Origami using da Vinci Surgical System

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Introduction

Great progress has been made in the development of robotic surgical technology, but it is necessary to become skilled in using the robot. Among the advantages of the robot is practice in acquiring skill with stereoscopic three-dimensional (3D) imaging. We describe use of the da Vinci surgical system (Intuitive Surgical, Inc. Sunnyvale, CA) in developing necessary skills by practicing traditional Japanese Origami (paper folding) , and we quantified the robotic-assisted dexterity.

Technique

We prepared square sheets of paper (2 cm x 2 cm), and folded crane origami using the da Vinci surgical system. Scaling was kept constant as “ultra fine” mode throughout the maneuver with 0 degree scope of 10 times magnification, and Endowist black diamond forceps were mounted on both robotic arms. Folding of the crane origami was done using the same way as in the traditional Japanese manual method. The time to successful completion, and all maneuvers were recorded. On the first two occasions we failed to fold the origami because we tore the paper. The third trial was successful, the total folding time being 23 minutes (Fig 1).

Comment

Origami designs generally begin with a square sheet of paper, and usually the paper is not cut. The crane origami is one of the more advanced origami designs, and the best results are obtained by carefully matching the

corners and making the creases sharp without tearing the paper.

The surgical robot offers the advantages of allowing accurate maneuvering and providing depth perception during operation. We were able to evaluate enhanced dexterity in Origami work by means of two intuitive master handles at the remote console and the 3D imaging afforded by the da Vinci Surgical System.

The disadvantage of the surgical robot is the lack of tactile feedback, son that the console surgeon must perform suturing relying on visual feedback only. Badani et al have reported advantages of robotic three-dimensional suturing [1]. A high-resolution, binocular, 3D and magnified imaging of da Vinci Surgical System enable the console surgeon to feel that he or she is operating as if the open surgical technique were being used. Our study confirms that the console surgeon can benefit from 3D imaging. The development of robotic instruments has added two more degrees of freedom than conventional endoscopic instruments, to obtain seven degrees of freedom. The presence of the “wrist like” joint is particularly useful in procedures like suturing and knot tying , which need high maneuverability and flexibility. The technology of the surgical robot, such as tremor filtration and motion scaling, also facilitates maneuverability. Moorthy et al reported that these technological advantages enhanced dexterity by nearly 50% as compared to laparoscopic surgery [2].

We believe that practicing origami with the robot is excellent training for robotic surgery by acquiring the sense of tactility from 3D imaging and precise maneuverability.

References

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Fig 1

Crane origami using da Vinci Surgical System.