ROBOTIC, AI-ASSISTED FOLLICULAR UNIT EXCISION AND IMPLANTATION FOR HAIR RESTORATION WITH ARTAS® IX

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INTRODUCTION

Medical robotic systems are assisting an increasing number of surgical procedures across multiple medical specialties. In 2011, the first robotic platform for hair transplantation was introduced, enabling follicular unit excision of hair grafts (ARTAS, Venus Concept Inc, San Jose, CA). Recently, a new robotic system was developed that, in addition to harvesting follicular units, also creates recipient sites and implants grafts. (ARTAS iX, Venus Concept, San Jose, CA).

Robotic hair transplantation allows for electronic visualization of the harvest and recipient areas, contains an Artificial Intelligence algorithm that helps in optimizing the procedure, but perhaps most importantly, allows for repeated preciseness of excision and implantation with no reduction in quality as can happen with increasing physician fatigue in manual hair transplantation. Furthermore, less graft handling is necessary, which limits the chance of damage to the follicle.

OBJECTIVE

The objective of this case study was to evaluate the use and efficacy of the new robotic ARTAS iX System in both harvesting and implantation of follicular units in hair transplantation surgery.

METHODS

A 46-year-old male with light brown straight hair presented with androgenic alopecia, Norwood Grade 3, and elected to undergo a Follicular Unit Extraction (FUE) hair transplantation procedure using the ARTAS iX System (Fig. 1). The study protocol was received IRB approval.

The patient was prepped and given the standard anesthesia protocol, which includes a ring block for the harvest area and a supraorbital nerve block followed by a ring block for the recipient area. The physician created a 3-D preoperative plan design using the ARTAS Hair Studio graphical user interface. This graphical user interphase allows the physician to customize the harvesting and implantation parameters.

Fig. 1 ARTAS iX System

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For the harvesting procedure, a tensioner was placed on the scalp to provide uniform skin tension and fiducial guidance for the robot. Using machine vision image guidance, and following the device AI established treatment algorithm, the system excised predetermined individual follicular units with a combination of a 1.0mm needle and rotating coring punch (Fig. 2a). The grafts were harvested, counted, trimmed, and placed in linear cartridges of 25 grafts each. The cartridges were then loaded individually into the implantation mechanism of the system. Temporary fiducial markers were applied around the recipient area of the scalp spaced 2-3cm apart. A tensioner was also used to provide tension on the scalp skin during the implantation procedure. Using a 0.9mm (19G) implantation needle and "stick and place" technique, the ARTAS iX implanted the grafts by simultaneously creating a recipient site (Fig. 2b) and inserting a graft from the cartridge according to the digital plan prescribed by the physician. After the treatment, the patient was discharged under standard protocol, and returned home. The patient returned for follow up photographs 12 months after the procedure.

