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REVIEW

Hemi-hamate donor site morbidity and complications: a systematic review

Sam J. Hamilton[1] · Nicholas S. J. Tang[1] · Jieyun Zhou[1] · Katherine A. Davis[2] · James C. Leong[1]

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Abstract

Background The hemi-hamate arthroplasty is utilised for the management of complex fracture-dislocations for injuries of the proximal interphalangeal joints (PIPJ) of the fingers. PIPJ outcomes are well described, including the post-operative range of motion, grip strength and osteochondral graft union. However, there is a paucity of evidence analysing the rate of donor site morbidity and complications. This systematic review aims to present the published morbidity of the donor site for the hemi-hamate arthroplasty.

Methods A search was conducted in MEDLINE, Embase, Emcare, CINAHL and ProQuest Nursing and Allied Health databases from their inception which yielded 384 articles to be screened. Pertinent anatomy, harvesting techniques and post-operative donor site care of the hemi-hamate arthroplasty is reviewed.

Results One hundred three cases of hemi-hamate arthroplasty were included in this review with seven (6.8%) complications presented, one of which required operative intervention.

Conclusion Donor site morbidity resulting from harvesting an osteochondral graft for a hemi-hamate arthroplasty is low. The overall quality of evidence from the studies in this review is low, highlighting the need for further robust prospective trials.

Level of evidence Not gradable.

Keywords Hemi-hamate arthroplasty · Dorsal fracture dislocation · Donor site morbidity · Proximal interphalangeal joint

Introduction

The hemi-hamate arthroplasty (HHA) is now widely utilised in the management of complex fracture dislocations of the proximal interphalangeal joints (PIPJ) of the hand since Hasting's first description in 1999. The anatomical resemblance between the dorsal hamate articular surface and the volar lip of the middle phalanx base allows the hemi-hamate autograft to restore joint congruency at the injured PIPJ and permit early mobilisation and rehabilitation of that joint [1, 2]. The success of this technique is well described within the literature [1–10].

However, there has been far less emphasis placed on the donor site. In fact, the dorsal hamate has generally been considered expendable, which may account for the paucity of literature examining this topic. The hamate sits in the distal carpal row alongside the trapezium, trapezoid and capitate. Distally, the hamate articulates with the 4th and 5th metacarpal bases, forming the 4th and 5th carpometacarpal joints (CMCJ) in a saddle configuration. This anatomical configuration is what confers the relative mobility of the ulnar CMCJs, with greatest mobility at the 5th CMCJ, permitting precision and power grip in the hand [11]. Ligamentous support is provided by various carpometacarpal, intermetacarpal and intercarpal ligaments, with additional dynamic stability provided by the extrinsic flexor and extensor tendons [12].

Given the alteration in anatomy of the 4th and 5th CMCJ following hemi-hamate autograft harvest, the aim of this systematic review is to analyse the clinical effect of harvesting a hemi-hamate osteochondral graft from a patient's wrist. Specific clinical outcomes include the type and frequency of donor site complications reported following hemi-hamate arthroplasties (Fig. 1).

✉ Sam J. Hamilton
hamiltonsj@icloud.com

1 Plastic and Reconstructive Surgery Department, Monash Health, Melbourne, VIC, Australia

2 Department of Anaesthesia, Austin Health, Melbourne, VIC, Australia

Method

Systematic review

This systematic review was conducted according to the Preferred Reporting Items for Systematic reviews and Meta-analyses (PRISMA) 2020 updated guidelines [13]. Our search was completed on April 12, 2021 in MEDLINE and then translated to Embase, Emcare, CINAHL and ProQuest Nursing and Allied Health databases from their inception. This was followed by a hand search of the grey literature and key journals. There were no study design limitations placed on the literature search. The specific search strategy conducted for MEDLINE can be found on the published protocol on PROSPERO. This was then translated to the subsequent databases.

