Long-term outcome and quality of life after continent ileostomy for ulcerative colitis: A systematic review

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Abstract
Aim: The continent ileostomy allows evacuation of an ileal reservoir at a time convenient to the patient. It is a surgical option for patients with ulcerative colitis (UC) when a restorative option is not suitable or has not succeeded and the patient does not want a conventional end ileostomy. Continent ileostomy types include the Kock pouch, Barnett continent intestinal reservoir and T-pouch. All of the published evidence on the long-term outcome and quality of life after continent ileostomy for UC was systematically reviewed.

Methods: A systematic review was performed in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Studies published between 1990 and 2020 were included. A descriptive synthesis was used due to the clinical heterogeneity.

Results: The search returned 1655 abstracts and after screening of abstracts and full text review, 19 were included in the final review, involving 1602 patients. Operative mortality is low (0%–3.6%) after all types of continent ileostomy but reoperation rates are high (20.8%–65%) because of valve mechanism failures. Rates of fistulae (0%–25.5%) and stomal stenosis (0%–25%) can be relatively high postoperatively. Quality of life scores improve for most patients undergoing continent ileostomy, especially for patients converted from ileal pouch anal anastomosis. Overall, continent ileostomy retention is high in the long-term.

Discussion: In the long-term, patients report high satisfaction and a good quality of life with continent ileostomy, despite high reoperation rates and complications. Newer technologies may reinvigorate interest in the continent ileostomy for this population.

Keywords
continent ileostomy, ulcerative colitis
INTRODUCTION

The aim of a continent ileostomy is to provide the patient control over the evacuation of an ileal reservoir at a time convenient to them. The continent ileostomy was first described by Kock in 1969 [1]. It comprises a small bowel pouch which leads to an intussusceptive valve that prevents flow of ileal contents (see Figure 1). It was constructed for patients after colectomy for ulcerative colitis (UC) or familial adenomatous polyposis in the era before restorative surgery. When Sir Alan Parks and Professor John Nicholls described an ileoanal pouch that restored continuity of the bowel in 1978 [2] the use of the continent ileostomy declined. However, the continent ileostomy still plays a role in those patients for whom an ileal pouch anal anastomosis (IPAA) is not suitable, or where an IPAA may have failed. Additionally, patients with a conventional ileostomy who would prefer not to have an external appliance may also opt for conversion to a continent ileostomy.

Although Kock described his pouch first, other types of continent ileostomy have been developed such as the Barnett continent intestinal reservoir (BCIR) [3] and the T-pouch [4]. The BCIR utilises a “living intestinal collar” to support the intussusceptive valve (see Figure 2). The T-pouch does not have an intussusceptive valve but instead places an outflow segment of small bowel in a serosa lined tunnel that leads from an intestinal pouch (see Figure 3). Most recently, a medical device, the transcutaneous implant evacuation solution (TIES), has been invented to perform the same function as a continent ileostomy [5]. The TIES utilises a titanium mesh device into which the patient’s ileal tissue will biointegrate. The stoma is then closed with a cap that connects to the titanium device.

This systematic review will investigate the long-term outcome and quality of life of a continent ileostomy in patients with ulcerative colitis. This review will consider all types of continent ileostomy as well as novel devices which perform the same function.

METHOD

The systematic review was performed in accordance with the Preferred Reporting in Systematic Reviews and Meta-analyses (PRISMA) guidelines and the Cochrane Handbook for Systematic Reviews of Interventions.

**FIGURE 1** Construction of a Kock Pouch. A U-shaped pouch is created from the distal small bowel. The efferent limb (dashed white arrow) of the distal small bowel is intussuscepted to create a nipple valve (solid white arrow) that provides continence. Staple fixation stabilises the nipple valve configuration [33]
Search strategy

MEDLINE and EMBASE (searched via Ovid) and Web of Science were searched in a systematic manner. Reference lists in articles that were analysed for full text review were also searched. The last search was conducted on 6 January 2021.

The two main concepts of continent ileostomy and ulcerative colitis were searched for. Terms within each concept were combined with the Boolean operator "OR" and then the concepts themselves were combined with the Boolean operator "AND". The concepts were searched both by subject headings and as keywords depending on the database. Only keywords were used to search the Web of Science database. See Appendix 1 for the search strategy used. No search limit was put on year of publication or on language published; however, only articles in English were screened. Two reviewers (MD and GW) screened the abstracts and discrepancies were resolved by consensus after discussion with a third reviewer (KP). Covidence systematic review software was used to perform the search, screen abstracts, review full-text articles and construct the PRISMA diagram (available at www.covidence.org).

Inclusion criteria

All articles describing studies of long-term outcome and quality of life after continent ileostomy in patients with ulcerative colitis were included. Long-term outcome was defined as a surgical complication, reoperation and/or pouch/device excision at any point during the study follow-up period.

