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ORIGINAL ARTICLE

Simultaneous treatment of ureteropelvic junction obstruction complicated by renal calculi with robotic laparoscopic surgery and flexible cystoscope

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Abstract

Objective To present our experience of combining transperitoneal robot-assisted laparoscopic pyeloplasty (RALP) and concomitant flexible cystoscope lithotomy for ureteropelvic junction obstruction (UPJO) complicated by renal caliceal stones in the same session.

Patients and methods Between October 2014 and November 2017, RALP combined with flexible cystoscope lithotomy was performed in 16 patients with UPJO and ipsilateral renal caliceal stones. Stone location and size were preoperatively assessed. After pyelotomy with appropriate length (about 8–15 mm), a 16F flexible cystoscope through the assistant trocar or robotic trocar was introduced directly into the renal pelvis under laparoscopic vision. Holmium laser lithotripsy and pressure irrigation via a pump were used for caliceal stone removal. Subsequently, robot-assisted laparoscopic pyeloplasty was undergone in a standard fashion.

Results The calculi sizes ranged from 5 to 34 mm (mean 18.6 mm) and an average of 3.4 stones per patient was removed (range 1–8 stones). Complete stone clearance confirmed by postoperative imaging was achieved in all patients. Mean operative time was 204.6 min and estimated blood loss was 55.6 mL. Mean hospital stay was 6.7 days (3–17). The stent was removed after 8 weeks. No major intraoperative or postoperative complications were noted during a mean follow-up of 10.4 months (range 6–27 months).

Conclusions RALP combined with flexible cystoscope lithotomy is safe and effective alternatives for the simultaneous management of UPJO complicated by renal caliceal stones.

Keywords Ureteropelvic junction obstruction · Renal calculi · Robotic surgery · Flexible cystoscope

Introduction

Ureteropelvic junction obstruction (UPJO) is the most common obstructive pathology of the upper urinary tract. Approximately, 16–30% adult patients with UPJO present concomitant calculus [1, 2]. During the past decades, the minimally invasive treatments of UPJO are increasingly popular, providing similar success rates with open surgery and decreased length of hospitalisation. Importantly, robot-assisted laparoscopic pyeloplasty (RALP) has gained popularity due to various benefits such as high definition vision and enhanced dexterity, which enable intracorporeal suturing to be performed with greater ease. However, the selection of the appropriate management of UPJO associated with concomitant ipsilateral calculus is still a therapeutic dilemma for urologists. Open pyelolithotomy and pyeloplasty have been the golden standard for a long period in the past [3]. Minimally invasive approaches in combination with rigid nephroscopy or ureteral scope may retrieve stones from calyces closeby, but it is still challenging to reach the distal calyces [4, 5]. In the context with those limitations, we present our experience with UPJO complicated by renal

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calculi using RALP and flexible cystoscope at a single academic institution from 2014 to 2017.

Patients and methods

Patient select and stone evaluation

From October 2014 to November 2017, 63 patients diagnosed with UPJO underwent RALP at our institution. Concurrent renal calculi were found in 16 patients and simultaneously treated with flexible cystoscope during RALP. None of the patients had the previous intervention of UPJO or stones. The study was approved by the Ethical Committee the First Affiliated Hospital of Anhui Medical University. Informed consent was obtained from all the patients. To confirm the diagnosis of UPJO and access the unilateral renal function as well as the number, size, and location of the stones, all patients received intravenous urography (IVU), computed tomography (CT) or magnetic resonance imaging (MRI) urography, and diuretic renogram preoperatively.

Ten males and six females present with concurrent renal calculi. The mean age of the patients was 32.6 years. The stone sizes ranged from 5 to 34 mm. Two patients were diagnosed with bilateral stones and UPJO. Stone-free status was determined by (kidney, ureter, and bladder) KUB and CT scan postoperatively. Follow-up consisted of IVU, and diuretic renogram was conducted at 3, 6, 12 months, and yearly thereafter to. RALP success was defined as improved drainage as well as improved or stable hydronephrosis radiographically.

