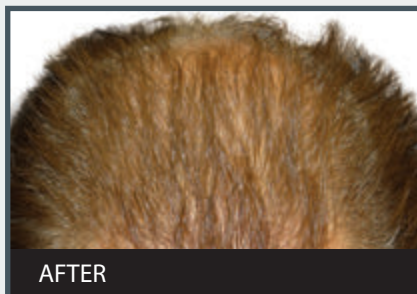


AFTER

**Matt – 9 months after,
1995 grafts, Norwood 6**



BEFORE



AFTER

**Kevin – 9 months after,
2228 grafts, Norwood 5A**



PROUD PROVIDER OF THE

ARTAS[®]
ROBOTIC HAIR TRANSPLANT

Ask us for details about
how this award-winning
robotic technology can
help you regain a thicker,
permanent head of hair.



*Recognized as the 2013 Best New Product in
the Medical/Science Category*

About the Edison Awards™

The Awards have been recognizing and honoring the best in innovations and innovators since 1987. They honor game-changing innovations that are at the forefront of new product and service development, marketing and human-centered design, and are one of the highest accolades a company can receive in the name of successful innovation.

www.artashair.com

LB-46056 Rev. A

THE ARTAS ROBOTIC SYSTEM RECOGNIZED AS 2013 EDISON AWARD WINNER

Restoration Robotics Honored with Gold Medal at Prestigious Innovation Award Ceremony

SAN JOSE, Calif., April 26, 2013 (GLOBE NEWSWIRE) -- Restoration Robotics, Inc. today announced that its revolutionary ARTAS® System has been honored with the Gold medal at the 26th Edison Awards, the international awards ceremony honoring innovators and innovation, in the science/medical category.

The Edison Awards, which were presented yesterday at the 2013 Edison Awards Ceremony and Gala Dinner, are among the most prestigious accolades presented to innovative new products, services, and designs. The awards celebrate human creativity and excellence in achievement, and recognize leading innovations in the spirit of ingenuity embodied by Thomas Alva Edison.

The ARTAS Robotic System is the first and only FDA-cleared, physician-controlled, computer-assisted technology for hair transplantation. This minimally invasive solution offers patients permanent results with no linear scar. The system's robotic precision offers hair restoration physicians and patients unprecedented levels of safety, efficacy, and patient comfort.

"We are honored and pleased that our technology has garnered such prestigious recognition at the Edison Awards," said Jim McCollum, CEO & President of Restoration Robotics. "This award reaffirms the ARTAS System as a significant and cutting-edge innovation at the forefront of hair restoration technology."

The Edison Awards are selected from among innovators and industry leaders in 15 categories through an intensive vetting process. Finalists are chosen by members of the Edison Award Steering Committee, a panel comprised of over 3,000 senior business executives and academics from across the nation. These panelists evaluate nominations according to the awards criteria of concept, value, delivery, and impact.

About the Edison Awards™

The Edison Awards is a program conducted by Edison Universe, a non-profit, 501(c)(3) organization dedicated to fostering future innovators. The Awards have been recognizing and honoring the best in innovations and innovators since 1987. They honor game-changing innovations that are at the forefront of new product and service development, marketing and human-centered design, and are one of the highest accolades a company can receive in the name of successful innovation. For more information about the Edison Awards complete program and a list of past winners, visit www.edisonawards.com.

About Restoration Robotics

Restoration Robotics, Inc., a privately held medical device company, is dedicated to revolutionizing the field of hair transplantation by developing and commercializing its state-of-the-art image-guided ARTAS® System. This interactive, computer assisted system uses image guided technology and precision robotics to enhance the quality of hair follicle harvesting for the benefit of physicians and their patients. To learn more about the ARTAS System and its unique technology, visit www.restorationrobotics.com or www.artashair.com.

CONTACT:

Audra B. Friis (917) 519-9577
audra@pascalecommunications.com



WHITE PAPERS



RESTORATION™
ROBOTICS



Mark Bishara, MD
Specialty: **Plastics**
Location: **Texas**
Customer Since: **2012**

Dr. Mark Bishara is a member of the American College of Surgeons (ACS), the American Academy of Cosmetic Surgery (AACCS), the Dallas County Medical Society, and the Texas Medical Association. He currently holds licenses to practice surgery in Massachusetts, New Jersey, Texas and Florida.

The ARTAS[®] Robotic System Is Transforming the Hair Restoration Industry – Physicians Are Leading the Way

Background

For decades, the primary form of hair transplantation surgery in the United States was strip surgery, also referred to as strip harvesting. This is an invasive surgery that requires excising a band of tissue from the back and/or sides of the scalp (the “strip”) followed by manually hand cutting the strip of tissue into individual follicular units under a microscope. An intact follicular unit consists of one to four hairs surrounded by a small amount of fatty tissue and epidermal tissue. These follicular units are then transplanted into the thinning or balding areas of the scalp. One of the biggest drawbacks of strip surgery is the linear scar it leaves.

Recently, a newer modality called Follicular Unit Extraction (FUE) has become an increasingly attractive alternative to strip surgery. Because surgically removing a strip of tissue from the back and/or sides of the scalp is not necessary for the FUE procedure, it promises patients less, if any, scarring, no need for sutures, less post-procedural pain and numbness and a shorter recovery time with fewer long-term side effects. The advantages of the FUE procedure are attractive to patients, but there are two distinct challenges facing the surgeons performing the procedure: 1) Since FUE extracts each follicular unit individually and manually, it takes longer than strip surgery and 2) Manual FUE requires a proficiency where physicians need months of training and frequent practice to develop the skills and precision for competency. The repetitive nature of extracting the follicular units, associated tedium, fatigue and time required to complete a procedure is a barrier for surgeons performing these cases. New advances in robotic-assisted hair transplantation help physicians overcome these constraints, yielding better clinical results for patients with no linear scar, virtually no downtime, a nearly undetectable donor area and fast recovery. Physician benefits include control, consistency, increased procedure volume capability and greater patient throughput.

The ARTAS[®] Robotic System

The ARTAS Robotic System (Restoration Robotics, Inc., San Jose, California) is the only FDA-cleared, physician-controlled, computer-assisted robotic technology for minimally invasive hair transplantation. The ARTAS Robotic System represents a major improvement in the field of hair restoration. Utilizing high-resolution digital mapping and tracking technology and a minimally invasive dissection system combined with an image-guided robotic



arm, the system locates and harvests the most viable and robust intact follicular units. Precision, consistency, reproducibility and harvest efficiency are all optimized, while operator fatigue and human error are virtually eliminated.

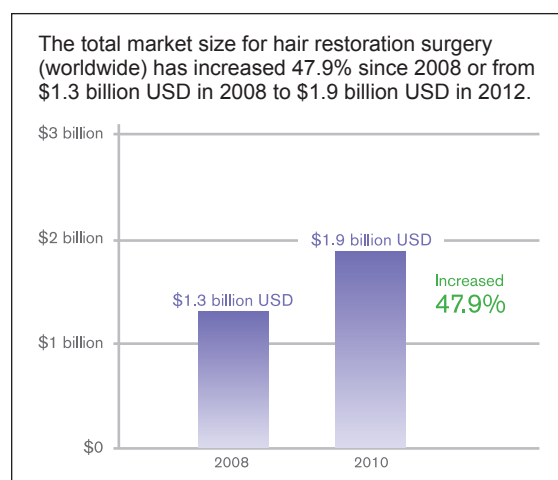
In comparison to the time and training required for manual hair restoration methods, the ARTAS Robotic System shortens the traditional learning curve. Additionally, in contrast to manual harvesting procedures, the ARTAS Robotic System can cut the duration of harvesting time in half. With the robotic precision offered by the ARTAS System, physicians are able to deliver consistent, reproducible patient outcomes.

The ARTAS Robotic System in Practice

The experience of Mark Bishara, M.D., owner of Bishara Cosmetic Surgery & Hair Restoration (Southlake, Texas and Mansfield, Texas), makes the economic case for robotic technology in hair transplantation. Dr. Bishara trained at New York Medical College and Morristown Memorial Hospital, and completed a fellowship appointment in Aesthetic and Reconstructive Plastic Surgery at Harvard Medical School. He also founded the American Plastic and Reconstructive Research Association, a think tank for novel concepts and clinical applications in plastic surgery. Dr. Bishara completed a hair transplantation fellowship with Dr. Mark DiStefano in Worcester, Massachusetts and continued his education with Dr. James Harris, Medical Director of Hair Sciences of Colorado and a pioneer of the FUE technique. Dr. Bishara no longer uses strip harvesting as his first choice for hair transplant surgery; instead he has shifted his practice to focus on ARTAS procedures exclusively. He purchased an ARTAS Robotic System for his Mansfield, Texas office in January 2012; in February 2013, he was the first surgeon to install a second system, this time in his Southlake, Texas location.

Results: Topline Growth, Practice Expansion, Return on Investment (ROI)

Dr. Bishara's solo practice employs eight staff members and a provider in a similar situation as Dr. Bishara likely generates between \$2.5 to \$3 million. Global demand for hair transplantation has been on the rise, according to the International Society of Hair Restoration Surgery's most recent census (2013), "The total market size for hair restoration surgery [worldwide] has increased 47.9% since 2008 or from \$1.3 billion USD in 2008 to \$1.9 billion USD in 2012."¹ As this overall demand increases, consumers will continue to seek out less painful, less invasive, and more personalized alternatives to hair transplantation (as they have done with surgeries such as all-custom laser eye correction). The impact for Dr. Bishara's practice is already clear: In his plastic surgery practice which offers a full range of plastic surgical options, ARTAS procedures now account for 70% of his overall business.



2013 ISHRS Census

¹ 2013 Practice Census Results. International Society of Hair Restoration Surgery, prepared by Relevant Research, Inc., Chicago, IL (July 2013)

Experienced in keeping detailed performance metrics in his practice, Dr. Bishara keeps a close eye on practice economics, procedural growth and their drivers. The ARTAS Robotic System has “totally changed the dynamic” according to Dr. Bishara and has been the cornerstone of his practice’s growth in term of revenue volume, market and geographic expansion. His practice grew from performing three to four hair transplantation cases per month prior to adding the ARTAS Robotic System to performing typically between twelve to fifteen cases per month post-adoption. He reports that 100% of hair transplant inquiries are in direct reference to the ARTAS procedure. This growth in procedure volume has further enhanced his confidence in the technology’s appeal and his investment decision. He expects the monthly volume to increase to about thirty ARTAS procedures by the end of 2013.

Due to the high patient demand for the ARTAS procedure in Dr. Bishara’s practice, he is opening a third and fourth location in the Dallas Fort Worth area as soon as possible. All of his offices are in a single metropolitan area, providing strong evidence of his need to plan for future growth as soon as possible. The rate of this growth is significantly more rapid relative to industry standards for plastic surgeons in the early stages of their private practice careers. Dr. Bishara calculates that with the adoption of the ARTAS procedure his practice growth has accelerated in about one-third of that time.

Differential Demographics: Attracting Affluent Clients

Dr. Bishara’s shift from more commodity-oriented, strip-based surgeries to value-added robotic procedures has caused a demographic shift to a more affluent client base which values the specialized procedure with its range of exceptional features and benefits. The impact of this shift includes a decrease in price sensitivity, the kind of powerful word-of-mouth that having an affluent patient base brings, and breaking out from geographic constraints. A considerable number of patients travel to Dr. Bishara from other cities in Texas and from out-of-state. This is proof that discerning, educated patients will go to significant lengths to seek out a more advanced hair transplant procedure from a trusted, experienced, reputable surgeon.

Education and Patient Outreach

Educating the consumer is a crucial piece of any technological innovation. Dr. Bishara has built a multi-faceted marketing campaign to build his practice. With the ARTAS Robotic System, Dr. Bishara appeals to a more sophisticated consumer, one who is interested in state-of-the-art results with fewer risks. These patients are willing to invest in a higher priced procedure which offers superior patient outcomes. Nearly 40% of his patients fly to Texas solely to have the procedure. He reaches these patients through a variety of strategic marketing approaches (see sidebar).