Human studies of any form discussing HHA donor site morbidity were included in this review. Morbidity was defined as any undesired sign or symptom noticed by the participants or study team at the donor site secondary to HHA. Acute and chronic PIPJ injuries were included if the

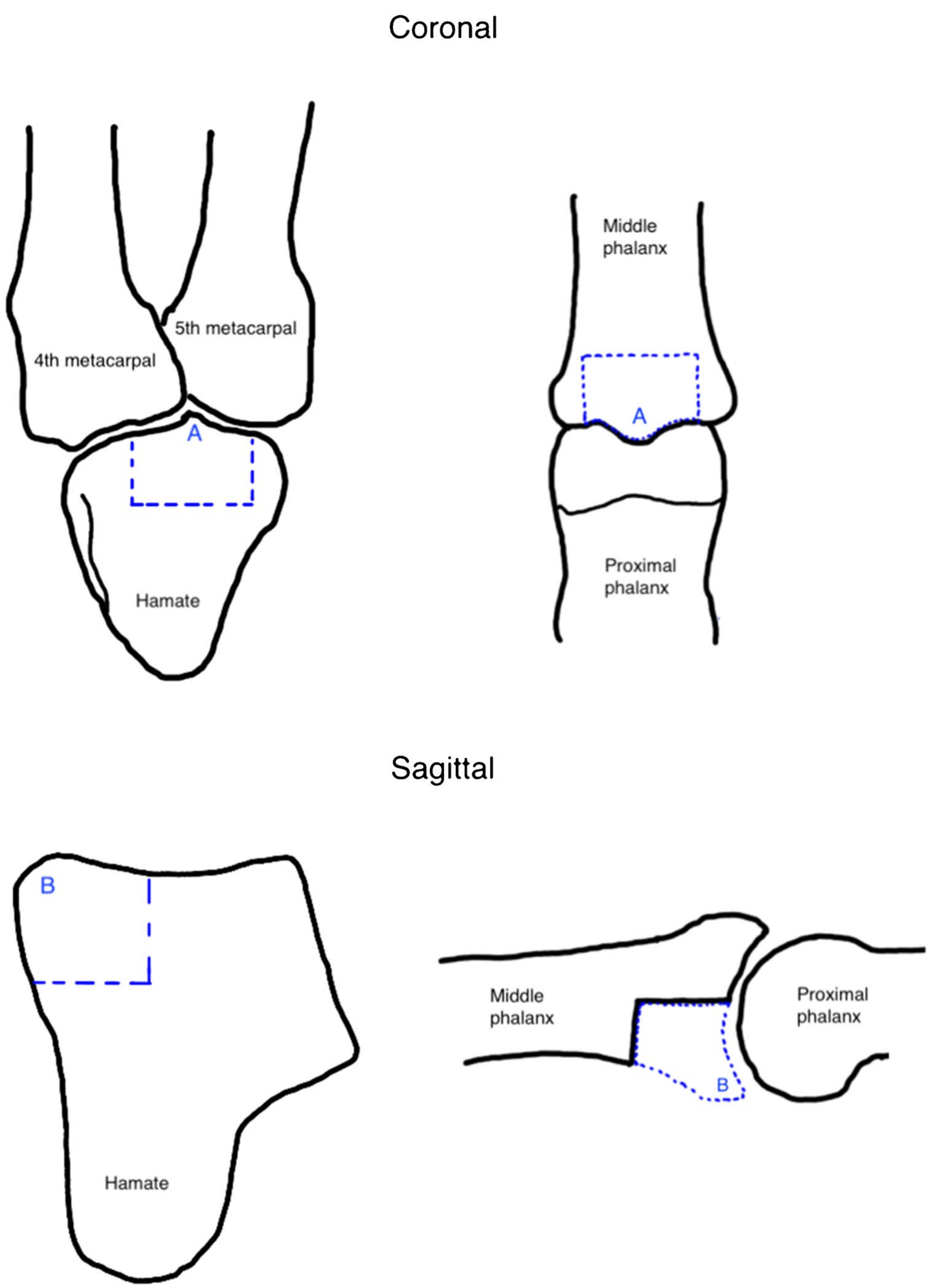

Fig. 1 Common harvesting technique of hemi-hamate arthroplasty. Points A and B in the left images are the distal aspects of the hamate bone in a coronal and sagittal plane, respectively. These are then represented in their final location in the right-hand images once the osteochondral graft has been transferred to the proximal interphalangeal joint. The distal dorsal articular surface of the hamate is harvested through a longitudinal incision over the 4th and 5th carpometacarpal joints (CMCJ). Dorsal veins, the dorsal sensory branch of ulnar nerve and the extensor tendons are protected and retracted to expose the joint capsule. Capsulotomy of the 4th and 5th CMCJs is performed to expose the dorsal surface of the hamate. The templated defect from the finger middle phalanx base is transcribed to the hamate. An oscillating sore is used to make the one transverse and two vertical osteotomies of the hamate. Over sizing the graft by ~ 1 mm in all dimensions is suggested to allow subsequent tailoring of the graft. An osteotome is used in a retrograde or anterograde fashion to complete the final osteotomy, assisted by traction and volar displacement of the metacarpal bases. The joint capsule and skin are closed with the surgeon's preferred suture

study mentioned donor site morbidity. Other forms of PIPJ fracture management or HHA articles that did not discuss donor site morbidity were excluded. There were no limitations placed on level of evidence, length of follow-up, study setting, sample size or publication date. Three hundred and eighty-four articles were generated from the systematic review, with an additional 16 articles from hand search (see Fig. 2).

Data extraction

Three independent reviewers screened each title and abstract of all 290 publications, following the removal of duplicates and errors. All reviewers worked independently, with disagreements resolved using the majority rule approach. Once title and abstracts were screened, 20 articles were reviewed in full by all three reviewers independently, and nine were selected for inclusion. Data was collected by one reviewer for analysis and discussion from the final nine articles. This method of final data collection differs from the PROSPERO published protocol as the final number of articles was more manageable than predicted. The authors made the decision for all reviewers to analyse all 20 articles as opposed to dividing up the studies, to further strengthen the review.

Results

This systematic review identified nine articles which examined donor site morbidity in hemi-hamate arthroplasties. Of the nine studies included, there was one prospective case series, seven retrospective case series, and one study was a description of a surgical technique with specific commentary on the donor site (see Table 1).

No article included in this systematic review focused on hemi-hamate donor site in detail. The data presented