Exclusion criteria

Review articles, editorials, guidelines, letters, published abstracts and audits were all excluded. Small case series with less than five patients were excluded (this was waived for innovative surgical technologies to ensure novel devices were included in the review). Articles published before 1990 were excluded because of the change in surgical techniques that have occurred over 30 years. Where the outcome of a single surgical cohort was reported multiple times after 1990, the most recent article was selected for data extraction and the older articles excluded.

Data collection

Data were extracted from articles and tabulated in Microsoft Excel for Mac version 16.37 (by MD and GW). Data fields extracted included study design, study duration, number of participants, median age, sex, country of study, number of intervention groups, pouch type, length of follow-up, most common complication, mortality; pouch excision rate, continent rate, nipple valve slippage rate, reoperation rate, leak rate, fistula rate, prolapse rate, hernia rate, stomal necrosis rate, stomal stenosis rate, and if a quality of life assessment was carried out.

Data analysis

A descriptive synthesis was used to analyse the data collected due to clinical heterogeneity. Risk of bias was assessed (by MD, verified by KP, see Table S1) with the Joanna Briggs Institute Cohort Studies Critical Appraisal Tool (available from https://synthesismanual.jbi.global) [6].
Construction of a T-pouch. An isolated segment of distal small bowel is placed in a serosa lined tunnel formed from the base of adjacent ileal segments (blue arrow). The valve is opened and tapered along a 30 Fr tube (blue catheter pictured). The adjacent bowel segments are opened and the two large flaps of ileal tissue are brought over the isolated segment to create the valve. The pouch is then closed (white arrow) [34]

FIGURE 4  PRISMA diagram.

1,655 references imported for screening as 1,655 studies → 245 duplicates removed

1,410 studies screened against title and abstract → 1,259 studies excluded

151 studies assessed for full-text eligibility → 132 studies excluded

79 Before 1990
13 Not English
9 Case report
7 Review article
5 Conference Abstract
5 Wrong outcomes
3 Editorial
3 Operative technique article
3 Wrong intervention
3 Wrong study design
1 Letter to Editor
1 PhD Thesis

19 studies included
RESULTS

Characteristics of included studies

A total of 1655 abstracts were returned following the search and 245 duplicates were removed. A total of 1410 abstracts were screened, and 1259 studies were found to be irrelevant. One hundred and fifty-one full text articles were reviewed and 19 were included in the final review for data extraction and qualitative analysis (see PRISMA diagram, Figure 4). All studies were retrospective cohort studies involving 1602 patients with UC (see Table 1).

Surgical outcomes after the Kock continent ileostomy were reported in 13 studies [7–19]. Outcomes after BCIR were reported in two studies [20, 21]. Outcomes for both Kock pouch and BCIR combined have been reported in two studies [22, 23]. A single study reported outcomes after T-pouch [24] and a single study reported outcomes after TIES [5]. On two occasions, authors published their main cohort of all continent ileostomy patients and then published a smaller cohort of only those patients that had a continent ileostomy after IPAA with the possibility of some overlap in data [13, 17, 20, 21].

Outcomes and complications

Table 2 outlines the surgical outcomes including 30-day mortality, reoperation rate, indication for reoperation, average time to reoperation, rate of valve dysfunction and pouch/device removal rate. Table 3 outlines the remaining major surgical complications. Berndtsson et al. [11, 25] and Borjesson et al. [12] only reported patient characteristics and outcomes after Kock pouch and not the incidence of postoperative complications and are therefore not included in Table 3.

| TABLE 1 | Summary of included studies |
|---|---|
| **Authors** | **Country** | **Year** | **Study duration** | **n (UC)** | **Age (average or range reported)** | **Sex (% male)** |
| **Kock** | | | | | | |
| Leijonmarck et al. | Sweden | 1992 | 1955–1984 | 88 (88) | NR | NR |
| Handelsman et al. | USA | 1993 | 1975–1989 | 95 (87) | 13–66 | 47 |
| Litle et al. | USA | 1999 | 1975–1995 | 129 (119) | 31 | 50 |
| Lepisto et al. | Finland | 2003 | 1972–2000 | 96 (88) | 34 | 58 |
| Berndtsson et al. | Sweden | 2004 | 1967–2003 | 88 (88) | 60 | 35 |
| Börjesson et al. | Sweden | 2004 | 1967–1974 | 13 (10) | 31 | 31 |
| Nessar et al. | USA | 2005 | 1977–2001 | 330 (251) | 35 | 43 |
| Castillo et al. | USA | 2005 | 1993–2003 | 24 (17) | 22–73 | 21 |
| Hoekstra et al. | Netherlands | 2008 | 1996–2007 | 28 (18) | 46 | 36 |
| Wasmuth et al. | Norway | 2009 | 1983–2007 | 63 (55) | 37 | 43 |
| Aytac et al. | USA | 2019 | 1982–2013 | 67 (53) | 38 | 37 |
| Risto et al. | Sweden | 2020 | 1980–2016 | 85 (75) | 36 | 51 |
| Denoya et al. | Sweden | 2008 | 1998–2003 | 31 (NR) | NR | NR |
| **BCIR** | | | | | | |
| Mullen et al. | USA | 1995 | 1988–1991 | 510 (475) | NR | 44 |
| Behrens et al. | USA | 1999 | 1989–1996 | 42 (NR) | 34 | 38 |
| **Kock and BCIR** | | | | | | |
| Parc et al. | France | 2011 | 1973–2007 | 49 (31) | 42 | 31 |
| Mukewar et al. | USA | 2014 | 2002–2011 | 36 (36) | 35 | 47 |
| **T-pouch** | | | | | | |
| Kaiser et al. | USA | 2012 | 2000–2010 | 40 (35) | 51 | 43 |
| **TIES** | | | | | | |
| Strigård et al. | Norway and Sweden | 2011 | 2011 | 4 (3) | NR | NR |

