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Does Time to Surgery for Distal Radius Fractures Impact Clinical and Radiographic Outcomes? A Systematic Literature Review

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Abstract

Distal radius fractures are one of the most common upper extremity fractures across all age groups. Although the American Academy of Orthopaedic Surgery (AAOS) Clinical Practice Guidelines have defined recommendations for the treatment of distal radius fractures, the optimal time to surgery was not included. There remains relatively little guidance or consensus regarding

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the optimal timing of surgical intervention for distal radius fractures and the impact of time to surgery on outcomes. As such, the purpose of this investigation is to systematically review clinical and radiographic outcomes associated with time to surgical management of distal radius fractures.

Keywords

Time to surgery; Distal radius < Fracture/dislocation < Diagnosis; Treatment < Research & health outcomes; Patient Reported Outcome Measures; Patient outcome; Clinical Outcome; Functional Outcome

Introduction

Distal radius fractures are common and represent approximately 8–18% of adult fractures treated in emergency departments across the U.S.[1] They are the second most common fracture in elderly patients and the most frequent upper extremity fracture in women over 50 years of age.[2] The incidence of both distal radius fractures and surgical fixation of distal radius fractures is on the rise.[3] The American Academy of Orthopaedic Surgery (AAOS) Clinical Practice Guidelines have defined recommendations for the treatment of distal radius fractures, including when surgical fixation is recommended[4]; notably, the optimal time to surgery was not included. The British Society for Surgery of the Hand (BSSH) and the National Institute for Health and Care Excellence (NICE) guidelines for distal radius fractures recommend surgical intervention within 72 hours of injury for intra-articular fractures and within one week for extra-articular fractures.[5–6]

The timing of surgery and its influence on outcomes has been studied in other common orthopaedic injuries, such as for hip fractures, flexor tendon injuries, and pediatric type III supracondylar humerus fractures.[7–9] Delays may impact not only rates of systemic complications like pneumonia and deep vein thromboses, but also fracture-related complications. For example, previous studies on hip fractures have demonstrated decreased mortality and postoperative complication rates when surgery is performed within 24–48 hours of the injury.[10] In addition, repair of Zone II flexor tendon lacerations within 7–10 days is preferable due to the risk of contracture formation, tendon retraction and adhesions, and degenerative changes at the tendon ends that make primary repair more difficult at later stages of follow up.[11] Furthermore, other studies on the treatment of traumatic injuries have demonstrated that early surgery leads to shorter hospital stays and faster recovery and, thus, there may be economic implications for early definitive treatment of traumatic injuries, including earlier return to work.[12–14]

For fracture care in particular, callus formation and soft tissue contractures begin around days five to eleven.[15] While surgeons anecdotally prefer to operate on most fractures soon after the injury because callus formation makes fractures more difficult to reduce, it is not always possible due to patient medical comorbidities, access to care, limited surgeon or operating room availability, or patient preference.[16] For distal radius fractures in particular, loss of reduction after attempted non-operative treatment is not uncommon[17–18] and may lead to delays in surgical treatment for longer than 3 weeks. Souza et al. found that 30% of patients in a retrospective cohort study who initially presented with nondisplaced or minimally displaced fractures showed displacement that exceeded AAOS acceptable criteria at week 6.[17] Despite this, there remains relatively little guidance or consensus regarding the optimal timing of surgical intervention for distal radius fractures and the impact of time to surgery on outcomes. As such, the purpose of this investigation is to systematically review clinical and radiographic outcomes associated with time to surgical management of distal radius fractures.