Operative technique

Patients were placed in a 45 lateral decubitus position. A standard 12-mm camera port was placed at the umbilicus, and the other two 8-mm robotic ports were placed in a triangulated configuration. A 12-mm or 5-mm assistant port was placed in a subumbilical position. A flexible cystoscope was introduced into the collecting systems via a 12-mm assistant port or a robotic port for providing suction, assist in retraction, and retrieve sutures (Fig. 1). After pneumoperitoneum was established, a da Vinci Si (Intuitive Surgical, CA) robot was then docked. The Toldt line was first incised to reflect the colon medially, then the kidney and the dilated renal pelvis were identified using standard techniques [6, 7]. The renal pelvis was partially incised with an appropriate length (about 8–15 mm) for placement of the flexible cystoscope and nephrolithotomy.

The cutting edge of the renal pelvis was held by one robotic arm to keep the system distended, which can gain a better space and visualisation. A 16F flexible cystoscope (KARL STORZ GmbH & Co. KG., Tuttlingen, Germany)

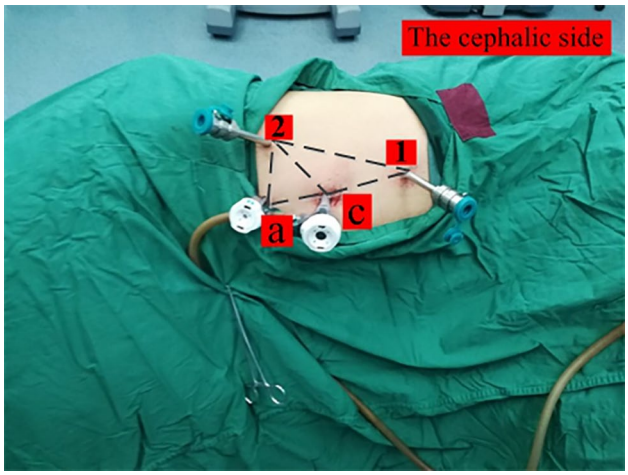

Fig. 1 *C* camera, *A* assistant port, *1* robot arm 1, *2* robot arm 2

was introduced through the 12 assistant trocars or a robotic trocar directly into the renal pelvis with the help of one robotic arm (Fig. 2a). The stones were extracted using a nitinol NGage basket (COOK MEDICAL INC, Bloomington, USA) (Fig. 2c). For larger stones or patients with narrow neck of renal calyx that could not be retrieved directly, a holmium laser (Lumenis Inc., San Jose, CA, USA) was applied to fragment the calculi (Fig. 2b). The stone retracted from the renal pelvis was placed into the specimen retrieval bag and removed at the end of the procedure. Smaller stone fragments in the calyces were washed out by irrigation fluid and removed by the suction system via the assistant's port (Fig. 2d).

A standard laparoscopic pyeloplasty procedure was performed after the calculus retraction. All patients underwent dismembered Anderson-Hynes pyeloplasty, and the anastomosis was performed using 4–0 Vicryl suture. The double-J stent was placed indwelling for 8 weeks. A drain was placed through the lowermost trocar sites and removed on postoperative days 2–3.

Statistical analysis

All analysis was performed using the SPSS (version 13.0) software (SPSS, Inc., Chicago, IL, USA). Numerical variables were compared using the Student's *t* test and categorical variables were compared with the Fisher exact test.

Results

The patient demographics and perioperative characteristics are listed in Table 1. The mean age of the 16 patients with concomitant stones was 32.6 (14–57) years. The mean number of stones removed was 3.4 (1 to 8). The stones

