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Original Research Paper

Gynecology

DESIGN DEVELOPMENT AND FABRICATION OF AN ATRAUMATIC ROSAI BOWEL PROTECTOR/ RETRACTOR

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ABSTRACT Primary goal of this project was to design an effortless retractor for atraumatic bowel protection/retractor for deep pelvic surgeries with MRI assessment for normal human anatomical range of pelvic dimensions and bowel volume dimensions and AI enabled design.

KEYWORDS : Atraumatic, Bowel retraction, Artificial Intelligence enabled, Magnetic Resonance Imaging for pelvic dimensions and bowel volume dimensions.

INTRODUCTION

Retractors are crucial for success of any surgical procedure [1-3]. They can be broadly classified as hand held or self retaining retractors. They come in different sizes shapes and designs. With adequate lighting they help the surgeon to navigate into generally inaccessible areas like deep or minimally open cavities. Better visibility helps in finishing the surgery quicker with fewer complications that related to the procedure. Designing the right retractor for the procedure is crucial and not all retractors serve the same purpose. Surgeries in pelvis provide challenges of depth and size that needs to be customized for the patient [4, 5]. We have studied the normal human variation with MRI [6,7] and with AI prediction algorithm designed a retractor that would fill the gap of a suitable device for deep pelvic surgeries making it quicker and safer. Integrating MRI analysis delineating normal human anatomy with AI enabled designing has helped us to come up with the design of ROSAI BOWEL PROTECTOR for deep pelvic surgeries.

Design and fabrication.

MRI analysis of pelvic dimensions and bowel volume contents were done for normal population in the age range of 10 years to 80 years and bowel volume and height in pelvic cavity and recto uterine pouch dimensions were calculated. AI based algorithm was designed to fabricate the dimensions of a retractor that would effortlessly reach the maximum depth of recto uterine pouch and flanges were designed to cover the span of pelvic cavity and number of flanges were adjusted to two to cover the pelvic bowel depth that had to be retracted. Ergonomically and AI [9-11] enabled design was then fabricated with stainless steel with polyurethane coating with silver doped hydroxyl apatite nanoparticles.

Advantages and unique design characteristics.

For surgeries in pelvis, bowel retraction is of paramount importance. There are no retractors that cover all surgical safety points. No single size that fits into all patients too. This necessity led us to design this bowel retractor for pelvic surgeries. This is unique and has the following advantages

1. Natural specially designed shape that fits into recto uterine pouch – universal size adaptation.
2. Malleable flanges that can be moulded to required retraction extent
3. Atraumatic soft malleable flange with rounded edges that avoids bowel trauma and compression
4. Two adjustable malleable flanges that allows customisation of depth according to patients pelvic cavity depth
5. Flanges that can be dismantled for adjustment during surgery, for cleaning and sterilisation
6. Easy fit technology for flanges that saves time
7. Rounded ergonomically designed retractor tip that avoids tissue and bowel injury
8. Ergonomic shape that adapts to depths of recto uterine pouch
9. Light weight and atraumatic
10. Multiple use with sterilisation
11. Permits surgery to be quicker and safer
12. Handle grip that gives thumb leverage fulcrum for rotation to desired angle in depth for surgical visualisation
13. The round hole grip at the edge can be attached to self retaining systems reducing the number of assistants.
14. Unique non corrosive, antibacterial coating.
15. Makes surgery smoother safer and quicker

Blunt rounded tip

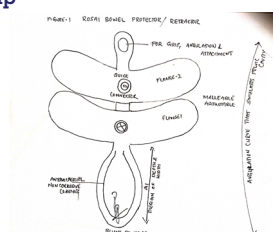

Figure 1. Sketch of Rosai Bowel Retractor

Figure 2 Photograph of Bench work design made in stainless steel

CONCLUSION

Use of AI enablement in design and fabrication of surgical instruments amalgamates surgical necessity with anatomical dimensions and could lead to better and more suited devices for various methods of surgical intervention both open and minimally invasive. For minimally invasive procedures the same model inflatable flanges would work well. Advances in material science would enable various kinds of coating which could be corrosion proof and antibacterial or antithrombotic as per surgical necessity. AI is growing, but exact numbers can be difficult to obtain, as the definition of technologies such as machine learning, AI, machine vision, and others are often hazy. New tools in CAD technology use AI to create a generative design. This takes the specifications and inputs needed for a design and generates all possible materials, geometries, and even costs. Generative design software program tests all the probable alternatives and promptly "generates" the design permutations as a solution. Lastly, the software uses machine learning capability to examine each iteration to determine the best design to adopt.

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