Abbreviations: N/A, not applicable; NR, not reported.

a Denoya’s series is of patients who required reoperation after 10 years of a functioning Kock pouch.

b Aytac et al. report data for 20 patients that had conversion from IPAA and are likely included in Nessar’s larger series.

c Behrens et al. report data that had conversion from IPAA and are likely included Mullen’s larger series.
## Table 2: Summary of included study outcomes

| Authors | Follow-up (mean/median years) | 30-day mortality (%) | Reoperation rate (total or major) (%) | Most common indication for reoperation | Average time to reoperation (years) | Rate of valve dysfunction (%) | Pouch/device removal (%) |
|---------|-------------------------------|----------------------|---------------------------------------|---------------------------------------|-----------------------------------|------------------------------|--------------------------|
| Kock    |                               |                      |                                       |                                       |                                   |                              |                          |
| Leijonmarck et al. | 7 | 0 | 50 | Valve slippage | NR | 57 | 15 |
| Handelsman et al. | >2.5 | 0 | 22 | Valve slippage | NR | 6.3 | 13 |
| Litle et al. | 11.4 | 0.7 | 46 | Valve slippage | <1 | 36 | 36 |
| Lepisto et al. | 18 | 1 | 59 | Valve slippage | NR | 28 | 22 |
| Berndtsson et al. | 31 | NR | 65 | Valve slippage +/- fistula | NR | NR | NR |
| Börjesson et al. | 6 | 0 | 61 | Valve slippage | NR | NR | 16 |
| Nessar et al. | 11 | 0.3 | NR | Valve slippage | 1.2 | 29.7 | 22 |
| Castillo et al. | 5.5 | 0 | 54 | Stomal stenosis | 2 | 46 | 8 |
| Hoekstra et al. | 3.8 | 3.6 | 56 | NR | NR | 21 | 3.5 |
| Wasmuth et al. | 12.5 | 0 | 30 | Valve slippage | 1 | 15.8 | 10 |
| Aytac et al. | 5 | 0 | 52 | Valve slippage | 1 | 31 | 21 |
| Risto et al. | 24 | NR | 59 | Valve slippage | 1–4 | 35 | 8 |
| Denoya et al. | 7 | 0 | 32 | Valve slippage | N/A | N/A | 6.5 |
| BCIR     |                               |                      |                                       |                                       |                                   |                              |                          |
| Mullen et al. | 2.2 | 0 | 21 | Fistula | NR | 6 | 6.5 |
| Behrens et al. | 3.6 | 0 | 33 | Valve slippage | NR | 10 | 4.7 |
| Kock and BCIR |                               |                      |                                       |                                       |                                   |                              |                          |
| Parc et al. | 20.5 | 0 | 45 | Valve slippage | NR | 32.6 | 10.2 |
| Mukewar et al. | 21 | NR | 46 | Valve slippage | NR | 41.7 | 8.3 |
| T-pouch  |                               |                      |                                       |                                       |                                   |                              |                          |
| Kaiser et al. | 6.2 | 0 | 30 | Valve dysfunction | NR | 15 | 7.5 |
| TIES     |                               |                      |                                       |                                       |                                   |                              |                          |
| Strigård et al. | 1.5 | 0 | 50 | Skin-device defect | NR | N/A | 25 |

Abbreviations: N/A, not applicable; NR, not reported.

*Denoya’s series is of patients who required reoperation after 10 years of a functioning Kock pouch.

*Aytac et al. report data for 20 patients that had conversion from IPAA and are probably included in Nessar’s larger series.

*Behrens et al. report data that had conversion from IPAA and are probably included in Mullen’s larger series.
Mortality was low in all types of continent ileostomy. Mortality (30-day) ranged from 0% [7, 12, 14, 17, 18, 26, 27] to 3.6% [15] for Kock pouches. Mortality was reported as 0% after both BCIR [20, 21] and T-pouch [24]. Strigard et al. found the TIES device did not cause any short term mortality amongst their four patients [5].