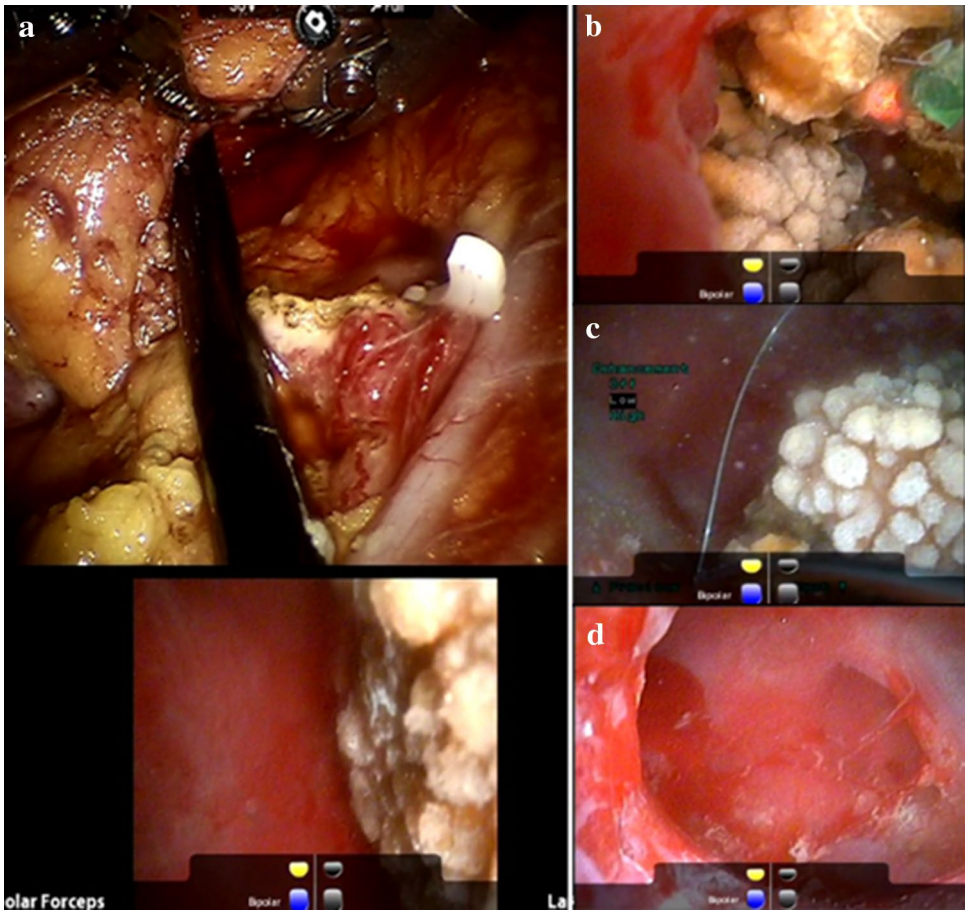

Fig. 2 Surgical procedure (**a**). The flexible cystoscope enters the renal pelvis with the help of the robot arm (**b**). Lithotripsy of larger calculus by holmium laser (**c**). The stones were extracted using a nitinol NGage basket (**d**). Renal calyceal stones were cleared out

Table 1 Patient demographics and perioperative data

Variables	UPJO + renal stone	UPJO	*P* value
Number of patients	16	47	–
Mean age (range)	32.6 (14–57)	28.6 (8–49)	–
Mean number of stones (range)	3.4 (1–8)	–	–
Mean stone size, (mm) (range)	18.6 (5–34)	–	–
Application of holmium laser	9	–	–
Mean operative time, (min) (range)	204.6 (145–360)	153.7 (81–335)	0.856
Mean estimated blood loss, (mL) (range)	55.6 (20–140)	48.2 (10–100)	0.342
Mean hospital stay, (days), (range)	6.7 (3–17)	6.1 (3–14)	0.745
Open conversion	0	0	–
Complications	1	0	–
Stone-free rate	100	–	–
Mean follow-up	10.4 (6–27)	11.2 (3–28)	0.289
Success rate (improvement in drainage)	16 (100%)	46 (97.8%)	0.720

were 5–34 mm in diameter, locating mostly in the distal calyces. Stones were directly retracted by a basket in nine patients, and other seven patients underwent a holmium laser lithotomy additionally. The calculus was retrieved with a specimen retrieval bag at the end of the operation. The mean (range) operative time in patients with concomitant renal calculi was 204.6 (145–360) min. In those without renal calculi, it was 153.7 (81–335) min, with a mean of 50.9 min shorter compared to with concomitant stone extraction. All stones were retrieved successfully, resulting in a complete stone clearance of all patients. No significant difference was found in estimated blood loss, duration of stay, open conversion, and success rates in patients with and without renal calculi. No major intraoperative or postoperative complication

was noted in all patients. 1 of 16 patients with renal calculi presented urinary leakage. The patients undergone a double-J stent adjustment via ureteroscopy and urinary leakage disappeared after 2 days. The double-J stent was removed after 8 weeks in all patients.