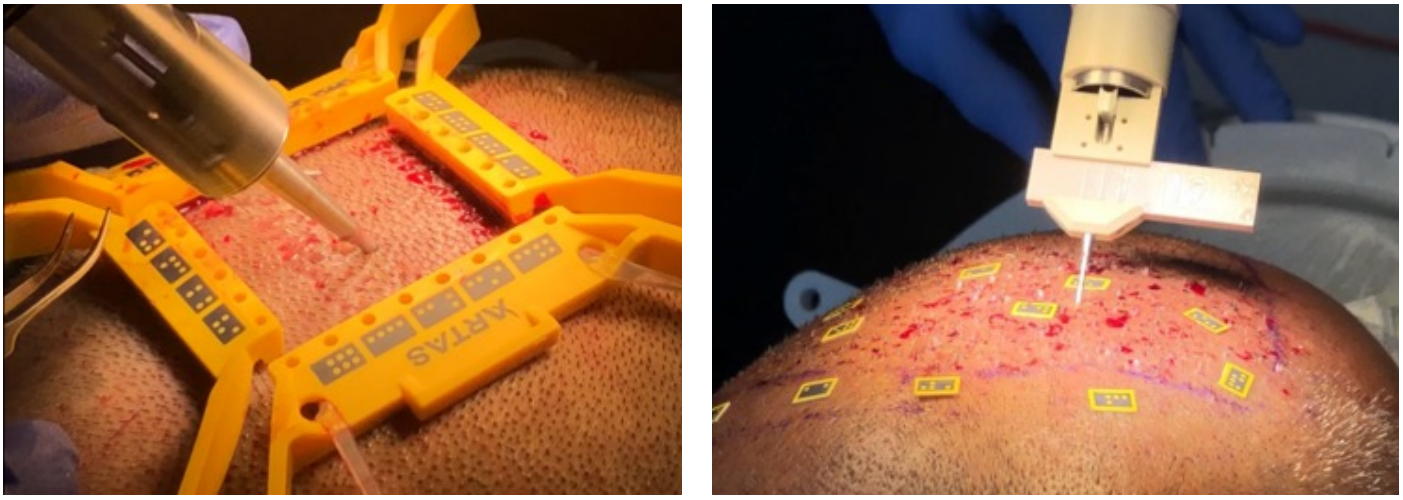

Fig. 2 a) ARTAS iX excising an individual follicular unit. b) ARTAS iX creating a recipient site and inserting a graft from a loaded cartridge.

RESULTS

During the transplantation procedure, 2412 follicular unit grafts containing 5910 terminal hairs (average of 2.45 hairs/graft) were harvested from the patient's donor area using the robotic system at an average harvesting speed of 1093 grafts/hour, with peaks as high as 1318 grafts/hour. The total harvesting time was thus just over 2 hours long. Thereafter, the grafts were implanted robotically at an average rate of 468 grafts/hr., with peak rates at 794 grafts/hour for a total implantation time of approximately 5 hours. No adverse events or post-operative complications were reported. The patient returned for follow up, up to 12 months after the procedure (Fig. 3).

Fig. 3 Photographs before (left) and 12-months after (right) the hair transplant procedure using the ARTAS iX Robotic System.

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DISCUSSION

Manual FUE is a widely used and clinically proven technique in hair transplantation. However, the procedures are often long and require thousands of precise repetitive motions to accurately excise and implant individual grafts. Fatigue can cause pain and discomfort for the clinician,[1] and potentially lead to human error and higher transection and reduced yield rates,[2] particularly towards the end of long cases. Furthermore, manual implantation requires a significant amount of graft handling at the bulb of the hair follicle. Given the relative fragility of the follicles, increased handling can lead to a higher risk of damaging the follicle.[3] The amount of handling and hence opportunity for the graft to be damaged is limited with the use of the robotic implanter. Use of an image-guided, AI controlled robotic system, such as the ARTAS iX to assist in the procedure, addresses many of the physical limitations of human vision, decision of the location from which to excise or where to implant, physical fatigue, and motor skill precision. At the same time, ARTAS iX produces comparable 12-month results to those achieved using manual techniques by an experienced surgeon. The stick and place method of implantation used by ARTAS iX (placing the graft immediately after incision) reduces bleeding, and eliminates the need for continual cleaning of the recipient sites of blood as is common when sites are premade.[4],[5] With no fibrin occluding the recipient site, it is smoother and softer potentially improving graft acceptance. Issues such as leaving empty holes or placing two grafts in the same hole and/or planning errors such as making more holes than available grafts are non-existent.[4]

Minimizing the amount of overall operative time is of interest to both the patient and the physician. ARTAS iX was able to excise hairs at a rate of 1093 grafts/hour which is at the top of the range possible by an experienced surgeon doing a manual hair transplant. Typical excision rates vary between 100-1000 grafts/hour for the manual method. The implantation rate was 468 grafts/hour, which is significantly faster than manual stick and graft or separated needle stick and graft placement rates of about 371 grafts/hour.[6]

This case study demonstrates that the ARTAS iX can provide clinically efficient surgical workflows that are superior to manual techniques, with the potential to reduce total case time for FUE procedures, while at the same time reducing graft manipulation thanks to the stick and place technique used by the device.

CONCLUSION

The ARTAS iX System is a novel robotic hair restoration platform that provides safe, effective, and clinically efficient follicular unit harvesting and implantation functionalities.

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