Reoperation rates were high for all types of continent ileostomy. Rates of reoperation ranged from 22% [26] to 65% [11] for Kock pouch and 21% [20] to 33% [21] for BCIR. Reoperation rates were 30% for T-pouch [24] and 50% for the TIES device [5].

The most common indication for reoperation after Kock pouch was slippage of the nipple valve mechanism, causing incontinence with or without difficult intubation. This was the most common cause in 10 out of 12 Kock pouch studies. Rates of nipple valve slippage were reported as high as 57% by Leijonmarck et al. [7] and as low as 15.8% by Wasmuth et al. [16].

Denoya et al. looked at a specific cohort of 31 patients with Kock pouches that had required reoperation after a minimum of 10 years of normal function [18]. Nipple valve slippage was also found to be the most common cause of failure (84% of the reoperations) in this cohort. They found 12 out of 31 patients went on to have a second revision procedure. Only two of the 31 patients had their Kock pouch excised after an average of seven years of further follow-up.

Mullen et al. reported the most common indication for reoperation after BCIR was fistula which occurred in 10% of patients postoperatively. The rate of nipple valve slippage in their large multicentre series was 6% [20].

The T-pouch does not utilise a nipple valve but instead places an isolated segment of bowel in a serosa-lined tunnel of two apposed limbs of small bowel [24]. However, the main complication requiring reoperation was also related to the valve mechanism and the valve would

### Table 3: Surgical complications

| Authors                  | Incontinence (%) | Leak (%) | Fistula (%) | Prolapse (%) | Hernia (%) | Stomal necrosis (%) | Stomal stenosis (%) | Bowel obstruction (%) |
|--------------------------|------------------|----------|-------------|--------------|------------|---------------------|----------------------|-----------------------|
| **Kock**                 |                  |          |             |              |            |                     |                      |                       |
| Leijonmarck et al.       | NR               | 2.3      | 2.3         | NR           | 3.4        | NR                  | 2                    |                       |
| Handelsman et al.        | NR               | NR       | 2.1         | 6.3<sup>b</sup> | NR         | 0                   | 6.3<sup>b</sup>      | 5.7                   |
| Little et al.            | 25               | NR       | 7           | NR           | NR         | 4                   | 20                   | NR                    |
| Lepisto et al.           | NR               | NR       | 3           | NR           | 2          | 4                   | 2                    | 20                    |
| Nessar et al.<sup>c</sup> | NR               | NR       | 25.2        | 6.1          | 4          | NR                  | 10                   | 17.6                  |
| Castillo et al.          | NR               | NR       | 4           | NR           | 4          | NR                  | 50                   | NR                    |
| Wasmuth et al.           | NR               | NR       | 4.7         | 0            | 2          | 20                  | 6.3                  | NR                    |
| Hoekstra et al.          | 14               | 3.6      | 3.6         | 3.6          | NR         | NR                  | NR                   | NR                    |
| Ayte et al.<sup>c</sup>  | 11               | 9        | 21          | 15           | 16         | NR                  | 5                    | 8                     |
| Risto et al.             | NR               | NR       | 14          | NR           | 2          | NR                  | 8                    |                       |
| Denoya et al.<sup>a</sup> | 17               | NR       | 6.5         | 9.7          | NR         | NR                  | 29                   | 6.5                   |
| **BCIR**                 |                  |          |             |              |            |                     |                      |                       |
| Mullen et al.<sup>d</sup> | NR               | 1.96     | 10.2        | 1.56         | NR         | 7.8                 | 10                   |                       |
| Behrens et al.<sup>d</sup> | NR               | NR       | 9.5         | NR           | 2.4        | NR                  | 2.4                  | 2.4                   |
| **Kock and BCIR**        |                  |          |             |              |            |                     |                      |                       |
| Parc et al.              | 32.6             | NR       | 20.4        | 4            | NR         | 2                   | 10                   | NR                    |
| Mukewar et al.           | NR               | NR       | 0           | NR           | NR         | 8.3                 | NR                   |                       |
| **T-pouch**              |                  |          |             |              |            |                     |                      |                       |
| Kaiser et al.            | 8.3              | 12.5     | 12.5        | NR           | 2.5        | 25                  | NR                   |                       |
| TIES                     | Strigárd et al.  | 75       | 0           | 0            | NR         | 25                  | 0                    | 0                     |

Abbreviation: NR, not reported.

<sup>a</sup>Denoya’s series is patients who required reoperation after 10 years of a functioning Kock pouch.

<sup>b</sup>Handelsman et al. combined the reoperation rates for stomal stenosis and prolapse.

<sup>c</sup>Ayte et al. report data for 20 patients that had conversion from IPAA and are probably included in Nessar’s larger series.