At the mean follow-up of 10.4 months, IVU and diuretic renogram confirmed the absence of obstruction, indicating an improvement in drainage in all patients (Fig. 3).

Discussion

Up to 16–30% of patients with primary UPJO may have concomitant renal calculi [1]. The presence of renal calculi complicates UPJO may induce infection or inflammation, leading to oedema and friability of the tissue [7]. It may result in increased complexity of the surgical suture and increase the operative time as well as blood loss. Therefore, the selection of the ideal treatment always presents a therapeutic dilemma for urologists. The "golden standard" treatment of UPJO with concomitant renal calculi has long been open pyeloplasty and pyelolithotomy, with a success rate of 90% [3, 8, 9]. However, several drawbacks of open approaches still bother the clinicians as well as the patients, including substantial postoperative pain due to the flank incision and prolonged hospitalisation of open pyeloplasty.

To minimise the shortcomings of the open surgery, several alternatives minimally approached has been developed during the past decades. One choice was percutaneous lithotripsy (PCNL) followed by percutaneous endopyelotomy in the setting of UPJO and concurrent renal calculi [10, 11]. Several studies indicated that patients could be achieved stone free and the success rate of this approach fluctuates from 65–90% regarding UPJ patency in 55 months' follow-up [11, 12]. On the other hand, other reports advocated that endopyelotomy presents a higher incidence of complication,