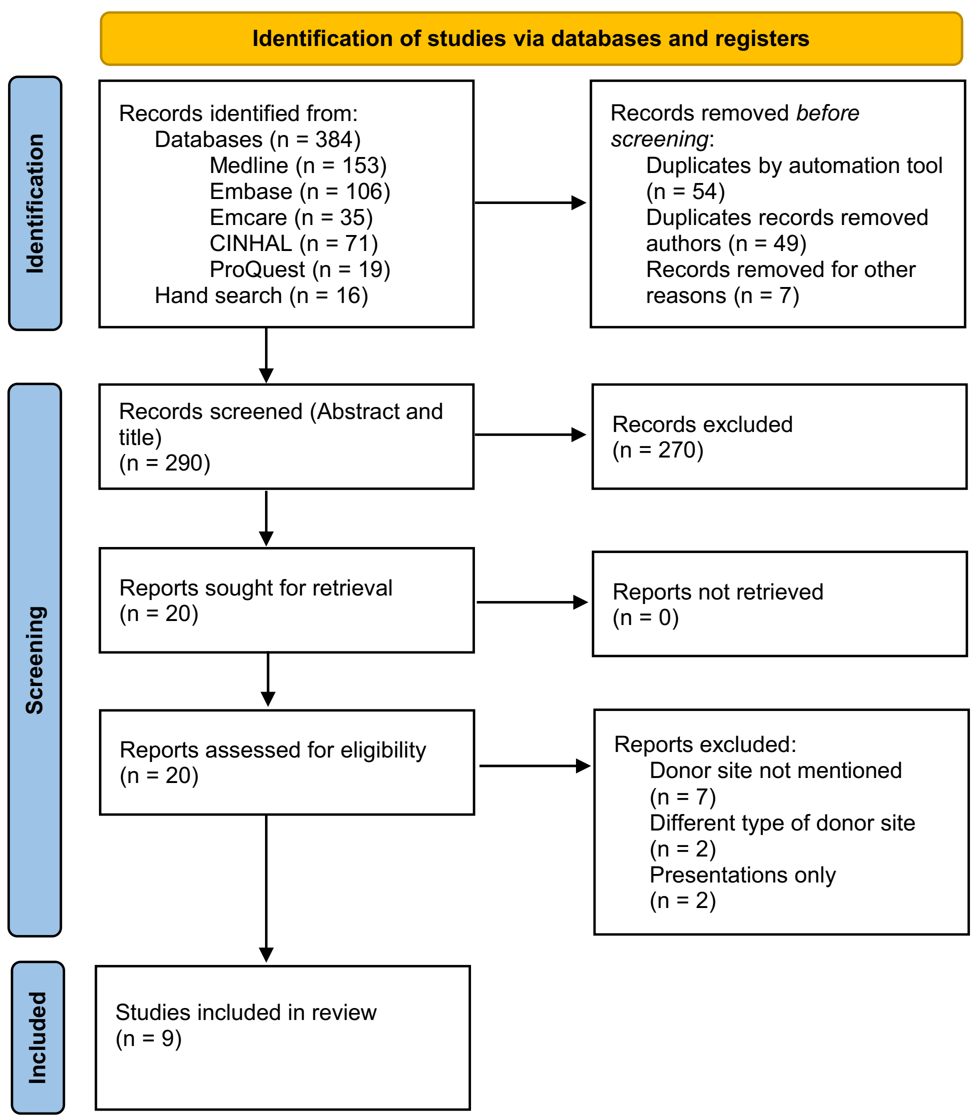

Fig. 2 PRISMA protocol flow chart outlining the screening of articles

was largely without robust measurement tools i.e. patient reported outcome measures (PROM), although three studies did use the visual analogue scale (VAS) to assess donor site pain, and a further two studies assessed range of movement (ROM) at the wrist. With one exception, all the case series were retrospective in nature, making pre- and post-operative comparisons impossible.

The only donor site complication recorded amongst the nine included studies was pain. This was reported in 7/103 cases (6.8%). The included studies are discussed in further detail below.

Kibar [17] details the only prospective case series in this review. Thirteen patients were included. Active movement was undertaken from post-operative day one, with light activities of daily living allowed for 3 weeks, followed by a specific hand rehabilitation program from 3 weeks onwards. The authors stated that no morbidity was seen in their cohort of patients, including wrist range of motion, pain and paraesthesia at the donor site. No formal assessment tools were mentioned in their assessment of donor site morbidity.

Tang et al. published a series of six patients in 2021 [9], focusing on PIPJ outcomes, with a mean follow-up of 31 months (ranging from 6 to 60 months). In a cohort of five males and one female, focus was placed on PIPJ ROM, grip strength and radiological union of the osteochondral graft. As a secondary outcome measure, Tang and colleagues completed a visual analogue scale (VAS) on donor site pain. They found one participant suffered from 1/10 pain that resolved with conservative management after 12 months. All six patients had a circumferential thermoplastic wrist splint post operatively for 2–3 weeks.

Hussain et al. [10] published a retrospective case series of twenty patients with a mean follow-up of 24.4 months. There were 15 males and 5 females. Once again, ROM and grip strength were the main outcome measures, with inclusion of pain at the PIPJ. No donor site morbidity was reported in this study. However, there was no description on how this was assessed.

Lindenblatt et al. [2] completed a retrospective case series of 10 patients post-HHA, with an average follow-up time of 8.6 months (range 3 to 14 months). The post-operative management of the donor site was not published. Of the 10 patients in their series, the authors reported only one case of donor site morbidity. The patient experienced persistent, severe donor site pain at 10 months post-operatively, requiring neurolysis of two tethered branches of the dorsal branch of the ulnar nerve within the scar, with good relief. This is the only case in the systematic review which required operative intervention. No mention is made in the paper regarding validated outcome measurement tools.

Verdins and Nefjodovs [14] presented a series of 17 patients, with six lost to follow-up. The 11 patients who participated in the study undertook a series of questionnaires. These included disability of arm, shoulder and hand (DASH) with an average score of 6.9 (range 0–27.5), patient-rated wrist evaluation (PRWE) with an average score of 5.2 (range 0–20), and Modern Activity Subjective Scale 2007 (MASS07) with an average of 6.8 (range 0–37). Patients also completed a VAS for donor site pain with an average of 0.6 (range 0–3), and donor site aesthetic appearance with an average score of 1.2 (range 0–5). They noted no instability or chronic pain at the donor site.