To attract local patients, he informs and educates existing patients about the procedure via extensive patient database mining, offers complimentary consultations, and relies on patient referrals and word of mouth.

In order to track and measure his marketing success and productivity, Dr. Bishara appointed a dedicated point person to handle all of his ARTAS procedure patients. This staff member is an ARTAS Robotic System expert and records the referral source to the practice. Dr. Bishara personally conducts all the ARTAS procedure consultations, but his

Nearly 40% of his patients fly to Texas solely to have the procedure. He reaches these patients through a variety of strategic marketing approaches:

- Google Adwords
- High quality print publications
- VIP treatment packages tailored to out of town patients
- Blogging
- Patient Education Seminars/Open Houses

dedicated point person handles all incoming ARTAS Robotic System phone calls. Dr. Bishara also conducts extensive field marketing reports and utilizes social media marketing reports to insure that information about the ARTAS Robotic System is communicated accurately and reaches the appropriate target audience to produce tangible, measurable results.

Conclusion

As evidenced by his practice growth and hair transplant surgery success, Dr. Bishara is confident in his investment in the ARTAS Robotic System. With a well-coordinated marketing plan supporting his ARTAS Robotic System hair transplantation procedural focus, Dr. Bishara has expanded his practice at a much quicker rate than is normally achievable in this segment of medicine. Dr. Bishara intends to perform at least 30 procedures per month in the short term and plans to leverage the scalability and that the ARTAS Robotic System provides to increase his hair transplant procedures in the near future.



Restoration Robotics, Inc.

128 Baytech Drive • San Jose, CA 95134 • U.S.A. • 1.408.883.6888
contactus@restorationrobotics.com • www.restorationrobotics.com

© 2013 Restoration Robotics, Inc. All Rights Reserved. LB-46346 Rev. A

RESTORATION ROBOTICS, ARTAS, the stylized logos, ARTAS KEY, ARTAS VISION, ARTAS GENERATION, ARTAS FX, ROBOTIC REVOLUTION, ESSENTIAL TECHNOLOGY FOR HAIR, HAIR RESTORATION REDEFINED and VISUALIZE THE POSSIBILITIES are among the trademarks and/or registered trademarks of Restoration Robotics, Inc. in the United States and other countries.

Transforming Hair Restoration through Precision Robotics and Advanced Imaging Technology

Young. Hong, MD
Visual Plastic Surgery - Los Angeles, California
By Carolyn Pexton

For both men and women, noticeable hair loss by the age of 60 is a distressingly common experience. Millions of people seek treatment for this condition each year. According to the International Society of Hair Restoration Surgery (ISHRS) ¹, in 2010, global revenue for hair restoration procedures exceeded \$2 billion, and patient demand growth in some markets is estimated at more than 300%. Demand for advanced methods for coping with hair loss has also sharply increased, as patients seek a less invasive approach, shorter recovery time and better results.

The introduction of the ARTAS® Robotic System provides a compelling response to this rising demand. Through advanced imaging technology and robotics, the ARTAS system delivers accurate, consistent results, dissecting individual follicles hundreds to thousands of times within a single session. Precision with the robotic procedure has been recognized as a major improvement in hair restoration.



Decision Points and Doubling Volume

At Visual Plastic Surgery in Los Angeles, Surgical Director Young Hong, MD became interested in the efficiency and precision of this approach, and the significant advantages it seemed to offer his patients. "ARTAS takes the art and science of hair restoration to an entirely new level," says Dr. Hong. "With *the robotic approach*, I'm able to obtain *better quality* in the hair samples that are extracted" says Dr. Hong," and this lead to excellent results in terms of hair growth."

The ARTAS Robotic System represents a partnership between the robot and the doctor, rather than a replacement. The robot harvests each follicular unit precisely, while the doctor applies expertise in the transplantation process.

According to Dr. Hong, it requires roughly five hours to complete the entire procedure. "On average, it takes a little less than two hours to harvest, and then with the implant, maybe another two hours."

Key features of the ARTAS Robotic System include:

- High-resolution digital imaging for rapid, micron-level targeting accuracy
- Image-guided robotic alignment for speed and precision beyond manual techniques
- Minimally invasive dissection delivers healthy, intact grafts with nearly undetectable harvest sites
- Intuitive operation that shortens the learning curve and makes the procedure easier to perform

"For me, the decision to move to the ARTAS system was driven by a few key factors," says Dr. Hong. "I really like the high tech approach to hair restoration, with low transection rates and minimal discomfort for patients."

Growth in business and revenue has followed the introduction of the ARTAS Robotic System. Since he added the ARTAS System to his practice, Hong said he's seen a *dramatic increase in the volume* of hair restoration clients.

"After introducing the ARTAS procedure, my practice nearly doubled over a period of just six months," says Dr. Hong. "Patients have responded very well because they know they're getting the best possible procedure. And pricing doesn't seem to be a barrier. At the moment, I am providing both the robotic and strip procedure. As it turns out, *9 out of 10 patients prefer the ARTAS robotic procedure*, even though the price is a little higher."

As in many other areas of medicine, the use of robotic technology is helping to improve outcomes for patients who may have been disappointed with previous hair restoration procedures. Whereas the strip method requires removal of a thin piece of tissue from the back of the scalp, FUE (follicular unit extraction) harvests individual hair samples for transplantation to other areas.

Higher Patient and Physician Satisfaction

"I've seen a number of patients who had previously gone through a strip procedure for hair restoration, and without exception, they all preferred the robotic procedure and felt it was a much better approach," says Dr. Hong. "In fact, I've heard patients say they would never do a strip procedure again. Many patients mentioned they would refer their friends."

"My staff has responded very well to the ARTAS system, and they are quite comfortable working with the robot," Dr. Hong noted. "I was actually pleasantly surprised that the adjustment was so smooth, and the learning curve was much better than I had anticipated."

Among potential clients, there is a growing awareness about this high tech process and the benefits for anyone seeking a safe, permanent solution to hair loss. Recovery time is much shorter with ARTAS than with traditional strip surgery, which means patients can return to their normal lives and activities with minimal disruption.

“There are so many benefits for patients with the ARTAS system,” says Dr. Hong. “It is minimally invasive, involves far less pain and discomfort, requires very little down time, and does not leave the patient with detectable scarring. Overall, we’re seeing better results and higher patient satisfaction.”

In terms of marketing this new system, Dr. Hong is currently targeting primarily Asian populations through local newspapers. The patients themselves play a key role in marketing this system, as they are more likely to recommend it to friends when they are happy with the results.

For any medical practice, time is an important factor when weighing various solutions. As Dr. Hong observed, “The ARTAS system is efficient and timesaving. Another important consideration is that it comes with great support. Everyone on the team has been very helpful and professional. Adding the ARTAS System is one of the best decisions I’ve made in the last ten years.”



Young Hong, MD

has been performing hair restoration for more than 30 years. He is a licensed plastic surgeon. Dr. Hong is the medical director of Visual Plastic Surgery in Los Angeles.



RESTORATION[™]
ROBOTICS

Restoration Robotics, Inc.
128 Baytech Drive San Jose, CA 95134
Email: contactus@restorationrobotics.com
Phone: (408) 883-6888
Copyright © 2013 Restoration Robotics, Inc. All Rights Reserved.

ARTAS Robotic System Transforms Hair Restoration for Physicians and Patients



Mark Bishara, M.D.
Bishara Cosmetic Surgery &
Hair Restoration
Mansfield, TX



Samuel Lam, M.D.
Lam Facial Plastic Surgery Center
Plano, TX



**Gregory A. Turowski, M.D.,
Ph.D., F.A.C.S.**
Medical Director
New Horizons Center for Cosmetic Surgery
and Medical Spa
Chicago, IL

"Fatigue and error are major contributors to transection, but the precision and accuracy of the ARTAS are unrivaled in terms of the human hand."



ARTAS Robotic System

By Desiree Ifft, Contributing Editor

As an FDA cleared, physician-controlled, computer-assisted technology for minimally invasive hair transplantation, the ARTAS Robotic System from Restoration Robotics (San Jose, Calif.) is a significant advancement in its field. Utilizing proprietary digital mapping and tracking technology, a minimally invasive dissection punch and an image-guided robotic arm, this system harvests follicular units from the patient's donor area, surpassing manual follicular unit extraction (FUE) in four crucial areas: precision, control, reproducibility and efficiency. In addition, it eliminates a major drawback associated with hand-held tools and automated hair restoration systems – physician fatigue.

The ARTAS Robotic System opens the field of surgical hair restoration to physicians willing to commit to mastering the art and science behind this in-demand service. By identifying and mapping the location of thousands of follicular units to be harvested in one session, and targeting them for dissection at the appropriate angle of approach, this system maximizes the likelihood of high-quality, transplantation-ready grafts and minimizes the transection rate. With the ARTAS System, the surgeon can adjust dissection settings, including puncture and coring depth, angle and speed, all without interrupting the procedure.

Providing a permanent, natural looking solution for hair loss that is safe and efficient, the ARTAS Robotic System transforms both the surgeon's and patient's experience. Unlike the strip harvesting approach to hair transplantation, the ARTAS procedure involves little or no discomfort. Patients can return to all of their normal activities in one to two days. Also, since there is no linear incision and resulting scar, they can continue to wear their

hair in any length or style. Intelligent algorithms ensure the donor area maintains a natural appearance.

Mark Bishara, M.D., of Bishara Cosmetic Surgery & Hair Restoration in Mansfield, Texas, has used the ARTAS Robotic System for nearly 100 patients in a little over a year. In his experience it alleviates the repeated stress and strain on the surgeon's eyes and lumbar spine that are typically associated with manual FUE. "By eliminating operator fatigue, the potential for human error is reduced," he pointed out. "The robot simply does not tire."

Samuel Lam, M.D., of Lam Facial Plastic Surgery Center in Plano, Texas, agreed, noting that avoiding transection of the hair follicles is key to successful hair transplant. "Fatigue and error are major contributors to transection, but the precision and accuracy of the ARTAS are unrivaled in terms of the human hand," he said.

According to Gregory A. Turowski, M.D., Ph.D., F.A.C.S., medical director of New Horizons Center for Cosmetic Surgery and Medical Spa in Chicago, Ill., the ARTAS Robotic System is much more efficient than even an experienced surgeon using automated FUE. Experienced in using both automated and robotic FUE, he and his team prefer the robotic ARTAS System, which allows them to perform on average over 500 FUEs in an hour.

In Dr. Bishara's opinion, "Comparing automated FUE to ARTAS is like comparing apples and oranges. The automated FUE device is a hand tool guided by the physician who must rely only on his or her eyes to determine the appropriate angles of the individual hairs to be harvested. Conversely, ARTAS gives us

real-time digital targeting down to the micron level and consistently harvests the hairs with its robotic arm to deliver healthy grafts every time."

Between 2008 and 2010 the worldwide market for hair restoration increased by 47.9%.* With this rapid growth, the ARTAS System is well-positioned to further expand the market. "Even patients who are not only thin shafted, but sparse in the universal donor area are now candidates for ARTAS Robotic Hair Transplantation," Dr. Bishara said. "In addition, now that a robot is used in the provision of this service, appropriately selected patients will enjoy a more widespread availability of hair restoration procedures that will not commit them to a linear scar, which for many of today's patients is considered aesthetically unacceptable."

Dr. Lam believes the introduction of the ARTAS System is helping to raise awareness of the latest solutions for hair loss that are available to patients. "The company is running direct-to-consumer ads, and a buzz has been created in the media," he said.

While purchasing the ARTAS System is a substantial investment for a practice, and the procedure cost for patients is considered relatively high, the market seems accepting. Today's patients are savvy, Dr. Turowski said. "They tend to research their options thoroughly and are willing to pay for solutions that provide true benefits and value."

Dr. Bishara agreed and compared it to other luxury items; "people are willing to purchase high-priced televisions if they want a high-definition experience, and televisions are far less permanent than a hair restoration procedure."