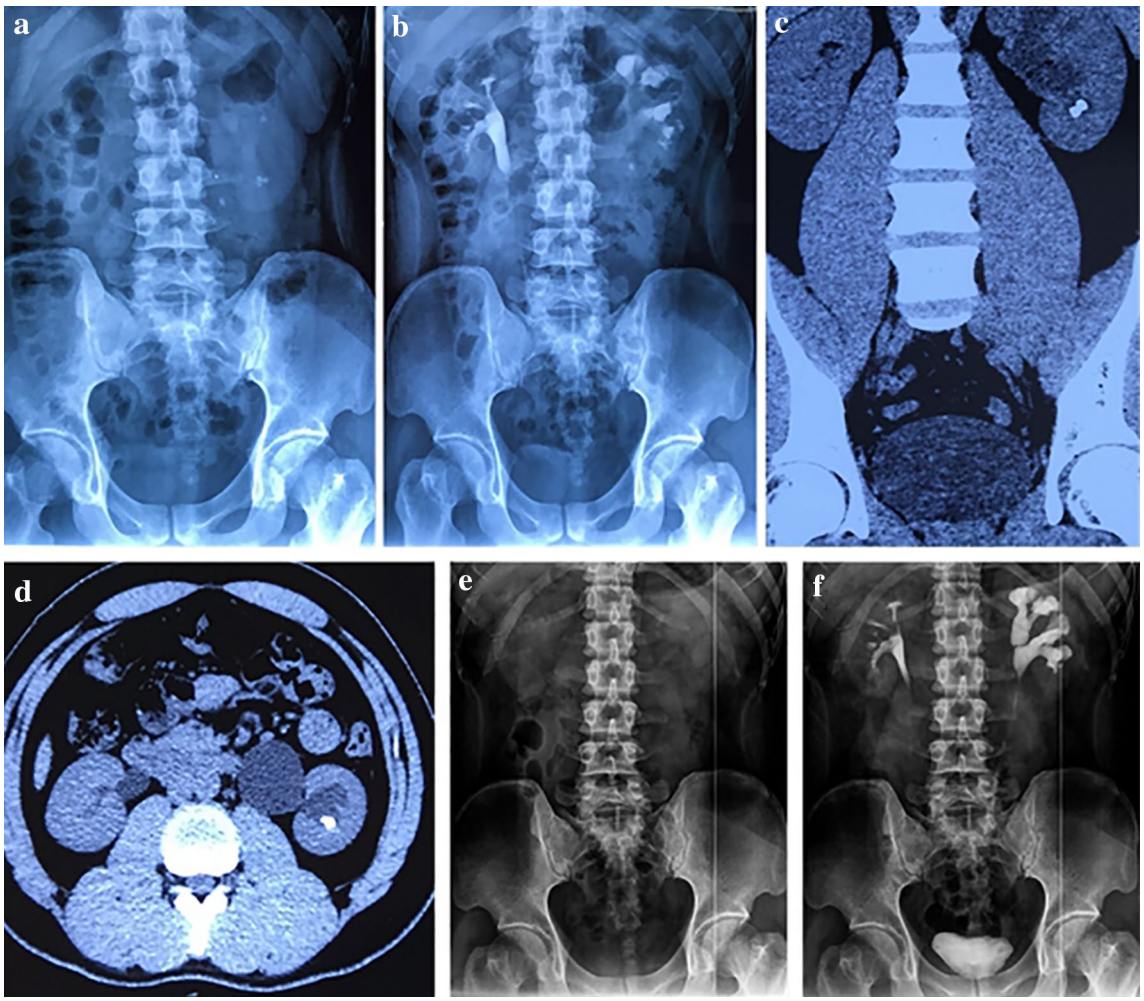

Fig. 3 Preoperative and postoperative imaging examination (**a**, **b**). Preoperative KUB and IVU (**c**, **d**). Peroperative CT examination (**e**, **f**). Postoperative KUB and IVU

including significant bleeding disorder, periureteral inflammation, renal failure, urosepsis and colonic or pleural injury [13].

The laparoscopic pyelotomy (LP) has combined the comparable results to that of open surgery as well as the benefits of minimally invasive surgery, which is advantageous regarding low morbidity, shorter hospital stay and convalescence. The first reported dismembered LP was in 1993, whose efficacy was confirmed subsequently [14, 15]. In the later decades, the performance of LP and concomitant stone removal are reported to be feasible and safe. One study reported LP concomitant with pyelolithotomy in 20 patients, resulting in 80% stone-free rate and 90% successful rate for pyeloplasty [16]. Another team performed laparoscopic pyeloplasty and pyelolithotomy with flexible nephroscope and presented a successful rate of 85.7% [17]. Srivastava et al. [18] reported a 75% stone-free rate for patients undergoing transperitoneal LP and simultaneous pyelolithotomy and a complete stone clearance after ancillary lithotomy procedures. Chen Z et al. [19] applied transperitoneal mini-laparoscopic pyeloplasty and concomitant rigid-ureteroscopy-assisted pyelolithotomy, showing a complete stone clearance. A major drawback for the above studies is the limited numbers of cases. Moreover, the loss of the single or multiple stones in the peritoneal cavity may cause irritation or inflammation [20].

As a matter of factor, the intracorporeal suturing via a laparoscopic requires a steep learning curve as well as considerable experience for proficiency. The RALP has been fastly gained popularity and is emerging as standard care for UPJO in a great number of institutions. The enhanced dexterity of the robot and magnified three dimension vision simplifies suturing dramatically. The long-term follow-up of RALP showed the optimistic outcome of improvement in subjective symptoms and resolution of obstruction [6, 21]. Few studies have reported RALP and contaminant renal stone extraction. One study showed concomitant stone removal and robotic pyeloplasty in eight patients and revealed a complete stone clearance [22]. Using rigid ureteroscope instead of a flexible scope, another team performed concomitant nephroscopy and RALP showing a stone clearance rate of 88.9% [5]. Successful pyeloplasty and stone extraction with the use of the robotic technology in horseshoe kidney were also reported by Nayyar et al. [23].

To our best knowledge, our study presents the largest amount of cases of RALP with contaminant stone extraction. The main advantages of simultaneous treatment of UPJO complicated by renal calculi with robotic technology and flexible cystoscope are as follows: first, the clear surgical field of view and flexible robotic arm can reconstruct UPJO with greater ease [7]. Furthermore, as we all know, when the infundibulopelvic angle is very small or the patient has severe hydronephrosis, flexible ureteroscope cannot access stones at lower renal calyces in an easy manner. By analysing preoperative imaging, we could select the optimal trocar for the passage of flexible cystoscope. Therefore, the calculus in distal calyces might be reached with an increased or even diminished infundibulopelvic angle (Fig. 4). In addition, due to the reduced intraoperative pelvis pressure during the lithotripsy, the risk of postoperative bacteremia might be reduced compared to PCNL [24]. What is more, stone extraction was performed simultaneously rather than a second percutaneous nephrolithotripsy, so as to prevent the possibility of haemorrhage and reduce the financial burdens of medical care for the patients. Last but not the least, with the aid