Burnier et al. [15] describe a series of 21 patients who underwent HHA. Two patients were excluded from follow-up, leaving 19 for assessment. One of the excluded patients had prior history of complex regional pain syndrome (CRPS), which was noted to have been reactivated following the procedure. The other excluded patient had an open fracture with nerve and arterial injury. The primary outcome measure for donor site morbidity was pain, measured using a VAS. No morbidity was noted.

The highest percentage of reported donor site morbidity was seen in a retrospective series of 13 patients undergoing HHA published by Williams et al. [8]. The authors reported on 4/13 participants who experienced donor site pain: one patient on a regular basis, and three patients only with sport or overuse. No formal assessment tool was used to measure this, and all four cases were managed non-operatively with an unknown outcome.

Yang et al. [4] describe an alternative method for harvesting the hemi-hamate graft. An osteotome or oscillating saw is used to create two sagittal hamate cuts, followed by hamate cutting in the coronal plane, as opposed to the traditional approach involving hamate cutting parallel to the coronal plane. They achieved this through forceful volar subluxation applied to the fourth and fifth carpometacarpal joints. Donor site morbidity was measured with wrist ROM and donor site tenderness, although no objective scale for pain was used. One patient reported pain at the donor site.

Denoble and Record [16] describe another alternative surgical technique for harvesting the hemi-hamate osteochondral graft, involving the additional resection of small wedges of the fourth and fifth metacarpal bases to facilitate access to the hamate. Standard closure of joint capsule and skin followed hamate harvest. In their technique, the wrist was immobilised for 3–4 days, following which unlimited mobilisation was permitted. Case numbers, follow-up and donor site assessment method were not included in this publication. The authors did not report any donor site morbidity following their method of hamate autograft harvest with regard to pain, joint stiffness or instability.

Table 1 Case series mentioning hemi-hamate donor site morbidity and complications

Author (year)	*N*	Mean age (range)	Sex (M:F)	Mean follow-up (range)	Donor site management	Donor site assessment	Donor site morbidity (n)	Management
Tang et al. (2021) [9]	6	43.5 (28–69)	5:1	31 months (6–60)	Circumferential thermoplastic splint 2–3 weeks	VAS	1	Conservative
Kibar (2021) [17]	13	39.5 (19–66)	11:2	12 months (A)	No limitations placed on the donor site, active movement from day 1 post-operative	Wrist ROM, pain, tenderness, numbness	0	N/A
Verdins and Nefjodovs (2019) [14]	11	40 (22–65)	8:3	43 months (6–138)	A	PRWE, DASH, VAS for pain and aesthetics	0	N/A
Burnier et al. (2017) [15]	19	39 (18–58)	17:2	24 months (5–73)	A	VAS	0	N/A
Denoble and Record (2016) [16]	A	A	A	A	Immobilisation for 3–4 days, active movement following this	A	0	N/A
Hussain et al. (2015) [10]	20	29 (16–45)	15:5	24.4 months (A)	A	A	0	N/A
Yang et al. (2014) [4]	11	30 (21–45)	8:3	38.1 months (24–60)	A	Wrist ROM, donor site tenderness	1	Conservative
Lindenblatt et al. (2013) [2]	10	34.9 (26– 46)	10:0	8.6 months (3–14)	A	A	1	Surgical B
Williams et al. (2003) [8]	13	29.3 (15– 50)	4:9	16 months (6–43)	A	Verbal discussion	4	Conservative

A Not specified

B Surgical release of the dorsal branch uf the ulnar nerve at the donor site was necessary due to nerve entrapment in the donor site scar

Discussion

The movement, variability and complexities of the hamate and its articulations are of significant functional importance to the hand and wrist [18–21]. Pathology involving these joints may result in chronic pain and functional limitations necessitating the need for surgical intervention [22, 23]. This review has highlighted the lack of robust clinical data specific to the hemi-hamate donor site in HHA. Nevertheless, the existing literature suggests that the distal hamate can be harvested without significant consequence. This finding is echoed by a recent systematic review by Faulkner et al. [6] focussing on overall outcomes of HHA. As a secondary outcome, they found 3% suffered from donor site morbidity in the form of pain or instability. Similarly, another systematic review described donor site morbidity after HHA as "low" [7].