<sup>d</sup>Behrens et al. report data that had conversion from IPAA and are probably in Mullen’s larger series.
| Assessment                | n (UC)   | Response rate | Average follow-up (mean/median years) | Reported outcome                                                                                                                                                                                                 |
|---------------------------|----------|---------------|---------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Kock                      |          |               |                                       |                                                                                                                                                                                                                 |
| Litle et al. SF-36        | 121 (119)| 46%           | 11.4                                  | 57% not limited in vigorous activity. 82% not limited in moderate activity 80% resume same employment. 67% did not feel restricted                                                                                                                                 |
| Berndtsson et al. II OAS  | 88 (88)  | 83%           | 31                                    | No differences in 8 subscales between patients with pouch and matched controls. Eight items with lowest median scores on OAS concerned embarrassing situations, activity, body image and sexuality  Most frequently mentioned topics were family, health, friends and employment. Respondents were self-reliant but had difficulties evacuating outside of the home especially public restrooms |
| Castillo et al. QOL       | 24 (17)  | NR            | 5.5                                   | 90% major improvement in lifestyle, 10% some improvement 40% no limitation in activities, 60% some limitation (e.g. heavy lifting or straining).                                                                                                                                   |
| Hoekstra et al. SF-36     | 28 (18)  | 85%           | 3.8                                   | SF36: Quality of life with continent ileostomy is not significantly better or worse than patients with Brooke or IPAA. EORTC QLQ-CR38: Lower sexual enjoyment score with Brooke ileostomy compared to IPAA. Lower GI tract symptom score with continent ileostomy compared to Brooke ileostomy. More male sexual problems with continent ileostomy compared to IPAA. |
| Lian et al. CGQL          | 64 (49)  | 80%           | 5                                     | CGQL 0.77, current quality of life 8, current quality of health 8, current level of energy 8. 97% stated life became easier compared to life with an end or loop ileostomy.                                                                                                      |
| Nessar et al. CGQL        | 330 (251)| 65%           | 11                                    | Higher CGQL on all subscales (life, health, energy) and summary scale compared to end ileostomy. CGQL 0.87 vs 0.7.                                                                                                                                                        |
| Risto et al. SF-36        | 85 (75)  | 71%           | 24                                    | 84% satisfied and 82% would choose it again. No difference in QOL compared to age-matched controls.                                                                                                                                                                        |
| BCRIR                     |          |               |                                       |                                                                                                                                                                                                                 |
| Mullen et al. a            | 510 (475)| 87%           | 2.2                                   | Consistently positive responses in quality of life post BCIR (after Brooke, conversion, IPAA or primary)                                                                                                                                                                    |
| Behrens et al. a          | 42 (NR)  | 90%-95%       | 3.6                                   | Patients with failed IPAA had lower scores than continent ostomy. Scores became similar after conversion at 2 years                                                                                                                                                     |
| Kock and BCIR Parc et al. | 49 (31)  | 88%           | 20.5                                  | Mean physical component score 48, mean mental component score 45.9 65% work, 52.5% play sport. 75% are sexually active. 37.5% considered body mage normal.                                                                                                                          |
need to be lengthened or shortened in 15% of cases. In 10% of cases the valve had to be shortened because intubation was difficult and in 5% the valve had to be lengthened because there was leakage [24].

Pouch or device removal

The rate of pouch removal was low amongst patients with Kock pouch, BCIR and T- pouches. The highest rate of excision for Kock pouches was 36% reported by Litle et al. [9] and the lowest was 3.5% reported by Lian et al. [15]. The series by Lian et al. comprised patients who had a Kock pouch after conversion from IPAA. Rates of pouch excision were low for BCIR ranging from 4.7% to 6.5%. [20, 21] Kaiser et al. [24] reported that 7.5% of T- pouches were removed. In the four patients who had a TIES device, one device had to be removed at 18 months [5].

Incontinence

Incontinence was not reported by all studies and not in a uniform manner when done so. In studies that did have some measure of incontinence, rates amongst Kock pouches ranged from 11% [17] reported by Aytac et al. to 25% [9] reported by Litle et al. Neither of the two studies that investigated outcomes after BCIR reported a measure of incontinence. Parc et al. reported 32.6% of patients had incontinence when they looked at both BCIR and Kock pouches together [22]. The incontinence rate after T-pouch was 8.3% [24].

Leaks

There were four studies that reported leak rates after Kock pouch. These leaks were from suture lines, staple lines and anastomoses. Aytac et al. reported the highest rate of 9% [17] and the lowest rate of 2.3% was reported by Leijonmarck et al. [7]. A leak rate of 1.96% was found after BCIR by Mullen et al. [20]. A leak rate of 12.5% was found after T-pouch by Kaiser et al. [24]. No leaks were found after TIES device which does not utilise stapler technology or anastomoses in its technique [5].

Fistula

Fistulization after continent ileostomy was reported by 10 of the 19 studies which investigated Kock pouches. The rate of postoperative fistulation ranged from 3% [10] to 21% [17]. Mullen et al. found that 10.2% of patients developed fistulae after BCIR [20] and Behrens et al. found a rate of 9.5% [21]. Parc et al. reported a relatively high rate of fistula formation of 20.5% in their combined series of both Kock pouches and BCIR [22]. 12.5% of patients developed fistulae after T-pouch [24] and no patients developed fistulae after TIES device [5].