In Dr. Lam's practice, being able to offer the ARTAS procedure has expanded

the hair restoration demographic to patients who would not have considered transplantation surgery otherwise. "Our business has tripled because of this," he said. "You have to be sure you will have a certain number of cases to justify bringing in the system, but the opportunity is there for someone who either doesn't perform hair transplantation at this time or wants to upgrade to a more sophisticated way of doing it."

For Dr. Turowski, his practice has achieved a favorable return on its ARTAS investment. "It helps to have a thriving practice to support it initially, including the necessary systems, such as marketing, personnel, etc., already in place," he stated. He views the ARTAS System as a technology that is moving both his practice and the field of hair restoration forward. "Poll results presented at a recent meeting of the *International Society of Hair Restoration Surgery* showed that a minority of transplantation procedures are currently FUE, but that is changing rapidly. I believe we are currently in a transitional period, where minimally invasive hair restoration procedures such as the ARTAS Robotic Transplant will explode," he shared. "This will be much like when there was resistance to new ways of performing liposuction, but eventually the older methods disappeared."

References:

2011 Practice Census Results. *International Society of Hair Restoration Surgery*. Available from: www.ishrs.org/sites/default/files/users/user3/FinalPracticeCensusReport7_11_11.pdf. Accessed March 5, 2013.



Donor area before Tx



Donor area after ARTAS Robotic Tx
Photos courtesy of Restoration Robotics



Before Tx



After 900 grafts with ARTAS Robotic Tx
Photos courtesy of Restoration Robotics

Follicular Unit Extraction Using Robot System (Artas™) in Asian

Jeong-Won Shin¹, Joo-Yong Kim², Chang-Hun Huh¹

¹Department of Dermatology, Seoul National University Bundang Hospital, Seongnam, Korea

²Mojerim Hair Clinic, Seoul, Korea

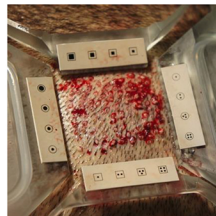
Introduction

- Follicular unit extraction (FUE) provides many advantages over strip
 - absence of linear scar, much less pain, short recovery time.
 - But, time-consuming, technically hard job for surgeons.
- **ARTAS™ system** : Interactive, computer-assisted, physician-controlled robotic system used for the FUE harvest.
- There's no data for robot harvested follicles.

Materials and Methods

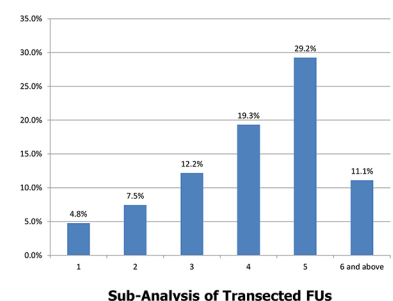
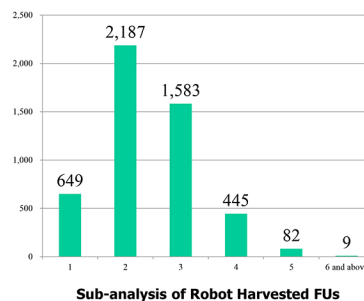
- **22 patients** who underwent FUE hair restoration surgery in SNUBH with ARTAS™ system. (Software version 4.8.2, Restoration Robotics, Mountain View, CA, USA)
- Analyzed all hairs from first 3 harvested grids from same standard sites were selected for analyze, to minimize variations in the patients.
- Follicular Unit Numbers(FUs), Hair Numbers, Transection rate(TR), Yield, and others were calculated.

Results



- **Sub-analysis of Robot Harvested FUs**
 - Hairs in a FU are variety : 1~7 hairs in a FU
 - Double hairs were majority (44.1%), and then triple follows(31.9%).
- **Sub-Analysis of Transected FUs**
 - 10.1% of Robot Harvested FUs were transected.
 - Quintuple (29.2%) Vs. Single (4.8%)

- Mean age : 49.4 ± 12.3 years old
- **Yield of Harvest** : 95.1%
(Total Punch : 5,213, Collected FUs : 4,955)
- **TR** : 4.9%
(Total Hairs : 12,017, Transected Hairs : 590)
- Telogen Hairs : 1,244(10.4%)
Vellus Hairs : 146(1.2%)
- **Average FUs/Grid** : 75.1 ± 9.1
- **Average Hairs/Grid** : 182.1 ± 32.6



- No significant side effect or complication was detected during and after the surgery.

Conclusion

- Robot Harvesting System with ARTAS™ is good enough for hair restoration surgery.
 - Low TR and High Yield
- It Harvest multiple hairs, efficiently. But, TR is higher in multiple hairs than single hairs.



Prof. Chang Hun HUH

Dermatologist
Seoul, South Korea

**Associate Professor of Department of Dermatology,
Seoul National University Bundang Hospital in Korea.**

Treasurer of the Korean Dermatologic Laser Association (2006 – present)

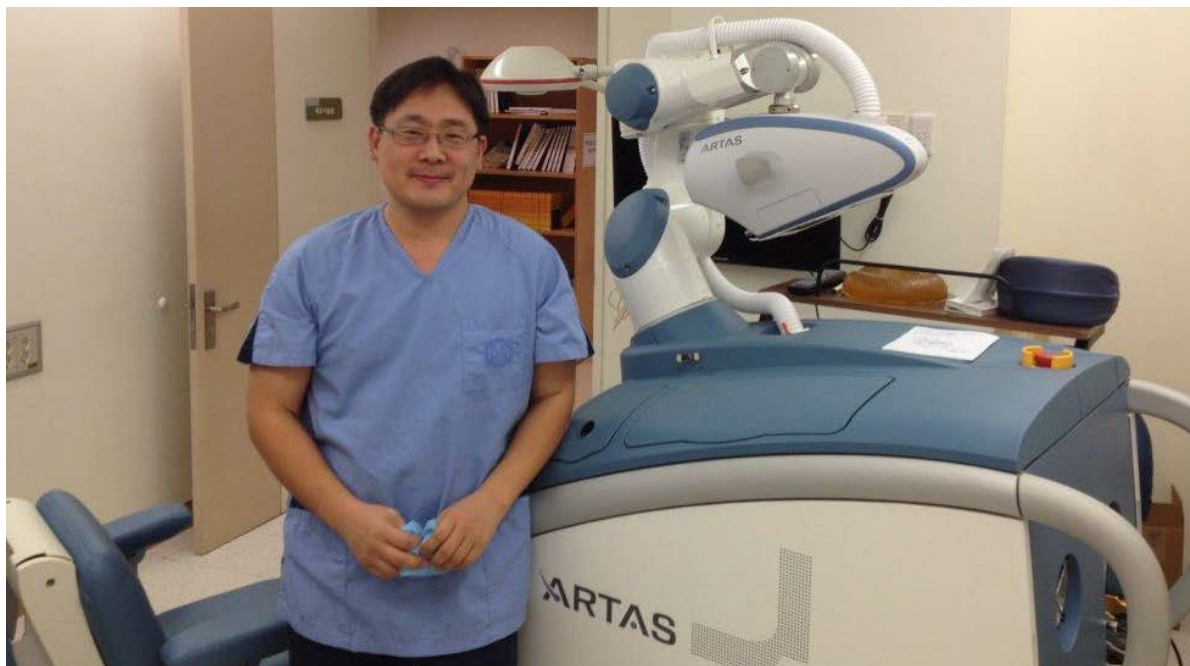
Treasurer of the Korean Society of Cosmetic Dermatology (2012 – present)

Scientific Director of the Korean Society for Dermatologic Surgery (2012 - present)

Public Relation Director of Korean Hair Research Society (2012 – present)

Ceremony & Social Director, OC of World Congress of Hair Research 2014.

Secretary General Deputy, OC of International Society for Dermatologic Surgery 2015.



Installed October 2012

Robotic Surgery: With New Technology Come New Opportunities?

Cosmetic practices can capture the male market if they move beyond facial rejuvenation to hair restoration. Robotic technology may enhance the practice opportunity.

BY PAUL WINNINGTON, EDITORIAL DIRECTOR

With all the press surrounding health care reimbursements and related topics, it's easy to forget that there are still new and exciting procedures to offer for the benefit of both your patients and your practice.

Robot-assisted hair restoration is one such procedure. The ARTAS System enables physicians to offer their patients a minimally invasive procedure that leverages image-guided robotics to deliver permanent, natural-looking results. Demand for a less-invasive hair restoration solution has seen a substantial increase over the past few years, and patients are willing to pay a premium price for the benefits.

EXTRACTION TECHNIQUES

Hair restoration has been the number one cosmetic procedure among men for several years, and it continues to grow in popularity.¹ Hair restoration procedures involve taking follicular units from "permanent" regions, such as the back and sides of the head, and transplanting them in the thin or bald areas on top of the head and hairline. Currently, strip harvesting represents the most common process for extracting follicles to be transplanted. Strip harvesting involves the use of a scalpel to remove a strip of hair-bearing tissue from the donor region and then the incision is closed with either staples or sutures. Using a microscope, the individual follicular units are then dissected from the tissue and transplanted to the area of hair loss.

Follicular unit extraction (FUE) presents an alternative to strip harvesting. Following surgical trends toward less-invasive procedures, single follicular units are extracted with small dermal punches so that the donor site does not require sutures or staples. Interestingly, while FUE seems like an obvious minimally invasive option for patients, practitioners have been slow to adopt the procedure. James Harris, MD, Medical Director of Hair Sciences Center of Colorado

and an FUE pioneer, explains the reason behind this industry-wide reluctance. "If physicians want to become proficient at FUE, they need to undergo special training and along with this, there's a significant time commitment. Analysis of the angle, direction, and type of skin is a complex process requiring extensive experience. Until the surgeon has acquired this experience, the process is very tedious and slow."

Mark A. Bishara, MD, of Bishara Cosmetic Surgery & Hair Restoration, concurs. "Right now, strip harvesting is the most commonly used technique, and it's an efficient means of harvesting large quantities of follicles. But I stopped offering it as a primary modality for a number of reasons, including patient recovery time and wound morbidity. It took me six months of training to fully learn FUE, and for many surgeons, that acclimation period can serve as an entry barrier."

This less-invasive procedure is beneficial for both patient and surgeon. Patients require less post-operative pain medications; healthy grafts with ample protective tissue can be transplanted; and the procedure does not result in linear scarring so patients can wear their hair very short post-procedure. Furthermore, patients typically undergo a quick recovery, returning to normal activity in three days or less. "Following strip-based surgery, the donor site isn't healed for seven to 10 days or until sutures are removed. It's not uncommon for strip-based surgery patients to report a sense of tightness and some degree of numbness for two to three months after a strip harvest. There is a very real potential for discomfort. With FUE, pain is largely mitigated—or absent entirely—post-procedure," says Dr. Bishara.

BENEFITS OF THE ARTAS SYSTEM

Robotic technology is used in a variety of surgical and diagnostic procedures and is a good match for FUE. The ARTAS System is the first and only FDA-cleared technology that allows physician-controlled, image-guided, robotic-assisted

FUE. The ARTAS System utilizes specialized cameras and the latest in digital mapping to automatically assess the angle and direction of each follicular unit. Sophisticated algorithms then determine the hair density as well as the proper angle and depth of incision required to effectively harvest the units. The system can also determine a random extraction pattern.

The ARTAS System can harvest follicular units in a random pattern, according to distance limitations, or as a percentage of the total number of follicular units in a designated area. Under physician control and direction, targeted units are dissected at rates of over 500 grafts per hour. “I make minor adjustments to dissection depths and angles during the extraction process, to ensure the patient receives optimal results,” says Dr. Bishara. “So there’s still an element of physician interaction. But overall, the robotic technology alleviates much of the burden.”

While in general FUE is less invasive, one drawback is its traditionally slow method for extracting hair follicles. “An average physician performing FUE may only be able to extract 200 to 300 grafts in an hour. This presents somewhat of a problem, as an average surgery requires 1,500 grafts. With the ARTAS System, we are able to extract 500 or more grafts per hour,” says Dr. Harris.

