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**Title:** Robotic repair of amyand's hernia: Case report and literature review

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26 **Short Running Title:** Robotic Repair of Amyand's Hernia

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29 submission.

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32 **TITLE:** Robotic repair of amyand's hernia: Case report and literature review

33

34 **ABSTRACT**

35

36 **Introduction**

37 Inguinal hernia repair is among the most common procedures in general surgery.  
38 Contents within the hernia sac are variable and in rare cases, the hernia sac  
39 contains the vermiform appendix termed Amyand's Hernia. While laparoscopic  
40 technique is the most accepted approach, few prospective studies have been  
41 completed comparing laparoscopic versus robotic techniques for hernia repair and  
42 none in the setting of an Amyand's hernia. We describe the first documented robotic  
43 approach to repair of Amyand's hernia.

44

45 **Case Report**

46 We present a 40 year old male that presented to outpatient surgery clinic with  
47 complaint of right scrotal mass. He was diagnosed with right inguinal hernia and was  
48 electively scheduled for robotic repair with mesh. Intra-operatively, type 1 Amyand's  
49 hernia (Table 1) was discovered. Using robotic technique the hernia was reduced  
50 and successfully repaired with mesh. Patient post-operative course was  
51 unremarkable.

52

53 **Conclusion**

54 Amyand's hernia is a rare subtype of inguinal hernia containing vermiform appendix  
55 within the hernia sac. Management of Amyand's hernia is surgery and extent of  
56 intervention is dictated by pathology of the vermiform appendix. While open and  
57 laparoscopic techniques have been well documented, robotic approach is safe,  
58 effective and provides a surgeon with a unique advantage in repair of Amyand's  
59 hernia.

60 Classification model (Table 1). The robotic platform Da Vinci Surgical System's 3D  
61 high definition imaging coupled with advanced degree of dissection control provides  
62 a surgeon with a unique advantage over open and laparoscopic techniques. Robotic  
63 approach to repair of Amyand's hernia is safe and effective.

64 **Keywords:** Amyand's Hernia, Incarcerated Amyand's Hernia, Robotic  
65 Herniorrhaphy, Appendectomy, Robotic Inguinal Hernia

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EARLY VIEW

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97 **INTRODUCTION**

98 Inguinal hernia repair is among the most common procedures in general surgery.

99 However, the contents within the hernia sac are variable. In rare cases, the hernia  
100 sac contains the vermiform appendix. This is termed "Amyand's Hernia" after  
101 Claudius Amyand, an English surgeon who performed the first appendectomy on an  
102 eleven-year-old boy with a perforated appendix inside an inguinal hernia sac in 1735  
103 [1, 2].

104 Usually, these are discovered as an incidental finding intra-operatively. The  
105 incidence of a normal appendix within the inguinal hernia sac is estimated to be 1%  
106 and that of an inflamed appendix to be 0.1% [2].

107 Treatment includes herniorrhaphy with or without appendectomy and/or mesh repair  
108 depending on the vermiform appendix's inflammation status, the patient's general  
109 condition, and other factors [3]. There are current classifications to help guide  
110 physicians proposed by Losanoff and Basson in 2007 [4, 5] (Table 1). There are  
111 however few guidelines on the approach to these situations with laparoscopic or  
112 robotic methods. In a case series done by Sahu et al. three patients with Amyand's  
113 hernia underwent laparoscopic transabdominal preperitoneal hernioplasty without  
114 appendectomy. Investigators found that laparoscopic repair, in the setting of  
115 Amyand's hernia, has a number of advantages including better visualization of the  
116 sac and the ability to inspect and repair a left sided inguinal hernia if present [6].

117 In 2000, robotic surgery platform da Vinci was the first robotic surgery platform  
118 approved by Food and Drug Administration (FDA) for general laparoscopic surgery.  
119 In the years to follow, this novel technology quickly penetrated all aspects of surgical  
120 fields including general surgery. The robotic platform Da Vinci Surgical System's 3D  
121 high definition imaging coupled with advanced degree of dissection control provides  
122 a surgeon with a unique advantage over open and laparoscopic techniques.

123 This technology although not specific to the setting of hernias, has already proven to  
124 improve precision and dexterity, allowing surgeons to perform various operations  
125 that were traditionally not amenable to minimal access techniques [7]. RoFew  
126 prospective studies have been completed comparing laparoscopic versus robotic

127 techniques for hernia repair and none in the setting of an Amyand's hernia. Thus as  
128 a start, this case report will document the first known documented robotic approach  
129 to repair a type 1 Amyand's hernia.

130

### 131 **CASE REPORT**

132 A 40-year-old male presented to the outpatient surgery clinic with a right sided  
133 scrotal mass that had been present since he was a child. Patient admitted that it has  
134 progressively become enlarged but has never become firm, irreducible,  
135 erythematous, or exquisitely painful. He denied changes in bowel habits, nausea,  
136 vomiting, fever, or chills. He did however complain that he could feel his bladder  
137 "slip into the swelling" on occasion which caused him difficulty in urination. This was  
138 not associated with any dysuria, pyuria, or hematuria.