Fistulation was particularly noted to be a problem by Nessar et al. in their series. Before 1984 Mersilene or Marlex mesh was used to stabilise the valve, prevent prolapse and secure the pouch to the abdominal wall. However, 31 of 73 patients (42.5%) who had the mesh reinforcement developed fistulae and so the practice was abandoned. In their series they found that the development of a fistula increased the risk of eventual pouch failure by three times [13].

Stomal stenosis and necrosis

Stomal stenosis after continent ileostomy was reported by six studies that investigated outcomes after Kock pouch. Rates of stenosis were noted to range from 2% [19] to 29% [18]. These studies reported that the stenotic segments could be dilated under local anaesthetic. The highest rate of stenosis was found in the series by Denoya et al. which looked at patients with functioning Kock pouches for at least 10 years suggesting stomal stenosis remains a possible complication in the long term. Similar rates of stomal stenosis were found for BCIR, 2.4%–7.8% [20, 21], and for studies that looked at both BCIR and Kock pouches, 8.3%–10% [22, 23]. A quarter of all patients who underwent T-pouch developed stomal stenosis [24]. Stomal stenosis was not found in those patients who had the TIES device [5].

Stomal necrosis was reported in all types of continent ileostomy. A patient who had the TIES procedure underwent necrosis of the distal 2 cm and the small bowel retracted exposing the titanium mesh in the device [5]. Stomal necrosis occurred in 3.4%–4% of patients who underwent Kock pouch and in 2% of patients when Parc...
et al. [22] looked at both Kock pouch and BCIR. Stomal necrosis occurred in 2.5% of patients who underwent a T-pouch [24].

**Quality of life**

Table 4 outlines the results of quality of life assessments carried out in included studies.

**Quality of life after Kock pouch**

A total of six studies published in seven articles looked at quality of life after a Kock pouch. Little et al., Risto et al., and Berndtsson et al. used the Short Form 36 Health Survey (SF-36) [9, 11, 19] and Hoekstra et al. used the SF-36 with the European Organization for Research and Treatment of Cancer Quality of Life Questionnaire Colorectal Cancer Module (EORTC QLC-CR38) [15]. Castillo et al. used a non-validated quality of life questionnaire [14] and Lian et al. used the Cleveland Global Quality of Life questionnaire (CGQL) [28].

Berndtsson et al. found no differences in the eight subscales of the SF-36 between patients with Kock pouches and an age- and gender-matched control sample from the general Swedish population [11]. In a separate paper Berndtsson et al. had the same cohort answer open ended quality of life questions and the disease specific Olbrisch Adjustment Scale (OAS) 36-item questionnaire [29]. Patients with Kock pouches were self-reliant but often had difficulty with evacuating their pouch outside of the home, especially in public restrooms. The items with the lowest median score on the OAS concerned embarrassing situations, activity, body image, sexuality and good care [29].

Similarly, Risto et al. found that age matched Swedish controls had similar SF-36 scores to those with a Kock pouch. Risto et al. reported 84% of patients were satisfied and 82% would choose a Kock pouch again [19].

Little et al. found that 57% of Kock pouch patients were not limited in vigorous activity and 82% were not limited in moderate activity, and 80% of those patients resumed the same type of employment postoperatively [9]. Little et al. used a modified version of the SF-36 and so their results are not as easily comparable to other studies [9].

Hoekstra et al. found that SF-36 scores in patients with a Kock pouch were not significantly better or worse than patients with conventional ileostomy or IPAA [15]. They reported significantly more male sexual problems for patients with continent ileostomy compared to patients with IPAA. A worse GI tract score was found in patients with continent ileostomy when compared to those with a conventional ileostomy.

Castillo et al. found that 90% of patients had a major improvement in their lifestyle [14]. Lian et al. also found a similar finding with 97% stating life had become easier with a continent ileostomy compared to an end or loop ileostomy [28]. The average CGQL score was 0.77 with an average score of 8 for current quality of health, current quality of life and current level of energy [28].

**Quality of life after BCIR and T-pouch**

Similar positive outcomes were found in studies investigating quality of life after BCIR. Behrens et al. found that there was a general improvement in SF-36 scores when a failed IPAA was converted to a continent ileostomy. Patients with a failed IPAA had lower scores compared with patients with a continent ileostomy at baseline. After conversion from failed IPAA to continent ileostomy their SF-36 scores improved and became similar to other patients with a continent ileostomy at 2 years [21]. Mullen et al. found consistently positive responses in quality of life after BCIR – this was after conversion from conventional ileostomy, conversion from IPAA or as a primary procedure [20].

Parc et al. in their mixed series of patients with both Kock pouches and BCIR [22] reported a mean physical component score of 48, and a mean mental component score of 45.9 on the SF-36 (the mean score of the general population is 50 with a standard deviation of 10). They found 65% of their cohort work or had worked and 52.5% play sport. 75% of patients are or had been sexually active and 37.5% of patients considered their body image to be normal.