“Initially, I was concerned that I would not be able to provide my patients the larger surgery session with the robot, but that concern was quickly shattered after we were able to extract 3,500 follicular units in one day,” adds Craig Ziering, DO, FAOCD, Founder and Medical Director at Ziering Medical.

Additionally, comparisons of traditional FUE to robotic-assisted FUE also reveal the computer’s ability to produce better grafts.² Newcomers to FUE often experience follicle transection rates of 20 to 30 percent when first learning the procedure. The ARTAS System, by comparison, consistently shows a follicle transection rate of about eight percent independent of operator experience. “The ARTAS System provides physicians a very safe method for consistently extracting a high volume of healthy, intact hair grafts in a short amount of time,” reports Dr. Harris. “Follicular units require little or no trimming and are ready to implant immediately after harvesting. This bolsters graft success rates and reduces technician time, facilitating more efficient appointment scheduling.”

PRACTICE GROWTH

According to the International Society of Hair Restoration Surgery (ISHRS), the total market size for hair restoration surgery has increased almost 50 percent since 2008, with a worldwide market close to \$1.9 billion.¹ ISHRS members performed an average of 16 surgical hair restoration procedures per month, with 77.5 percent using the strip harvesting technique and only 22 percent using FUE. “When FUE first came out, doctors were obtaining bad grafts and giving their patients less than acceptable results, so a lot of potential patients rejected an FUE

procedure,” recalls Dr. Harris. “The beauty of the ARTAS System is that you can take a physician with very little experience and after a couple of hours of training, the doctor can produce grafts as good as those achieved with several years of experience. It’s a remarkable achievement for the entire hair restoration industry.”

This less-invasive method represents a new way to attract prospective patients who would not normally consider hair restoration surgery, due to its traditional recovery time and visible scarring, among other factors. Dr. Ziering further explains how the ARTAS System can be instrumental in growing and strengthening a practice. “Introducing new technology for the sake of just having the latest, greatest technology is not a reason for me to invest in something like the ARTAS robot. However, technology that improves my patients’ overall hair restoration experience or meets a patient need, addresses a concern, or solves a problem—is worth it.” Dr. Ziering says, “My Beverly Hills practice attracts patients from all over the world, and we’re busier now than ever, because of my association with the ARTAS robotic-guided system that has already drawn in patients who would otherwise be apprehensive about the traditional drawbacks associated with FUE. My practice has always provided patients top-quality services, and ARTAS currently represents the state-of-the-art in less-invasive surgery. During the ARTAS procedure, I can devote more time to the artistry behind quality hair restoration, as the robotics eliminates a great deal of the operational tedium. There is a huge patient population waiting to be served.”

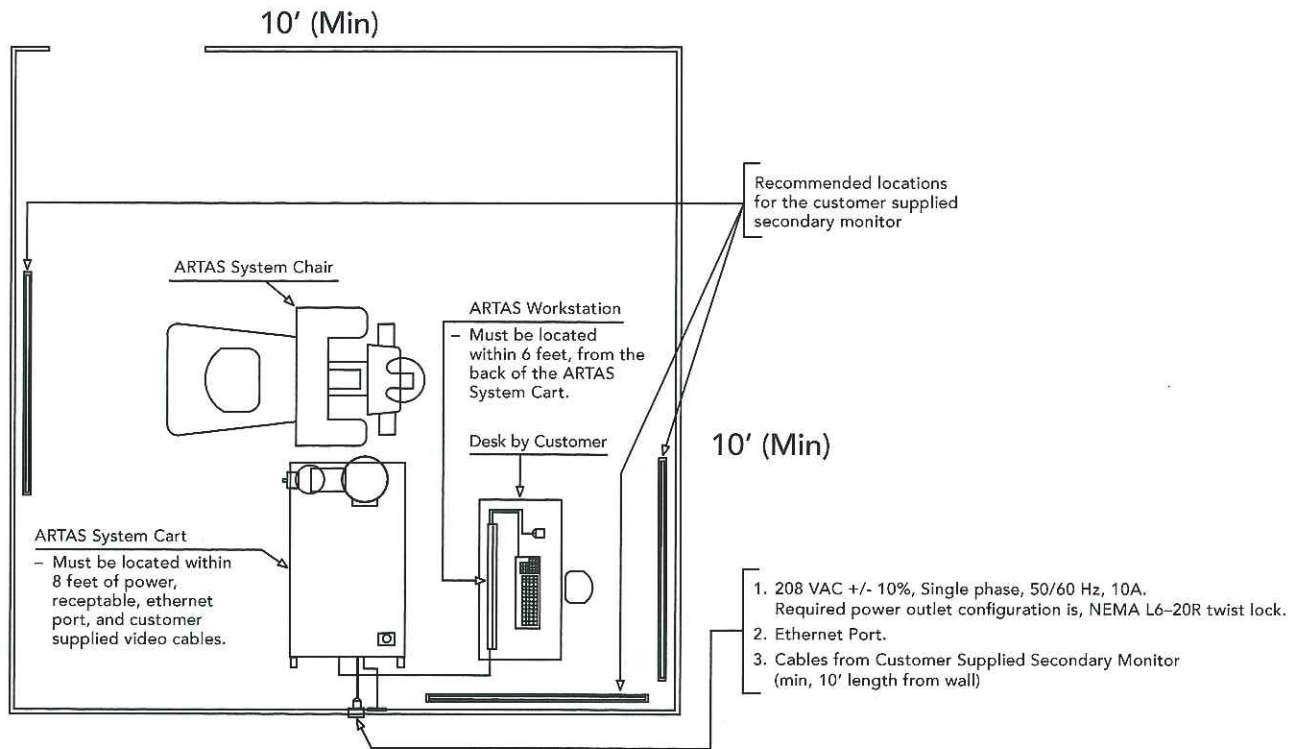
Much like in other areas of medicine, such as all-custom laser eye surgery, patients are willing to pay more for value. The ARTAS System marks a significant investment for a practice, but patients will perceive the greater service and better results and be willing to pay it, specialists say. Dr. Bishara says, “Simply put, my patients—many of whom travel great distances to undergo this cutting-edge procedure—are willing to pay a premium for comfort and results. At a minimum, I’m doubling my business—largely because of how happy my patients are coupled with the impressive results I’ve been seeing. Through word of mouth alone, these satisfied patients are driving my business and establishing a global reputation for my practice.”

“Hopefully, one day, I will have multiple systems doing robotic hair transplants,” he adds. “I anticipate that robotics will lead the future of several medical fields outside of hair transplantation. The way I see it, I could embrace this technology early in my career, or wait ten years to hop on board. I chose to seize the opportunity to be one of this new technology’s first adopters and subsequently become a world leader in my field. Without a doubt, I would encourage other practitioners to implement the ARTAS System. The benefits are too numerous and too important to ignore.” ■

1. ISHRS 2011 Practice Census Results. http://www.ishrs.org/PDF/FinalPracticeCensusReport7_11_11.pdf.

2. Data on file. Restoration Robotics.

ARTAS® System Typical Room Layout



ARTAS System Technical Specifications

Cart Dimensions	Length: 48 inches when robot is in parked position Width: 27 inches Height with robot (nominal position): 68 inches
Chair Dimensions	Length: 57 inches Width: 33 inches Height: 48 inches
Cart Weight	872 lbs.
Chair Weight	500 lbs.
Electrical	208VAC+/-10%, single phase, 50/60 Hz, 10A. Required power outlet configuration is NEMA L6-20R twist lock.
Temperature Requirements	Operating: 15-30 deg C and 20-80% humidity non-condensing; Storage: 0-50 deg C and 0-90% humidity non-condensing Operating: 59-86 deg F and 20-80% humidity non-condensing; Storage: 32-122 deg F and 0-90% humidity non-condensing
Continuous Use	Yes

Vacuum	29 in-Hg (generated internally)
Pressure	40 psi (generated internally)
FDA Classification	Class II
Warranty	1 year manufacturer's warranty
Patents	This product and/or its use is covered by one or more of the following U.S. patents: 6,585,746; 7,477,782; 7,627,157; RE 42,381; RE 42,437; 7,962,192; 8,048,090; 8,133,237; D641941; D641942; D644675; 8,199,983; 8,211,117. Additional US and foreign patents pending.

Customer to supply the following:

Personal Computer	Running Windows 7 or better; 64 bit version recommended; Intel Core Duo processor; 2 GB RAM or better
Secondary Monitor	Recommended 40"+ TV/Monitor HD 1080p; DVI-HDMI cabling from monitor to ARTAS System
Connectivity	Ethernet; Downstream speed up to 1.5 mbps; Upstream speed up to 384 kbps; Do not use WiFi
Desk (Workstation)	At least 2' x 3' working surface

Hair Transplant Embraces Rob

By Mark Bishara, MD

A foreword by Marco N. Barusco, MD

Chairman & Trustee for American Society of
Hair Restoration Surgery



My involvement began in this area of cosmetic surgery in 1998, when I began working at a hair restoration practice based in Florida. I had finished my general surgery residency in Brazil and wanted to dedicate myself to this growing specialty. I was fortunate enough to have seen

and been a part of some of the most important advancements in technique and technology in our specialty. Looking back, what I witnessed is nothing short of amazing!

We went from harvesting donor hair with 4 mm round punches to harvesting strips which healed better and increased the number of hairs that could be harvested. Loupes gave way to stereomicroscopes to dissect the "follicular unit" grafts from the donor strip. Recipient sites became increasingly smaller, from 2 mm round punches to slot punches, to thin razor blades as small as 0.7 mm in width. Results became more and more natural. Today, patients are afforded undetectable results that last their lifetime and hair transplantation is a growing specialty worldwide.

But the changes and advancements did not stop there. PRP and Acellular Matrix (ACM) are showing promising results in promoting better healing and native hair regrowth, as described by Dr. Gary Hitzig in his article. Research continues to be done with ACM materials in order to scientifically document their benefits.

In an effort to eliminate the linear scar that permanently identifies a hair transplant patient, the technique of Follicular Unit Extraction (FUE) has recently gained popularity. To facilitate and increase the accuracy in the removal of the follicular units, automated devices of various types have been developed. As described by Dr. Mark Bishara in his article, the ARTAS robotic system is the latest tool in our armamentarium. While FUE is not, in my opinion, a technique suitable or recommended for every patient, it is useful and may be desirable in some cases.

More advancements are on the horizon. These are exciting times for us, and I look forward to being a part of them. Ultimately, the real benefits are enjoyed by our patients.

It isn't often in one's career that you have the opportunity to be one of the first adopters of a new technology and thus become a world leader. Not only are the opportunities few and far between, but our nature is to wait until techniques are "tried and true" before jumping in. However, I believe the future of hair restoration surgery is in robotics and the ARTAS System (Restoration Robotics, Inc.) is a huge opportunity for my patients and my practice.

Hair restoration is the number one cosmetic procedure desired by men, and there are estimated to be more than 800,000 patients worldwide each year.¹ Single-strip/linear harvesting is the most commonly used technique. It is an efficient means of harvesting large quantities of follicular. However, there are a number of reasons I stopped offering strip/linear as a primary modality including patient recovery time and wound morbidity.

In order to enhance my patient's outcomes, I started offering motorized follicular unit extraction (FUE) after a significant training period with Dr. James Harris, a known leader in FUE. A training period of six months to one year with frequent practice is necessary to become truly efficient at this technique. Understandably, that can be a barrier to entry into this field for many surgeons. Robotic technology has played an important role in medical surgical techniques and as a result has made advances in a variety of surgical and diagnostic procedures. I felt that the application of ARTAS robotic technology to the process of extracting individual follicular units was the next step in offering my patients the best procedure possible.

The procedure begins by cutting the patient's hair down to about 1 mm in length to allow the imaging system to identify and map each follicular unit. The area is anesthetized and the patient is placed in a chair designed specifically for comfort during the procedure. A specially designed device called a skin tensioner, that provides tracking on the scalp to allow precise control of the incisions, is placed on the patient's scalp. Once in place, the physician starts to harvest the hair follicles. A robotic arm is guided by images from a set of cameras, which work together to analyze the hair follicles. A sophisticated set of algorithms calculates the angle and

Surgery tic Technology

direction of each individual hair follicle, and determines the proper angle and depth of incision to harvest each one.