To date, there has only been one biomechanical study examining the sequelae of distal hamate harvest. Capo et al. [24] demonstrated in eight cadaveric subjects that harvest of the distal hamate (with preservation of the ulnar and radial margins) did not result in any dislocation or gross subluxation at the 4th and 5th CMCJ. Indeed, one cadaveric study has suggested that the proximal and distal fourth–fifth intermetacarpal ligaments are the primary stabilisers of the 5th CMCJ [11], which are undisturbed during distal hamate harvest.

Other areas of interest raised, but not answered by this systematic review, are the methods used for osteochondral graft harvesting and post-operative rehabilitation. Within the literature, it is generally accepted that the templated hemi-hamate osteochondral graft should be oversized at the time of harvest to allow for more accurate tailoring of the graft [4, 25, 26]. However, some studies suggest modifications to the originally described technique. These include forced subluxation of the articulations between the fourth and fifth metacarpals with the hamate or ostectomy of the base of these metacarpal bases to increase access [16, 26]. It is unclear what clinical impact these modifications in hemi-hamate harvest have on the stability of the resultant ulnar carpometacarpal joints. Post-operative care also seems to vary within the published literature. Some authors elect to immobilise the wrist completely with splinting, whilst others place no limitations on the donor site at all [9, 16].

Other osteochondral donor sites, such as the knee, rib and metatarsal head have been shown to have significant donor site morbidity at a rate of 7.8% [27–30]. Pathology includes fibrocartilage hypertrophy resulting in pain and locking of the joint [28, 29] and accelerated degenerative changes. Donor site morbidity in osteochondral graft harvest should be an important consideration when harvesting the graft. This emphasises the importance of further investigation of the effect on the hamate and wrist following harvest of HHA.

This study adheres to the PRISMA guidelines and the PRISMA protocol was registered with PROSPERO. The literature search was created in conjunction with experienced librarians and a specialist hand surgeon.

The current literature regarding HHA comprises largely of retrospective case series reporting heterogenous data, with a paucity of evidence-based assessment tools and long-term follow-up. This raises issues of selection and publication bias, potentially resulting in underrepresentation of the rates of donor site complications and morbidity. A variation in osteochondral graft harvesting techniques also makes direct comparison between studies difficult. The impact that these limitations have on this systematic review have been minimised by the broad robust search that was conducted.

Investigation of donor site morbidity would benefit from further study in a prospective fashion with pre- and post-operative PROMs included in the collected data. This systematic review was undertaken to investigate the incidence of donor site morbidity in HHA, and the forms in which this occurred. From the current data, it appears that donor site morbidity in HHA is an uncommon occurrence, but mostly takes the form of pain, with no reports of carpometacarpal instability. However, the quality of the data available does not allow for a definitive conclusion to be drawn, and further robust clinical data is required.

Conclusions

The HHA for PIPJ reconstruction is an established technique in the management of complex fracture-dislocations of the PIPJ. This systematic review supports the findings of previously published works which suggest that hemi-hamate harvest is associated with low donor site morbidity, at a rate of 6.8% [6, 7]. This review also raises several pertinent points that can be used to guide future research directions. These include the need for robust clinical data specifically examining morbidity at the hamate donor site, a consensus regarding the ideal harvesting technique for these osteochondral grafts, as well as data regarding post-operative donor site management. Biomechanical studies investigating the impact of hemi-hamate harvest on CMCJ stability would also be of value.

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Authors' contributions All the authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Sam J. Hamilton, Nicholas S. J. Tang and Jieyun Zhou. All the authors read and approved the final manuscript.

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Declarations

Ethics approval As a systematic review of already published literature, this study does not require ethics approval.

Patient consent This article does not contain any studies involving human participants or animals performed by any of the authors

Competing interests The authors, Sam J. Hamilton, Nicholas S. J. Tang, Jieyun Zhou, Katherine A. Davis and James C. S. Leong, have no relevant financial or non-financial interests to disclose.

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