Finally, Kaiser et al. [24] found a significant improvement in all domains of quality of life after operation for T-pouch using a questionnaire similar to the CGQL.

**Conversion from failed IPAA to continent ileostomy**

See Table 5 for a summary of the studies that investigated outcome after conversion from IPAA to continent ileostomy. There were four studies that looked at the specific clinical scenario of converting a failed IPAA to a continent ileostomy [12, 17, 21, 28]. Aytac et al. and Behrens et al. specifically compared this cohort of patients to the larger population of continent ileostomy patients that did not have an IPAA previously. Aytac et al. employed a methodology of case-matching this cohort of patients for age, sex, BMI and diagnosis.

Overall continent ileostomy pouch survival rates were high after conversion from IPAA ranging from 79% [17] to 95% [28]. Nipple valve slippage was also the main surgical complication in this set of patients. Again, reoperation rates were high after conversion from IPAA and ranged from 33%–61%.

Some of the highest rates of fistula formation were also reported in these studies with 9.5% developing fistulae in Behrens et al series [21]. The Lian et al and Aytac et al. series included some of the same patients and they reported between 14.1% and 21% developing fistula after conversion from IPAA.

Furthermore, Aytac et al. also reported 8% of patients required TPN in their series and 3% developed short bowel syndrome.

Conversion from IPAA to the TIES has not been undertaken.
Outcome Summary Comparison for Different Types of Continent Ileostomy

The outcome summary comparing the different types of continent ileostomy is outlined in Table 6.

DISCUSSION

This review has found that the different types of continent ileostomy all have low postoperative mortality. However, they are all associated with a high reoperation rate which is primarily due to valve mechanism failure. Other significant complications from surgery for continent ileostomy include fistulae, stomal stenosis and stomal necrosis. Despite this the rates of pouch removal are relatively low. Patients might have their quality of life greatly improved by a continent ileostomy in a number of clinical scenarios – as a primary procedure, after a failed IPAA, or conversion from a conventional end ileostomy – and many patients report high levels of satisfaction afterwards.

Valve mechanism failures occur for different reasons in intussusceptive and non-intussusceptive types of continent ileostomies. In intussusceptive valves the fault is due to nipple valve slippage. Generally, the rates of slippage have decreased with improvements in surgical technique, but rates remain stubbornly high. Techniques to prevent nipple valve slippage include removing the fat from the valve mesentery and staple fixation of the valve [30]. Other mechanical and chemical methods have been used to promote scarring of the intussuscepted segment and prevent slippage.

It was nipple valve slippage that spurred Spencer and Barnett to invent the BCIR with its living intestinal collar to buttress the intussusceptive valve and prevent this complication. But Kaiser et al. note that their non-intussusceptive valve also has problems – specifically the outflow segment being too long or too short [24]. If it is too long the patient will have difficulty intubating the pouch and if it is too short it will lead to incontinence and leakage. They describe a learning curve to be able to predict the length of outflow segment needed. The general trend with continent ileostomy studies is that the learning curve reduces the complications and reoperation rate as time goes on.
Fistula rates can be high after continent ileostomy and can be the result of the use of mesh. Fistulation may also occur at a higher rate after conversion from IPAA. One possible explanation may result from the extensive pelvic dissection to mobilise the pouch before creating the new stoma which may pose a risk of occult injury to the bowel.

Stomal stenosis is reported at relatively high rates compared to what is otherwise reported in the literature [31]. It occurs in both intussusceptive and non-intussusceptive continent ileostomies and is a result of scarring of the skin at the stoma outlet. It is a usually a minor surgical complication that can be treated with dilatation. Definitive cure is excision of the scarred skin and resuturing of the bowel edge.

Stomal necrosis occurred in all types of continent ileostomy, including the TIES. The aetiology if this is uncertain but there might be a disruption in the blood supply to the distal bowel that is brought to this skin and this may be exacerbated by valve mechanisms.

In the era of IPAA and restorative surgery does the continent ileostomy have a role to improve the quality of life of patients who need surgery for ulcerative colitis? This systematic review has shown that continent ileostomy is a viable option for many patients such as those who have failed with IPAA, or for whom those IPAA is not suitable. Furthermore, there is a cohort of patients with a conventional end ileostomy for whom ridding themselves of an external appliance and the increase in quality of life that brings is an important goal.

What is striking across the studies is how often patients and surgeons are willing to revise the continent ileostomy rather than excise and convert to a conventional end ileostomy. Less than 10% of BCIR and T-pouches are excised despite the high reoperation rate. The long-term quality of life data may partly suggest why. Patients with Kock pouch, BCIR and T-pouch all generally reported an improved quality of life with their continent ileostomy.