A sharp needle first scores the skin 2-3 mm deep, and then a slightly larger blunt needle dissects the skin approximately 4 mm deep. The needles have markings on them to indicate depth and photos are constantly being taken to allow the physician to monitor the incision depth at all times. A light suction in the needles leaves the individual follicles slightly elevated from the skin so that the physician can easily extract and evaluate them. The image-guided robotic arm harvests the follicles in a random pattern, leaving the donor area nearly undetectable after the small incisions have healed.

The software that runs this system is absolutely super human. The way that the image-guided arm picks and chooses certain follicles and angles of approach are what makes it unique. Algorithms are able to volume average a series of follicles that are seen from the two cameras and then map an approach of the robotic arm to each individual follicle. It is fascinating. One of the things that the ARTAS System did for me was to help me look at the FUE dissection process and evaluate it with different metrics. I understand some of the angles of the hair on the scalp a little better as well as the correct puncture depth, coring depth and the angle of approach depending on where I am on the back of the head.

A typical session in my office is between 1,200 and 1,500 grafts, which requires a dissection period of about two and a half hours. However, we have routinely done over 2,500 grafts in one day with ARTAS. The



transection rate with the robotic arm is less than 10%. The ARTAS System provides a very safe manner of extracting healthy grafts that require little to no trimming before they are implanted. The ARTAS System can enhance graft success as well as reduces the technical staff required. The mean number of surgical assistants required for one hair transplant procedure using other means is 4.5.

One of the most important benefits of the ARTAS System to the patient is that recovery time is minimized to two to three days. With strip-based surgery, the donor site requires seven to 10 days to heal, or at least until the sutures are removed. In addition, there is little or no pain after a procedure is completed. On the other hand, it is not uncommon for people who underwent strip-based surgery to have an aura or some degree of numbness – something they perceive as uncomfortable in the donor area for months after surgery.

The field of hair restoration is still waiting for a paradigm shift away from strip-based extraction. Until that happens, the ARTAS robotic technology gives physicians a new tool to offer their patients a less invasive option. We have worked and reworked all of the things we have been taught about the machine and pushed it to certain limits. We are performing an average of three procedures per week with the ARTAS System, and we are excited to be a pioneer. Our association with the robot-guided system has allowed us to be considered elite in the field and has driven inquiries from all over the world to our office.

I anticipate that the future of surgery is definitely in robotics. My career will span at least another 30 years, and I could either embrace this technology early in my career, or do it ten years from now. It's a calculated risk when you are an early adopter of a technology, but one that I believe is already paying off. In a perfect world I will have multiple machines doing several robotic hair transplants in the future.



1. International Society for Hair Restoration Surgery Census Results. Viewed online May 24, 2012.

Robotic-Assisted Follicular Unit Extraction for Hair Restoration: Case Reports

James Harris, MD

Follicular unit extraction (FUE) is a graft harvest technique for hair restoration that offers the benefits of minimal postoperative pain and absence of linear scarring in the donor area. The demand for hair restoration procedures has rapidly increased, but the majority of physicians do not offer FUE as a treatment option for hair restoration because of the intensive training and experience required for proficiency. The ARTAS System (Restoration Robotics, Inc), a computer-assisted robotic technology used to perform FUE, received 510(k) clearance from the US Food and Drug Administration and enables more physicians to perform FUE by minimizing the traditional learning curve, which has slowed the adoption of this technique. This article presents 2 clinical cases of patients with androgenetic alopecia who were treated with FUE.

Cosmet Dermatol. 2012;25:284-287.

Hair restoration is a prevalent cosmetic procedure among men, and its popularity continues to grow.¹ The high demand for hair restoration procedures has created an impetus to offer better, less invasive treatments that are more widely available. This report of 2 cases of patients with hair loss demonstrates how new technology is impacting common hair restoration procedures.

HAIR RESTORATION SURGERY

The concept of extracting and grafting hair originated in Japan before World War II and has evolved from grafting relatively large segments of skin to implanting individual follicular units into small recipient sites. Based on Orentreich's² theory of donor dominance, hair restoration

surgery is performed under the premise that hair growing in permanent regions, such as the sides and back of the head, is resistant to the hormonal causes of hair loss that are predominant in the crown and forehead regions; thus when transplanted, these hair follicles will maintain their original characteristics.

For many years, single-strip excision—the process of cutting a strip of skin out of the donor area and harvesting the individual follicular units—has been the most common follicular unit graft technique; however, it poses a number of limitations. The procedure is fairly invasive, requiring the physician to be proficient in hemostasis, surgical techniques, and wound management. This strip-harvesting approach usually is associated with 2 to 3 days of mild to moderate pain, 5 to 7 days of soreness, and usually 1 to 3 months of numbness and tightness in the donor site. Additionally, the resulting linear scar may cause difficulty in repeated follicle harvests, and patients must maintain a longer hairstyle if they do not want the scar to be visible (Figure 1).

In the last 2 decades, the field of cosmetic surgery has shifted toward minimally invasive techniques that provide

From the University of Colorado School of Medicine, Aurora, and Hair Sciences Center of Colorado, Greenwood Village.

Dr. Harris is a consultant and principle investigator for Restoration Robotics, Inc.

Correspondence: James Harris, MD, 5445 DTC Pkwy, Ste 1015, Greenwood Village, CO 80111 (jaharris@hscolorado.com).

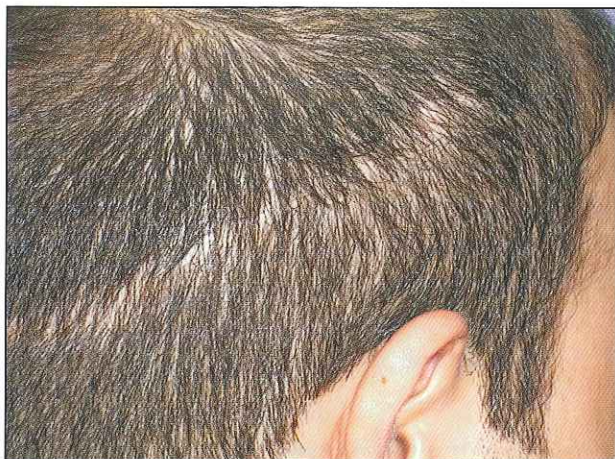


Figure 1. Clinical photograph demonstrating a visible linear scar in a patient with short hair.

the benefits of reduced pain, discomfort, and postoperative recovery periods; this same trend is now evident in hair restoration surgery. Technologic advances have led to a technique called follicular unit extraction (FUE), which allows single follicular units to be extracted with small dermal punches to avoid the need for sutures, staples, or linear incisions in the donor area. Follicular unit extraction initially was performed using sharp dermal punches and manual rotation, but a commercially available powered system called Neograft (Neograft Solutions, Inc) was developed as well as several other powered rotary systems. Anecdotally, sharp punch FUE techniques produced excessive rates of follicle transections in the hands of inexperienced physicians. To address this shortcoming, the SAFE (surgically advanced follicular extraction) SystemSM, a technique and instrumentation that allows more successful FUE graft harvest by using blunt rather than sharp dissection instrumentation, was developed.³ In a survey of 149 physicians, the FUE technique constituted 22% of all hair restoration surgeries.¹

Follicular unit extraction seems to be the natural next step in hair restoration techniques, but so far its adoption has been slow, primarily because of the special training and commitment to practice that are required for proficiency. Unfortunately, most physicians are hesitant to invest the time; therefore, few surgeons offer the procedure. Not only is the analysis of the angle, direction, and type of hair follicle a complex process that requires judgment from years of experience, but the process itself is tedious and can take a long time to complete until the surgeon has had substantial practice.

The ARTAS System (Restoration Robotics, Inc) was pioneered after years of development that included a team of hair restoration physicians, robotic engineers, and clinical experts. It is a computer-assisted, image-guided system

that enables consistent and reproducible results while resolving the challenges inherent to the FUE technique. It received 510(k) clearance from the US Food and Drug Administration in 2011 for harvesting hair follicles from the scalp in men diagnosed with androgenetic alopecia with black or brown straight hair. The ARTAS System uses 2 sets of cameras to enable assessment of every follicular unit in its field of vision and uses sophisticated software algorithms to choose and dissect the individual follicular units safely and efficiently under the guidance of the physician. The ARTAS System uses a small sharp inner needle to score the skin followed by the insertion of a blunt outer dissection punch, similar to the SAFE System, to harvest individual follicular units while maintaining low follicle transection rates.

CASE REPORTS

Patient 1

A 45-year-old man with diabetes mellitus presented with a history of hair loss beginning in his mid 30s. He previously had not taken medication for hair loss but intended to start after surgery. The patient had a maternal and paternal family history of hair loss. On examination the patient demonstrated a Norwood class 4a hair loss pattern (Figure 2). The patient elected to undergo a hair restoration procedure utilizing FUE and the ARTAS System.

On the day of surgery, the donor area was prepared by cutting the patient's hair to a length of 1 mm, and lidocaine 1% with 1:200,000 epinephrine solution was used to perform a ring block in the occipital donor area. A skin tension device with fiducial markings—printed symbols that provide a frame of reference for the imaging system—was placed in the donor target area (Figure 3). The device stabilized the skin to allow for more precise entry of the dissection needles into the skin and also placed the fiducial markings in position to be recognized by the system. Commands were entered into



Figure 2. A 45-year-old patient with Norwood class 4a hair loss before treatment.

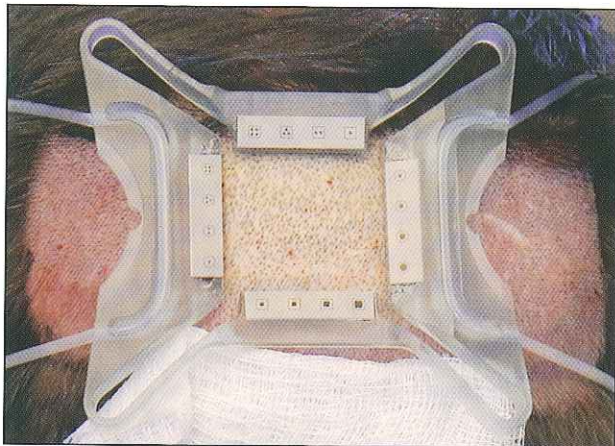


Figure 3. Skin tension device with fiducial markings—black and white square and circular figures—in place at the donor site.

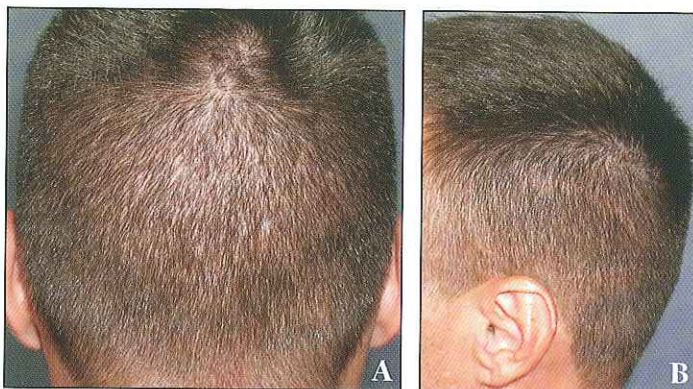


Figure 4. The donor area 10 days after follicular unit extraction showing minimal scabbing and some growth of the remaining donor hair in the occipital (A) and parietal areas (B).

the system to analyze the position of the follicular units, compute the follicular unit density, and assess the angles and directions of the hairs within the follicular units. Algorithms to guide the system for extraction patterns and densities were used to identify appropriate target units. Under physician control and direction, the targeted units were dissected at rates of 750 to 1000 grafts per hour. Minor adjustments to dissection depths and angle limits were made during treatment at the physician's discretion. Any targeted follicular unit easily could be skipped by an operator override.