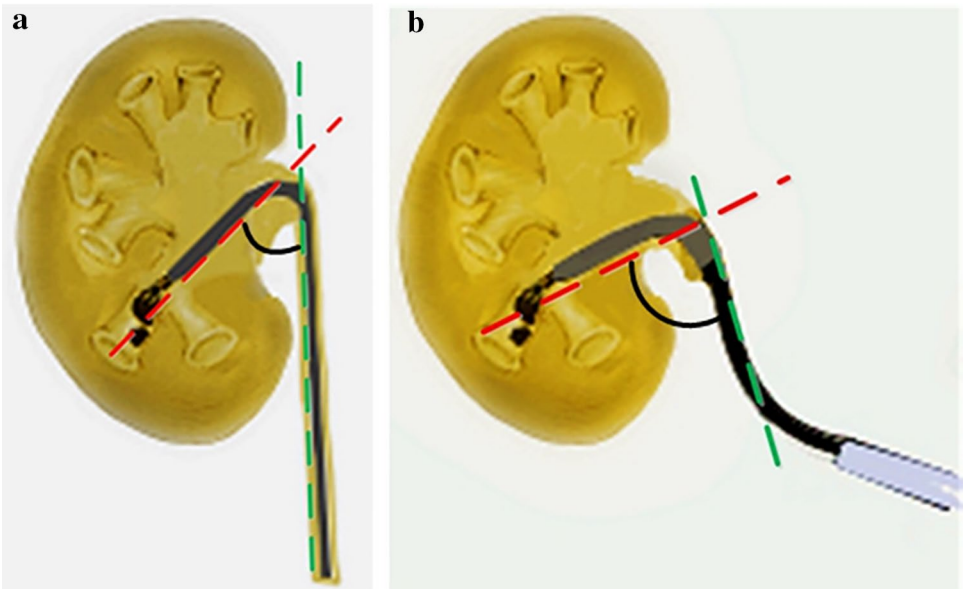

Fig. 4 The infundibulopelvic angle between the inferior calyx axis and the ureteropelvic axis during surgery (**a**). The flexible ureteroscopy in the treatment of subrenal calyx calculus (**b**). The flexible cystoscope in the treatment for the inferior calyx stone through renal pelvis incision

of flexible cystoscope and holmium laser, we reached a complete stone clear with the biggest mean size of the stone [5, 22, 25].

Therefore, the simultaneous removal of stones with flexible cystoscopy indicated the lower postoperative complication and better stone clearance rate compare with that of the previous reports [16, 18, 26]. Our experience showed that RALP with concomitant pyelolithotomy by flexible cystoscope is effective and feasible and may become the new standard of care for managing UPJO complicated by renal calculi.

Although successful attempts for treatment of UPJO complicated by renal calculi have been demonstrated, several issues are to be discussed. Firstly, what is the maximum stone size that could be retrieved during RALP with concomitant pyelolithotomy by flexible cystoscope? Throughout this article, we conclude that the maximum stone sizes of 3–3.5 cm are feasible for pyelolithotomy by a flexible cystoscope. These inferences were grounded on limited cases and needed further investigation. The complicated stones especially with branched or staghorn calculi are more likely to be managed by PCNL. Secondly, intraoperative irrigation fluids may flow freely into the abdominal cavity and occupy the space of the pneumoperitoneum, although some of it might be suctioned. Although no related complications were found in the current reports or the previous study, the excessive fluid may affect the recovery of postoperative intestinal function and might be a concern. Moreover, the high cost and loss of tactile feedback of a robotic surgical system still restricted its further popularity and application.

Conclusion

Our data suggest that treatment using RALP with flexible cystoscope for UPJO complicated with renal calculi is safe and effective. The long-term outcome of this method still merits further investigation.

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Author contributions CY, JZ and ZL contributed to data collection, data analysis and manuscript writing. ZH and JW took part in data collection and management. LZ involved in manuscript editing. CL contributed to project development and manuscript writing.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval The present study was approved by the Ethical Committee the First Affiliated Hospital of Anhui Medical University.

Informed content Informed consent was signed by the patients for the publication of related images and this report.

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