The crucial question of whether a continent ileostomy is better for a patient’s quality of life than a conventional Brooke ileostomy is not settled. There is conflicting survey or questionnaire data that shows patients on one hand much prefer their continent ileostomy after having it converted from a conventional end ileostomy. But it is much harder to demonstrate on validated measures a higher quality of life when comparing continent ileostomy to conventional end ileostomy.

Converting the failing IPAA to a continent ileostomy is also feasible and may improve a patient’s quality of life. Two of the largest series presented in this study reported good rates of functioning pouches many years after surgery and one showed an improvement of quality of life as measured by SF-36. The recurring problems of nipple valve slippage and reoperation affected these patients as it does with the general cohort of patients with a continent ileostomy.

However, there are two points to highlight here. First, patients should be counselled carefully about the risks of short bowel syndrome and the need for parenteral nutrition after conversion from IPAA. Conserving the pelvic pouch may not be possible and further small bowel may be required for construction of the continent ileostomy. If the continent ileostomy were to fail, the patient may be at high risk of a permanent end ileostomy with relatively high output. It would seem pragmatic to radiologically evaluate bowel length prior to undertaking conversion from IPAA to continent ileostomy. Second, the risk of fistulation is also higher in those who have had conversion from IPAA as noted above.

Published data on outcome after TIES is limited. There is no larger published series than the study of four patients included in this review [5]. There are concerns regarding the lack of biointegration of the small bowel into the titanium implant. It is known that a number of these devices have been explanted [32]. Other innovative technologies to replicate the continent ileostomy may be developed in the future.

A limitation of this review is the retrospective nature of all the studies identified. No prospective studies on continent ileostomies and how they compare to conventional end ileostomies has ever been

### TABLE 6 Overall outcome comparison.

|                     | Kock pouch | BCIR      | T-pouch | TIES |
|---------------------|------------|-----------|---------|------|
| 30-day mortality    | 0%-3.6%    | 0%        | 0%      | 0%   |
| Reoperation rate    | 30%-65%    | 20.8%-33% | 30%     | 50%  |
| Pouch/device excision rate | 8%-36%    | 4.7%-6.5% | 7.5%    | 25%  |
| Fistula             | 2.3%-25.5% | 9.5%-10.2%| 12.5%   | 0%   |
| Stomal necrosis     | 3.1%-4%    | NR        | 2.5%    | 25%  |
| Stomal stenosis     | 2%-20%     | 2.4%-7.8% | 25%     | 0%   |
| SF-36 score         | No difference in QoL compared to matched controls or IPAA or end ileostomy | Patients with failed IPAA had lower QoL than BCIR. After conversion to BCIR QoL improved | – | – |
| CGQL score          | Score of 0.77 in one study. 0.87 for Kock pouch vs. 0.7 for end ileostomy (P = 0.006) | – | Similar score to CGQL improved significantly for life, health and energy level (P < 0.001) | – |

Abbreviation: NR, not reported.
performed. Furthermore, there may well be a significant survivorship bias to the quality of life data and outcome data available to the centres that perform these procedures. Some of the outcome data is not reported by a majority of studies, such as average time to reoperation (which is particularly important for this procedure). Interpretation of the BCIR data requires caution: the results are dominated by a single study of 510 patients, although this was a collaborative study covering 12 surgeons’ practice at five different institutions across the United States. Likewise, data on the T-pouch is from a single publication and this limits the interpretation of the observed results.

Although IPAA remains the gold standard restorative option after proctocolectomy for ulcerative colitis, good pouch function is not guaranteed, and pouch failure represents a devastating outcome for such patients. We expect the future may also include novel devices to improve the options of a continent ileostomy for those with UC who do not want or are not suitable for IPAA. This review highlights that continent ileostomy is still an option for various patients. However, careful counselling of the risks and the possible difficult journey ahead with revision surgery must be made clear to the patient.

CONFLICT OF INTEREST
None of the authors have any relevant disclosures.

ETHICS STATEMENT
Ethics approval was not sought nor required for this work.

AUTHOR CONTRIBUTIONS
MD, GW, KP, AH and OF conceived and designed the review. MD, GW and KP conducted the search, appraised the studies and extracted the data. JF constructed the figures. All authors wrote the paper. All authors critically appraised the paper and edited the final version. OF is the guarantor of the paper.

DATA AVAILABILITY STATEMENT
Data available on request.

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SUPPORTING INFORMATION
Additional supporting information may be found online in the Supporting Information section.

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APPENDIX 1
Search strategy

1. exp Colitis, Ulcerative/
2. ulcerative colitis. mp. (mp=title, abstract, original title, name of substance word, subject heading word, floating subheading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms)
3. 1 or 2
4. (continen* stoma or continen* ileostom* or kock pouch or (kock adj3 reservoir) or T pouch or (continen* adj3 reservoir)).mp. (mp=title, abstract, original title, name of substance word, subject heading word, floating subheading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms)
5. exp colonic pouches/
6. 4 or 5
7. 3 and 6