The ARTAS System harvested individual follicular units in a random pattern according to the parameters specified by the physician; some of these parameters can be adjusted by the physician as required, such as the depths of the sharp needle and blunt punch, the spacing between each harvest site, and the approach angle of the dissecting needles. In this particular patient, 20% of the available follicular units in the targeted donor area were harvested. The grafts were removed from the skin and implanted

using jeweler's forceps into parallel recipient sites created with 0.8- and 1-mm chisel blades.

The patient received 894 follicular unit grafts in the frontal area. The surgical time required to harvest the follicles was 1.5 hours, resulting in an effective harvest rate of 596 follicular units per hour. Within 2 days of the surgery, the patient did not experience any pain or discomfort and was able to resume all normal activities 3 days after surgery. Within 10 days, scabbing in the donor site was minimal, and the patient's hair had grown to sufficient length so that there was minimal visible evidence that he had undergone hair restoration surgery (Figure 4). Nine months following treatment he presented with notable hair growth in the frontal area, and the restoration treatment resulted in a Norwood class 3 hair loss pattern (Figure 5).

Patient 2

A 40-year-old man presented with a history of hair loss beginning in his mid 20s. The patient reported a maternal family history of hair loss and no prior use of medication for hair loss. On examination the patient demonstrated a Norwood class 4 hair loss pattern (Figure 6A). Prior to his consultation, the patient heard about the advantages of FUE and was interested in surgical hair restoration via image-guided FUE and the ARTAS System.

The patient underwent 2 surgeries using the ARTAS System. The first was in January 2010, during which 755 follicular unit grafts were harvested and transplanted in the frontal area of the scalp, and the second surgery was performed in July 2010, during which 898 follicular unit grafts were transplanted to advance the frontal hairline. The combined time for harvesting 1653 total follicular units was 3 hours, resulting in an effective harvest rate of 551 follicular units per hour.

Within 2 days of each surgery the participant experienced no pain or discomfort. One year following treatment, the patient presented with a Norwood class 3 hair loss pattern, which was the treatment goal (Figure 6B).

COMMENT

These patients represent the most common candidates for hair restoration surgery; however, these cases are unique because of the method used for harvesting the follicular units. Follicular unit extraction has piqued the interest of both patients and physicians for many years because of its potential to provide a less invasive means of harvesting hair follicles, which allows for a quicker recovery time and no linear scarring. This technique also has been considered to be so complex and tedious that



Figure 5. The top of the scalp after hair restoration surgery with notable hair growth in the frontal area.



Figure 6. A 40-year-old patient before (A) and 1 year after hair restoration via follicular unit extraction (1653 total follicular units) using the ARTAS System (Restoration Robotics, Inc)(B).

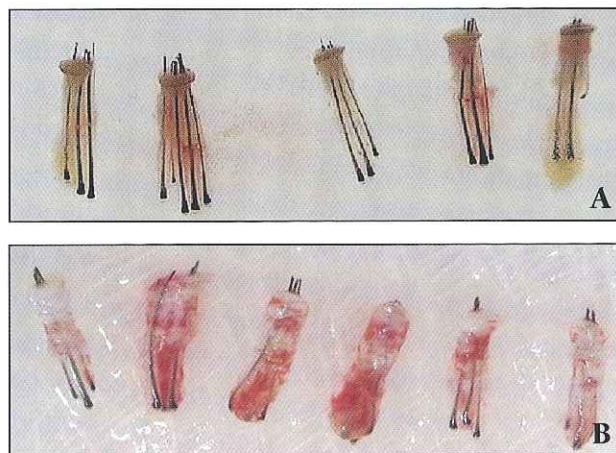


Figure 7. Standard follicular unit grafts demonstrating a noticeable lack of fatty tissue around the follicles (A) compared to ARTAS System (Restoration Robotics, Inc) grafts, which have substantially more fat around the follicles (B).

FUE has never been popular among physicians. If patient 1 had undergone manual FUE by a surgeon who was new to the FUE technique, he likely would have spent 6 hours in surgery instead of 3 hours, and the quantity of transected follicular units would have been

much higher. The ARTAS System offers a substantial reduction in surgical time, often by a factor of 2 to 3 times, and produces higher-quality grafts regardless of the surgeon's experience level.

One of the challenges that is associated with manual FUE is that the physician must look at a specific area of the scalp, analyze the direction in which follicles are pointed, make a judgment regarding the angle at which the follicles emerge from the surface, and then decide how far apart the extraction sites should be. The physician also must manually center the dissecting punch over the emerging hair and determine both the correct amount of pressure to apply and ideal depth at which to insert the dissecting tool. Instead of relying on human judgment and estimation, the process is accomplished more precisely by the vision and follicular unit assessment algorithms of the ARTAS System. Physician fatigue, which can result in lapses of judgment and lead to an increase in follicle transection rates, is not really an issue when using this system. Even the most experienced surgeon can benefit from the precision of this technology.

In addition to physician fatigue, another criticism of manual or powered FUE is that the follicular units often are stripped of fatty tissue (Figure 7A), which is associated with poorer transplant survival rates. The inherent qualities of the blunt dissection system produce grafts that have more fat around the follicles, thus improving the likelihood of graft survival (Figure 7B).

CONCLUSION

A solution to the complex and tedious nature of manual FUE procedures, the ARTAS System is an assistive device that will allow more physicians and patients to take advantage of the benefits of minimally invasive cosmetic procedures. The technology also requires fewer staff and physician hours yet still commands a premium price. Patients will benefit from quicker healing times, excellent results, and wider availability of the procedure. The ARTAS System has the potential to create a monumental change in hair restoration procedures.

REFERENCES

1. International Society of Hair Restoration Surgery. 2011 Practice Census Results. Geneva, IL: International Society of Hair Restoration Surgery; 2011. http://www.ishrs.org/PDF/FinalPracticeCensusReport7_11_11.pdf. Accessed May 11, 2012.
2. Orentreich N. Autografts in alopecias and other selected dermatological conditions. *Ann N Y Acad Sci.* 1959;83:463-479.
3. Harris JA. New methodology and instrumentation for follicular unit extraction: lower follicle transection rates and expanded patient candidacy. *Dermatol Surg.* 2006;32:56-62.

Robot-Assisted FUE May Be The Future Of Hair Transplantation

James A. Harris, M.D., F.A.C.S., principal investigator for Restoration Robotics, explains why

For years, robots have been the stuff of comic books, fantasy toys and science fiction movies. But today, they are very much a part of modern medicine.

In spring 2011, a robot developed by Restoration Robotics in Palo Alto, California was cleared by the FDA for hair transplantation. Men and women may be aware of other medical robotic systems such as the da Vinci and Sensei Robotic Catheter System, but this is the first time a robot has been applied to the delicate and painstaking task of identifying and extracting individual follicular units for hair restoration surgery.

The research took over 5 years and required the talent of computer scientists, mechanical engineers and hair restoration surgeons, not to mention some very deep pockets.

In a recent article published in *Hair Transplant Forum*, doctors Miguel Canales and David Berman estimated that over 45% of all prostate cancer surgeries in the United States are performed using the robotic da Vinci surgical system. Could the hair transplant industry embrace robotics with the same enthusiasm?

To find out, *The National Hair Journal* talked with James A. Harris, MD, one of the lead researchers in the development of the ARTAS™ hair restoration system and himself a distinguished hair transplant surgeon. ■



NHJ: Dr. Harris, every day our lives are being influenced by automated devices and technologies we could not have even imagined only a few years ago. Most of us are aware of computer-assisted surgery, and robotically-assisted surgery, but we probably did not realize just how far this technology has progressed.

What was the driving force behind the development of the ARTAS™ System?

JH: There were several forces. The first one was patient-driven. There was a new hair transplant technology, follicular unit extraction (FUE) that was becoming popular. More and more patients were requesting this procedure, but it was time consuming and required tremendous precision and dexterity. This conundrum provided an impetus, or at least an opening, for someone to ask, "Can I (or we) fill a need here?" The second factor was the lack of technology in the hair restoration field.

Follicular unit extraction is not complex, but it is a procedure that requires a high degree of eye-hand coordination. To become adept at this procedure a physician must spend a significant amount of time practicing to become proficient. The FUE procedure doesn't lend itself to being easily adopted into a lot of physicians' practices. So these two forces – people wanting this procedure, but a lack of physicians being able to provide it – created an opening for a new technology that would allow an average physician to perform follicular unit extraction in an efficient, safe manner and meet patient demand.

NHJ: What precisely is the ARTAS™ System robot able to do?

JH: It is extremely adept at assisting the physician identify, target and perform the dissection of follicular units from a patient's scalp.

... I've been doing follicular unit extraction for over eight years and I find it is actually helping me perform that surgery better.

NHJ: Let's pretend I'm a medical assistant assisting with hair transplantation. Should I be applying for another job, or is my career safe?

JH: Your career is safe. The ARTAS System may actually help you broaden your horizons. Medical assistants have been confined to certain aspects of hair restoration – the implantation and dissection of grafts, and so forth – but this adds a whole new level of expertise. I rely heavily on my assistants to help me, and they're now being trained in robotic control, manipulation of the hardware to change out the disposable equipment, removing grafts and assisting in logging the numbers of hairs per graft. So the ARTAS System is actually dependent on the medical assistant and it is broadening their role in the practice.

NHJ: Do you see it as a complementary device or a replacement device in your surgery?

JH: Definitely complementary. I've been doing follicular unit extraction for over eight years and I find it is actually helping me perform that surgery better. It's been built on the experience I've accumulated over eight years in terms of analyzing a patient's donor area, making decisions about angles and directions, and using eye-hand coordination to apply the dissecting tool to the scalp. ARTAS System assistive technology is very accurate and precise and that allows me to use my skills and judgment in other areas. It's freed up a lot of time as well as mental and physical energy. Doing three or four hours of extractions by hand is physically demanding.

NHJ: So, the patient gets the best of artistry and precision, while you stay fresh and alert.

JH: That's absolutely correct. That's certainly one of the major advantages of using this type of assistive technology. But remember, the robot is not making decisions on its own. It's drawing on our experience, then using its technology – its vision systems, its algorithms and the computers – to make accurate assessments of the hair follicles and their emergent angles very quickly and then apply a dissection tip to dissect the grafts out.

NHJ: This is not an easy technology. How did you go about testing each step along the way?

JH: It went through cycles. The basic robot was put together in California. Initially, we used models, dummy heads with implanted fibers that the robot would track. Once we got to the point where we were authorized by an institutional review board to conduct human studies, we had a prototypical robot made and brought to my clinic in Denver.

There were two test sites, one here and another in California. Every time the team came to Denver there was a plan for what was to be tested or reviewed; we were very focused on what we wanted to accomplish. If we had a certain type of tip, or dissection protocol, we closely examined them during each patient session and made detailed notes about how the robot responded.

We asked questions like were there any problems or technological enhancements we could make for the next cycle?

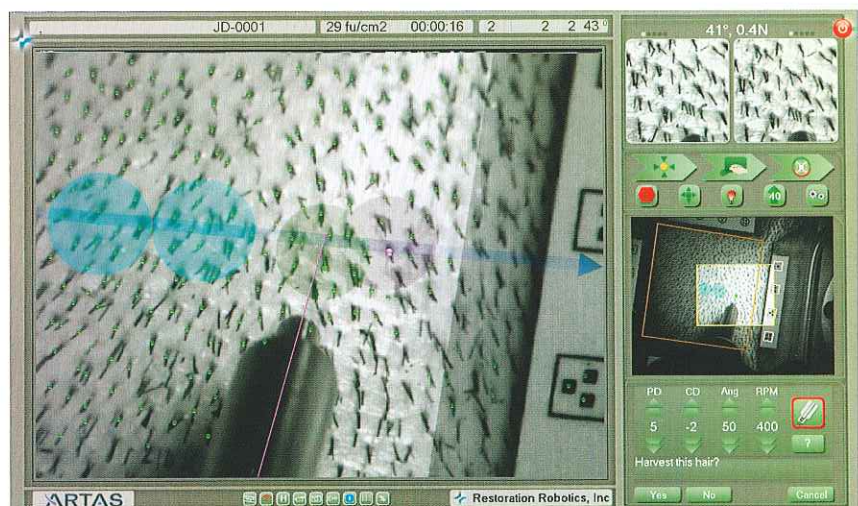
We would usually do three or four patients procedures during the week, and then we'd have a session to talk about how everything went. Then, we would devise a plan of what needed to be changed in terms of hardware or software or patient comfort. We would always try to implement those changes before the next visit, which was usually a month later.