139 Patient has a past medical history significant for obstructive sleep apnea on a CPAP  
140 machine at home, obesity, and borderline hypertension. His only surgical history  
141 was a childhood tonsillectomy. He was not on any medications and has allergies to  
142 penicillin. He denied smoking or drinking but admitted to occasional marijuana use  
143 approximately once every two weeks.

144 On physical exam, he presented with a reducible right inguinal hernia extending into  
145 his scrotum. There was no erythema or tenderness. The testicles were present in the  
146 scrotal sacs bilaterally. The patient was scheduled for an elective robotic assisted  
147 laparoscopic right inguinal hernia repair with mesh, possible bilaterally, in the  
148 ambulatory setting. Preoperative labs were within normal limits.

149 Standard antiseptic technique was used to prep the patient and a total of three port  
150 site incisions were made for the Da Vinci robot arms to dock and enter. The patient  
151 was placed in Trendelenburg position and robotic 8-mm trocars were placed in each  
152 anterior axillary line and a 30-degree camera was placed in the up position in the  
153 umbilical port. The robot was docked in the standard fashion. The right inguinal  
154 region was visualized and incarcerated inguinal hernia was noted. Once hernia  
155 contents reduced, a non-inflamed appendix and portion of the cecum was seen in  
156 the hernia sac. Type 1 Losanoff and Basson classification Amyand hernia was noted  
157 (Figure 1-2).

158 The appendix, cecum, and pericolonic fat were reduced into the abdomen and the  
159 peritoneum was scored from the medial umbilical fold laterally to the anterior  
160 superior iliac spine. A preperitoneal flap was created by dissecting the peritoneum  
161 away from the spermatic cord vas deferens anteriorly with the hook electrocautery.  
162 A 3D max mesh and a 6-inch V-Loc suture were introduced intraperitoneally under  
163 direct visualization. The mesh was used to cover the preperitoneal space overlying  
164 the direct and indirect inguinal spaces. No direct hernia was observed. The indirect  
165 space and rest of the potential hernia sites were covered with mesh with adequate  
166 coverage. The mesh was tucked into the small peritoneal pocket and appeared  
167 secure without evidence of migration. The peritoneal flap was closed with a running  
168 6-inch V-Loc suture. Patient was extubated in the OR and discharged home the  
169 same day after a non-complicated postoperative course.

170

## 171 **DISCUSSION**

172 Robotic surgery has progressed within the past 30 years from the Puma 560 used in  
173 1985 by Kwoh et al to perform neurosurgical biopsies to the NASA influenced Da  
174 Vinci Surgical system used today [8,9]. This system is a complex of 4 arms  
175 controlled by a remote console usually in the same room as the patient. Through  
176 small incisions, the Da Vinci robot features a magnified 3D high-definition  
177 visualization of the operative field and allows precise wristed movements with tiny  
178 instruments that can bend and rotate far better than the human hand.

179 From their inception, surgical robots have extended the capabilities of human  
180 surgeons beyond the limitations of laparoscopic surgery. Currently there are only  
181 few small scale studies comparing the two techniques, such as that done at Baptist  
182 Health South Florida by Dominguez et al. This single institution study was a  
183 retrospective chart review of A total of 123 robotically repaired hernias, 45 of which  
184 were bilateral hernias. Researchers concluded that robotic transabdominal  
185 preperitoneal (TAPP) inguinal hernia repair is evidenced to be a safe and adaptable  
186 approach that allows surgeons to perform this procedure in more complex cases  
187 such as those involving incarcerated and/or recurrent hernias [10]. Furthermore,  
188 early studies have shown that Da Vinci ventral hernia surgery has a lower rate of

189 recurrent hernia as well as a lower rate of pain, and lower rate of switching to open  
190 [11, 12, 13].

191 In our case of Amyand hernia, the precision and enhanced visualization provided by  
192 the Da Vinci system allowed easy manipulation of the vermiform appendix and  
193 placement of mesh without trauma to the appendix. This is especially important  
194 considering the fact that any trauma endured by the appendix while it is being  
195 reduced can increase the risk of appendicitis developing postoperatively [14]. Local  
196 trauma while handling the appendix could potential transform classification of  
197 Amyand's hernia from Type 1 to Type 4, thus complicating treatment and  
198 intervention.

199

## 200 **CONCLUSION**

201 Amyand's hernia, the presence of the appendix within the hernia sac, is a rare  
202 subtype of inguinal hernia and typically is an incidental finding. While there is no  
203 consensus on the ideal method for repair, Losanoff and Basson classification  
204 provides guidance on management. Robotic surgery is a relatively new field of the  
205 minimally invasive surgery spectrum. The superior anatomical imaging of the 3D  
206 high definition robotic endoscope coupled with the advanced dexterity, surgical  
207 control and degree of motion affords the surgeon a unique advantage over open and  
208 laparoscopic surgery. Our experience is the first documented case of robotic repair  
209 of Amyand's hernia and demonstrates that this is a safe and viable approach.