The technical research conducted by Restoration Robotics has been going on for about five years now and we've been doing clinical testing for three and a half years. During that time, we have been conducting transplant procedures every three to four weeks. The evolution over those three and a half years of patient testing has brought us to the level we're at now. When I stand back and look at it, I still find the capabilities of the ARTAS System amazing!

NHJ: All this meticulous research led to a happy conclusion in the spring of this year when the FDA cleared the device. What does it mean when they "clear" a device?

JH: We had to prove that there was a sufficient degree of safety so patients undergoing these procedures would not have any adverse outcomes. Safety is always the FDA's top concern. We'd done over 300 patients during the testing process and not seen any adverse events as a result of being operated on by the ARTAS System, so we were confident about this requirement.

The second thing was efficacy. Could the ARTAS System deliver to patients



The ARTAS System pinpoints the exact location of each follicular unit on the patient's scalp and then targets it for harvesting at the optimal approach.



Patient Hairline Pre-Procedure



Patient Hairline 9 Months Later

the same results that physicians were achieving manually? To answer this, we conducted handheld follicular unit extractions in parallel throughout the trials and compared them to the robotic procedures. We were able to demonstrate that the robot was producing at least as good or better results than doing it by hand.

NHJ: When a patient visits your clinic for robot-assisted surgery, what is different about the procedure?

JH: Everything starts the same way for every patient. We sit down and discuss the surgical plan – what the patient's desires are, and how we plan to meet them. We confirm the number of grafts we hope to produce that day.

Safety is always the FDA's top concern . . . over 300 patients during the testing process and not seen any adverse events as a result of being operated on by the ARTAS™ System . . .

The difference starts when I tell them about the new technology we will be using and the seating arrangement. For follicular unit extractions, I typically have the patient lie facedown in a prone position. They are probably not accustomed to this. I explain that we have a special chair that allows many adjustments and they will be in a seated position, leaning forward, with their head face down on a small pillow like one of the massage chairs they might have seen at a spa or massage facility. I also explain that they may be in this chair for several hours. Then I tell them where the robot is located and explain that when we bring it into position, it will be behind their head.

They also need to be told in advance what they might feel and hear during the procedure. The actual prepping of the donor area is the same as for a standard follicular unit extraction. We have to trim the hair short, down to a millimeter and a half and numb up the area just like we would normally do and I explain this is because the robot has to see what it's working on and be guided to the donor area. To do this, we have something we call a skin tension device, or "tensioner." It is a small, plastic, spring-loaded apparatus that we apply to the back of the scalp. It creates slight tension that keeps the skin stable in the target area. This area is a small square and on its outer margins there are what we call "fiducial markings," which are black and white markings that the robot has been taught, through computer programming, to recognize as the target area. Attached to the skin tensioner are the rubber reminder straps I mentioned earlier that in turn hook onto the chair, so not only does the skin remain stable, the patient is also reminded that we're working back there. After the skin tension device is placed on the back of the patient's head, I will explain that they're going to hear me request my assistant to issue commands to the robot about its position or inputting certain settings regarding depths, speeds and angles. Then, I'll bring the robot arm into a position where it can see the skin tension device and those fiducial markings, and I'll instruct it through a remote control to look for those fiducials.

The robot will then look at the tensioner through a wide-angle camera, and start to read the fiducial markings around the identified area. Once that is completed, it will analyze the data of every single hair and follicular unit and start assessing angles and directions.

When I give the command to proceed,

the robot will start the dissection process. The patient will hear some mechanical noises and pneumatic sounds which are simply the mechanism itself doing what it needs to do to get the punches to the scalp and complete the dissection.

Other than those sounds, the only other sensation the patient is likely to experience is a slight pushing sensation against the scalp and I usually tell them that they'll probably get bored after the first three or four of those and fall asleep.

Once we're done with the first donor area, we move the skin tension device to another position and repeat the process.

... the few of us who do offer FUE are inundated with patients from outside our geographic regions and we're having a hard time meeting the demand.

We usually get between 90 and 120 grafts at each application. We continue to move the tensioner along different areas of the scalp to get the number of dissections needed. After that, we remove the graft and prepare the patient for placement. From the patient's perspective, it's a benign experience. They're just sitting in a massage chair, hanging out for most of the day.

NHJ: What about the placement of the follicular units? Does the robot design and place the hair?

JH: Those are things for the future. Right now, our goal is accurate dissection of the follicular units. This is the major impediment for physicians wanting to provide follicular unit extractions. We've intentionally focused our attention on this portion of the procedure. But now that we've done this, I can tell you that further endeavors are underway to develop the robot's ability to create recipient sites and implant the grafts. Meanwhile, the profession must rely on the physician and his or her artistic abilities to create hairlines and gauge density.

NHJ: Does the ARTAS System now open the door wider to FUE?

JH: Absolutely. I've trained a lot of doctors to perform FUE, but because of the

amount of effort and time it takes to become proficient, many physicians are still reluctant to do this. With the ARTAS™ System however, I can show a doctor how to perform the surgery using this new technology in about 20 minutes, and they can become relatively proficient in less than an hour. It's an amazingly simple system to use, and it gives consistently reliable results in terms of graft production and great graft quality. When doctors around the world see this, I think they are going to realize this could be their entree into hair transplantation.

It's an amazingly simple system to use, and it gives consistently reliable results in terms of graft production and great graft quality.

NHJ: Does robotics lead to significant economies for the clinic... and its patients?

JH: That's one of the reasons I purchased an ARTAS System myself. I see it as a great way to achieve new efficiencies and leverage my resources. If I have members of my team who aren't actively assisting me in surgery, I can now have them work with the ARTAS System in a second operating room. I'm also finding that the technology is drawing new patients into the clinic who were hesitant before. It was for all those very reasons that I acquired the first ARTAS System in the world.

NHJ: You have invested a huge amount of time perfecting your surgical skills. Are these now going to be put at risk as the ARTAS System makes hair restoration surgery available to physicians without that specialist training?

JH: Both Restoration Robotics and I feel that this should only be put into the hands of physicians who are trained in hair restoration. The last thing we want to do is provide sophisticated technology to untrained individuals because we know that even though we can produce high quality grafts, only the expertise of someone trained in hair restoration can deliver the results that patients really want.

NHJ: How many locations are currently using the ARTAS System?

JH: One. I'm the one and only physician to have the ARTAS System in the world. As a member of the team that developed this, if ARTAS System wasn't a technology I could confidently integrate into my practice, I would not be involved in its marketing and I wouldn't be talking to you or any other news providers. I'm not paid by Restoration Robotics to say anything about the ARTAS System. I do this as a way to advance the field of hair restoration.

NHJ: If I was a physician reading this interview and wanted to bring robotics into my clinic, what should I do next?

JH: Contact Restoration Robotics. They will provide some basic information about the system and invite you to visit my office to observe a surgery being performed. Already, right through September, I have visiting physicians scheduled for every one of my surgeries.

NHJ: Is FUE going to become the hair transplant procedure of choice?

JH: FUE offers something that many physicians are having trouble providing—surgery that is less invasive than the strip and heals quicker. Within about two days, my patients feel like nothing ever happened to their donor area.

The mild to moderate postoperative pain that patients experience with strip surgery is basically eliminated. The FUE procedure produces mild soreness for a day or two, and that's about it. Most of my patients will just take a Tylenol or Motrin for one night and don't need anything after that. The numbness and tightness that people experience with the strip has also been eliminated.

NHJ: On a more trivial note, and with apologies to Stanley Kubrick, have you ever woken up from a nightmare where your ARTAS machine is leaning towards you saying, "I'm sorry, Jim, I can't do that"?

JH: There's a big, red button on the machine, another one on the remote in my hand and one for my medical assistant on the control panel. If the robot "says" anything unexpected we hit the big, red

button and everything stops.

NHJ: So the humans are still firmly in control...

JH: This system requires specific input from the physician and staff to function. But what I've told patients jokingly is that the worst thing that could happen is that they'll get more hair! ■



James A. Harris, MD

has been performing hair restoration for over 14 years. He is the medical director of the Hair Sciences Center of Colorado, and a clinical instructor at the University of Colorado Medical School in the Department of Otolaryngology and head and neck surgery. He was the principal investigator for Restoration Robotics and the development of the ARTAS System.

Dr. Harris designed and developed the Safe System for follicular unit extraction, which is the technological platform that the ARTAS System uses for its dissection.

About the Company

Restoration Robotics, Inc., a privately held medical device company, is dedicated to revolutionizing the field of hair transplantation by developing and commercializing a state-of-the-art image-guided system (ARTAS System) that enables follicular unit extraction.

For more information, contact:

Restoration Robotics, Inc.
Tel: 1-650-965-3612
www.artashair.com

Excerpted and reproduced with permission of The National Hair Journal



PRESS RELEASE



RESTORATION™
ROBOTICS



ARTAS System Receives FDA Clearance for Ground-Breaking Technology Treating Hair Loss

Restoration Robotics, Inc., a medical device company that pioneered the first robotic follicular unit harvesting system, today announced that it has received FDA 510K clearance for its revolutionary ARTAS System

MOUNTAIN VIEW, Calif.--([BUSINESS WIRE](#))--Restoration Robotics, Inc. a privately-held medical device company, today announced that its revolutionary technology, the ARTAS™ System, has received 510K clearance from the Food & Drug Administration (FDA) for harvesting hair follicles from the scalp in men diagnosed with androgenetic alopecia (male pattern hair loss) with black or brown straight hair. The ARTAS™ System was developed in close collaboration with several leading hair restoration physicians to enhance the quality of follicular unit harvesting for the benefit of physicians and their patients.

“There is growing interest in FUE because of its many patient benefits, such as less discomfort and a quicker return to normal activities. The ARTAS™ System solves many of the technical challenges experienced by physicians currently attempting the FUE procedure which gives physicians and patients an exciting new choice.”

“We are thrilled to receive FDA clearance, and look forward to rolling out the ARTAS™ System to leading hair restoration physicians,” said Jim McCollum, Chief Executive Officer, Restoration Robotics. “Hair loss is a very real issue for millions of men in the United States. We’re pleased to offer a powerful new technology for patients who are interested in a safe new way to enhance their quality of life.”

ARTAS™ is a physician-controlled, state-of-the-art, interactive, computer-assisted system that enables harvesting of hair follicles during hair restoration procedures. It combines several features including an image-guided robotic arm, special imaging technologies, small dermal punches, and a computer interface. The ARTAS™ System is capable of identifying and harvesting individual follicular units to implement the follicular unit extraction (FUE) technique.

The Benefits

“Many patients are seeking less invasive alternatives to the current hair restoration techniques,” said Miguel Canales, MD, Medical Director, Restoration Robotics. “There is growing interest in FUE because of its many patient benefits, such as less discomfort and a quicker return to normal activities. The ARTAS™ System solves many of the technical challenges experienced by physicians currently attempting the FUE procedure which gives physicians and patients an exciting new choice.”

Hair restoration is performed as an office-based procedure. Implanted hairs develop their own blood supply, begin to grow and new hairs are seen a few months after the procedure. New hair continues to grow over the course of a full year, making the change in the patient’s appearance gradually noticeable to others.

"I believe the ARTAS™ system will make hair restoration more attractive to a broader group of patients," said James Harris, MD, of the Hair Sciences Center in Denver, CO. "In my practice, I have seen a significant increase in patients asking for FUE because of its minimally invasive approach. They really liked the rapid healing and lack of a linear scar, which makes this procedure different from the strip method."

Hair Loss By The Numbers

According to the International Society of Hair Restoration Surgery (ISHRS)¹, at least 35 million men in the United States are affected by male pattern baldness or androgenetic alopecia. By age 50, approximately 50% of men will experience some degree of appreciable hair loss. Approximately one in four men suffer from male pattern baldness (MPB), which has psychological, professional and social consequences for these patients, such as:

- 68% of men feel helpless about their hair loss
- 73% of balding men feel they are less attractive than they were when they had hair²
- 77% of balding men would feel very or somewhat concerned if they were in their 20s, just starting their career and experiencing hair loss³

While prescription remedies, such as Propecia® and Rogaine®, offer some benefits to existing hair, hair restoration moves healthy, functioning follicles to the areas of the patient's scalp most impacted by baldness for more dramatic results. Hair restoration is a popular cosmetic procedure, with an estimated number of procedures exceeding 100,000 in the U.S. in 2009. Hair restoration is the only permanent solution for hair loss and can result in a natural, undetectable outcome.

About Restoration Robotics

Restoration Robotics, Inc., a privately held medical device company, is dedicated to revolutionizing the field of hair transplantation by developing and commercializing its state-of-the-art image-guided ARTAS™ System. This interactive, computer assisted system uses image-guided robotics to enhance the quality of hair follicle harvesting for the benefit of physicians and their patients. To learn more about Restoration Robotics and its unique technology, visit www.restorationrobotics.com. To learn more about hair loss and restoration, please visit the International Society of Hair Restoration Surgeons (ISHRS) at www.ishrs.org.

¹ International Society of Hair Restoration Surgeons (ISHRS) website. <http://www.ishrs.org/hair-loss/hair-loss-male.htm>. Accessed April 11, 2011.

² *Journal of the American Academy of Dermatology*

³ ISHRS 2006 Consumer Hair Loss Survey

Contacts

Pascale Communications, LLC
Rosemary Valenta, 917-701-3246
rosemary@pascalecommunications.com

Restoration Robotics' Revolutionary ARTAS System Receives CE Mark to Treat Hair Loss

MOUNTAIN VIEW, Calif.--(BUSINESS WIRE)--Restoration Robotics, Inc., a privately-held medical device company, today announced its revolutionary ARTAS® System received CE Mark Certificate (*Conformité Européenne*) to market in the European Union. The ARTAS System is the first physician controlled, computer assisted technology that allows harvesting individual follicular units directly from the scalp. This minimally invasive solution utilizes sophisticated digital mapping and precision robotics to deliver permanent and natural looking results.

“Receiving the CE Mark for Europe is a major milestone that indicates our FDA-cleared solution also meets the quality and safety standards required by the international healthcare marketplace”

“Receiving the CE Mark for Europe is a major milestone that indicates our FDA-cleared solution also meets the quality and safety standards required by the international healthcare marketplace,” said Jim McCollum, President and Chief Executive Officer, Restoration Robotics, Inc. “We have seen strong interest in bringing the ARTAS System to Europe, and we can now move forward with our expansion plans.”

Hair Loss By The Numbers

Hair loss affects approximately 50% of all men and over 25% of all women worldwide. Over 35 million men are affected by male pattern baldness (*androgenetic alopecia*) in the United States alone.¹ Approximately two-thirds of American men will experience appreciable hair loss by age 35; by age 50, 85% will see significant loss in hair thickness.² Genetic hair loss, which typically begins between late adolescence and before or during middle age, is largely untreatable outside of surgery.

About Restoration Robotics

Restoration Robotics, Inc., a privately held medical device company, is dedicated to revolutionizing the field of hair transplantation by developing and commercializing its state-of-the-art image-guided ARTAS® System. This interactive, computer assisted system uses image guided technology to enhance the quality of hair follicle harvesting for the benefit of physicians and their patients. To learn more about the ARTAS System and its unique technology, visit www.artashair.com.

¹ <http://www.ishrs.org/hairloss-hair-loss-male.htm>

² http://www.americanhairloss.org/men_hair_loss/introduction.asp

Contacts

Pascale Communications, LLC
Audra B. Friis, 917-519-9577
audra@pascalecommunications.com

TEXAS SURGEON DOUBLES CAPABILITIES IN 2013 WITH INSTALLATION OF SECOND ARTAS SYSTEM

The ARTAS Robotic Procedure Redefines the Focus of Doctor's Practice

Mansfield, Texas – 3.19.2013 – Restoration Robotics, Inc. announced today that Dr. Mark Bishara, with offices in both Mansfield and Southlake, Texas, has become the first surgeon in the United States to install a second ARTAS® System for his practice. The ARTAS System is the first and only FDA cleared, computer assisted technology that allows physicians to offer this minimally invasive robotic hair transplantation solution to their patients. The ARTAS System offers hair restoration physicians and patients unprecedented levels of safety, efficacy and patient comfort.

Dr. Bishara became one of the earliest adopters of the state-of-the-art system with his Mansfield office installation in January 2012. Now, a second ARTAS System has been installed in Dr. Bishara's Southlake office. Dr. Bishara has performed around 12-15 ARTAS procedures per month and within three months anticipates an increase to 32 cases per month – on average. Hair restoration now represents about 70% of his practice, which he attributes in great part to the ARTAS system completely redefining his focus and adding to his practice's capabilities.

“Bringing in a second ARTAS System was the centerpiece of my new location which just opened in Southlake. The demand for robotic hair transplantation has grown tremendously since we first started offering the procedure,” explains Dr. Bishara. “We want to give the consumers what they want, when they want it, and at an extremely high level of precision.”

Hair Loss by the Numbers

Over 35 million men are affected by male pattern baldness (*androgenetic alopecia*) in the United States alone.¹ Approximately two-thirds of American men will experience appreciable hair loss by age 35; by age 50, 85% will see significant loss in hair thickness.² Genetic hair loss, which typically begins between late adolescence and before or during middle age, is largely untreatable outside of surgery.

About Dr. Mark Bishara

Dr. Bishara is a member of the American College of Surgeon (ACS), the American Academy of Cosmetic Surgery (AACS), the Dallas County Medical Society and the Texas Medical Association. A native-born Texan, Dr. Bishara received his Bachelor's degree in Biomedical Science at Texas A&M University and worked in multi-specialty charity clinics in underserved areas of Latin America before returning to the United States for two years of clinical training at New York Medical College. After completing a five-year residency in general surgery at Morristown Memorial Hospital, which is affiliated with the prestigious Mount Sinai Medical School in New York, he founded the American Plastic and Reconstructive Research Association, a think tank for novel concepts and respective clinical applications in plastic surgery. He also completed a fellowship appointment in Aesthetic and Reconstructive Plastic Surgery at Harvard Medical School. In addition to hair restoration surgery, Dr. Bishara's specialties include cosmetic surgery of the breast, rhinoplasty, abdominoplasty (tummy-tuck), liposuction, cosmetic surgery of the face and body contouring after major weight loss.

About Restoration Robotics

Restoration Robotics, Inc., a privately held medical device company, is dedicated to revolutionizing the field of hair transplantation by developing and commercializing its state-of-the-art image-guided ARTAS® System. This interactive, computer assisted system uses image guided technology to enhance the quality of hair follicle harvesting for the benefit of physicians and their patients. To learn more about the ARTAS System and its unique technology, visit www.restorationrobotics.com or www.artashair.com.

1. <http://www.ishrs.org/hairloss---hair---loss---male.htm>

2. http://www.americanhairloss.org/men_hair_loss/introduction.asp

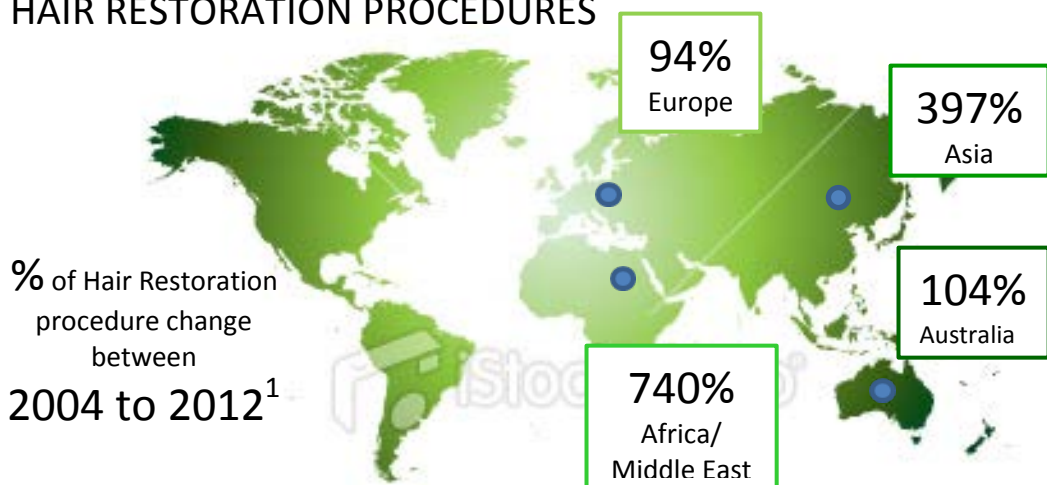
Media Contact

Pascale Communications LLC.
Mona Finston 201-839-556
mona@pascalecommunications.com

WORLDWIDE QUICK FACTS

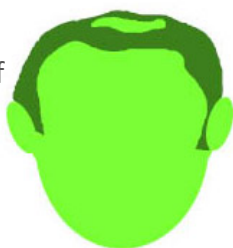
ACCORDING TO ISHRS

FAST GROW WORLDWIDE VOLUME OF SURGICAL HAIR RESTORATION PROCEDURES



On average, ISHRS members reported devoting nearly **70%** of their practice to hair¹

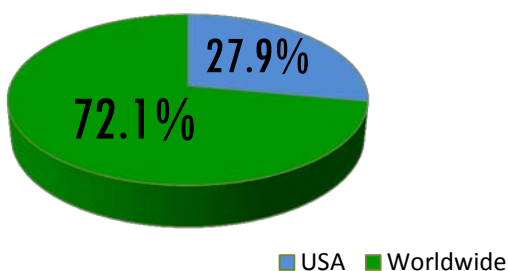
In 2012 **92.9 %** of the hair transplant procedures target **SCALP AREA**¹



Almost **1 MILLION** Hair Restoration patients were treated by ISHRS members in 2012¹

“The **TOTAL MARKET SIZE** for hair restoration surgery [WORLDWIDE] has increased **47.9%** since 2008 from **\$1.3 billion USD** in 2008 to **\$1.9 billion USD** in 2012.”¹

THE NUMBER HAIR RESTORATION PATIENTS TREATED WORLDWIDE IN 2012¹



International Markets

- Canada
- United Kingdom
- France
- Italy
- Japan
- South Korea
- Thailand
- Singapore
- Saudia Arabia*
- Germany*
- Australia*
- Turkey*
- Spain*
- Brazil*
- Mexico*
- Argentina*
- Colombia*

** Pending*



OUR PROMISE

Restoration Robotics is dedicated to ensuring customer success throughout the purchase, training and operation experience. We recognize that the ARTAS® System is a transformative technology for our customers' practices. Therefore, we have developed support services that are equally advanced and comprehensive to make the whole customer experience comfortable and rewarding.



**RESTORATION™
ROBOTICS**

128 Baytech Drive
San Jose, CA 95134
Phone: (408) 883-6888
Fax: (408) 883-6889
email: contactus@restorationrobotics.com
www.restorationrobotics.com

This product and/or its use is covered by one or more of the following U.S. patents: 6,585,746; 7,477,782; 7,627,157; RE 42,381; RE 42,437; 7,962,192; 8,048,090; 8,133,237; D641941; D641942; D644675; 8,199,983; 8,211,117. Additional US and foreign patents pending. RESTORATION ROBOTICS, ARTAS, the stylized logos, ARTAS KEY, ARTAS VISION, ARTAS GENERATION, ESSENTIAL TECHNOLOGY FOR HAIR, HAIR RESTORATION REDEFINED and VISUALIZE THE POSSIBILITIES are among the trademarks and/or registered trademarks of Restoration Robotics, Inc. in the United States and other countries.

© 2011-2012 Restoration Robotics, Inc. All Rights Reserved.

No part of this document may be reproduced or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without prior written permission from Restoration Robotics, Inc.