210

## 211 **CONFLICT OF INTEREST**

212 Authors do not have any conflict of interests to disclose pertaining to this case report

213

## 214 **AUTHOR'S CONTRIBUTIONS**

215 Thomas J. Shaknovsky, DO

216 Group1 - Conception and design, Acquisition of data, Analysis and interpretation of  
217 data

218 Group 2 - Drafting the article, Critical revision of the article

219 Group 3 - Final approval of the version to be published

220



221 Frederick Sabido, MD FACS  
222 Group 2 - Drafting the article, Critical revision of the article  
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224 Dooniya Shaikh, BS  
225 Group1 - Acquisition of data, Analysis and interpretation of data  
226  
227 Phillip L. Rosen, MD  
228 Group1 - Conception and design  
229

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**SUGGESTED READING****Video**

279 Robotic Repair of Right Inguinal/Scrotal Hernia:  
280 <https://www.youtube.com/watch?v=uD5dRr48Bzo>

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285 **TABLES**

286 Table 1: Losanoff and Basson classification of Amyand Hernia

287

Classification	Description	Management
Type 1	Normal appendix in an inguinal hernia	Hernia reduction, mesh placement
Type 2	Acute appendicitis in an inguinal hernia with no abdominal sepsis	Appendectomy, primary no prosthetics hernia repair
Type 3	Acute appendicitis in an inguinal hernia with abdominal and abdominal wall sepsis	Laparotomy, appendectomy, and primary no prosthetic hernia repair
Type 4	Acute appendicitis in an inguinal hernia with abdominal concomitant pathology	Same as type 3 plus management of concomitant disease

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302 **FIGURE LEGENDS**

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304 Figure 1: Robotic endoscope 3D high definition image of right incarcerated inguinal  
305 hernia. (A)- Incarcerated inguinal hernia, (B)- Medial umbilical fold

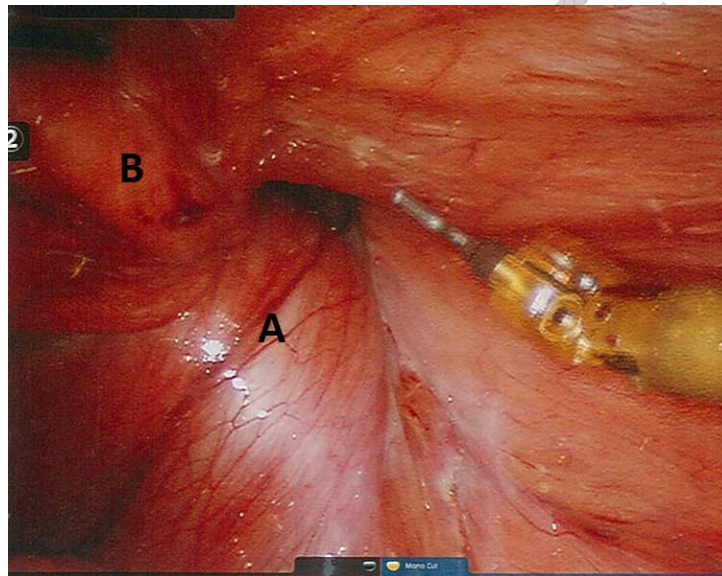
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307 Figure 2: Robotic endoscope 3D high definition image of partially reduced Amyand's  
308 hernia.

309

310 **FIGURES**

311



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313

314 Figure 1: Robotic endoscope 3D high definition image of right incarcerated inguinal  
315 hernia. (A)- Incarcerated inguinal hernia, (B)- Medial umbilical fold

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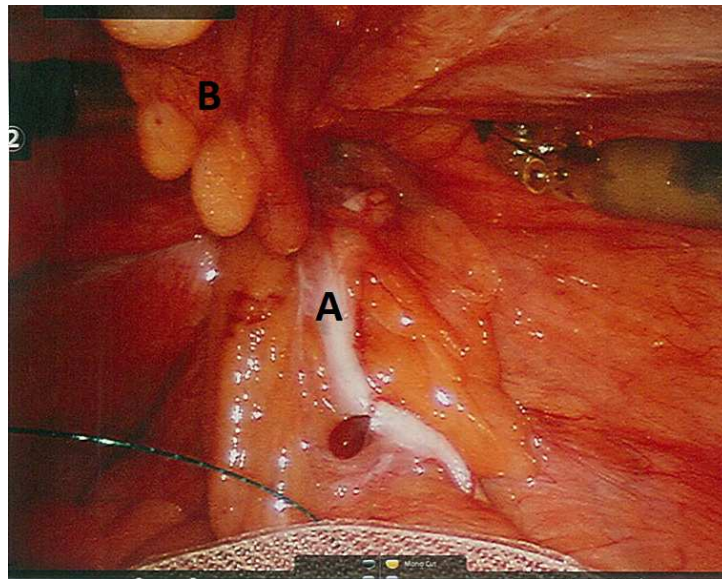
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327 Figure 2: Robotic endoscope 3D high definition image of partially reduced Amyand's  
328 hernia. (A)- Appendix, (B) - Medial umbilical fold

EARLY VIEW