Methods

Search Strategy

We performed a systematic review following the 2020 Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines.[19] Separate and comprehensive literature searches of PubMed, Web of Science, and Embase databases were performed. Two authors (K.R.J. and N.M.T.) independently searched and evaluated titles and abstracts for relevance on April 22nd, 2022. They were not blinded to the journals, organizations, or author information. All articles were uploaded to EndNote (Version 20, Web of Science, Clarivate Analytics, Philadelphia) and duplicates were removed. Article screening was completed through Rayyan software (Rayyan.qcri.org, Qatar Computing Research Institute, Qatar). Rayyan is a web and mobile application designed to facilitate article screening and promote collaboration between authors for inclusion decisions for systematic reviews. On June 22nd, 2022, the literature search was repeated to capture any new and relevant articles published in the literature. Disagreement between the coauthors was resolved through discussion and consensus. If consensus was unable to be reached, a third author (L.M.S) was consulted to resolve discrepancies. Any study that potentially met the inclusion criteria was retrieved and reviewed. The inclusion criteria were as follows: (1) Retrospective studies, observational studies, and randomized controlled trials (RCTs); (2) displaced distal radius fractures that were treated surgically; (3) outcomes consisting of patient reported outcomes measures (PROMs), radiologic findings, and/or clinical findings (e.g., stiffness); and (4) studies that compared outcomes noted above based upon surgical timing (e.g., surgery within and after 1 week). The exclusion criteria were as follows: (1) animal subjects and (2) case reports, technical reports, systematic reviews and biomechanical studies.

Quality Assessment

The Methodological index for non-randomized studies (MINORS) Criteria was used to assess the quality of each paper. The first eight criteria were used for the two non-comparative studies and all twelve criteria were used to assess the 13 comparative studies. The MINORs criteria include items such as a clearly stated aim and a prospective calculation of study size, and are scored 0 if not reported, 1 when reported but inadequate, and 2 when reported and accurate. The global ideal score is 16 for non-comparative studies and 24 for comparative studies. MINORS assessment was conducted independently by two authors (K.R.J and C.V.L.). Disagreement between the coauthors was resolved through discussion and consensus. If consensus was unable to be reached, a third author (L.M.S) was consulted to resolve discrepancies.

Data Extraction and Outcome Measures

Two authors completed data extraction (K.R.J and C.V.L.). To ensure consistency in classification, the two authors extracted all variables independently and compared results. The following variables were collected and reported descriptively: author list, publication year, journal, sample size, timing of surgical intervention and how this was defined (e.g. early and delayed groups), reasons for delay if noted, patient characteristics (e.g., age, sex), study inclusion and exclusion criteria, follow up duration, outcomes, confounding factors adjusted for, whether the study conducted power analyses and *a priori* power analysis, repair technique, and level of evidence. As there is no established time to surgery for distal radius fractures, we collected and evaluated time to surgery as defined and detailed by each study (e.g. early/delayed, more or less than two weeks). The primary outcome measures were scores on patient reported outcomes measures (PROMs), such as Disabilities of Arm, Shoulder, and Hand (DASH) scores, as well as radiographic outcomes, such as radial height, radial inclination, volar tilt, and intra-articular step off. Any other study outcomes, including clinical outcomes such as stiffness, complication rates, were also recorded.

Results

The literature search yielded 656 unique articles pertaining to operative distal radius fractures. A total of 633 citations were subsequently excluded after screening titles and abstracts and applying the exclusion criteria, leaving 22 citations. These full-text articles were retrieved and reviewed independently by two authors (K.R.J. and N.M.T). Seven of these articles were subsequently excluded due to a lack of definition of time to surgery or delay, articles written in languages other than English, examination of different fracture patterns and an article investigating time to debridement rather than time to fixation. This left a total of 15 studies that met the inclusion criteria (eight retrospective reviews, six retrospective cohort studies, one secondary RCT analysis, and one RCT). The trials ranged in size from 24 to 881 participants and were conducted in five countries. Figure I. demonstrates a flow chart of the search strategy.

Quality Assessment

The average MINORS score among the thirteen comparative studies was 17/24 (71% of the maximum) and 8.5/16 (53% of the maximum) for the two non-comparative studies. The results of the quality assessment are illustrated in Table I. Common limitations included lack of unbiased assessment/blinding (Criteria 5), significant loss to follow up (Criteria 7), lack of prospective calculation of study size (Criteria 8), and lack of adequate statistical analysis (Criteria 12). Some limitations are inherent to the retrospective nature of the studies.

Participant Demographics

Our review included 3,061 participants (31.7% male from 15 trials). Participants had a mean age of 58 years. Baseline characteristics are outlined in Table II.

Time to Surgery and Definition of Delay

Time to surgery evaluated and the definition of delay varied by publication, with 13% of studies defining delay within one week of injury, 47% after one week, 27% after two weeks, and 13% after three weeks or longer (up to 25 days after injury). Only five (33%) of the included studies provided reasons for delay that included: administrative and capacity related reasons such as operating room availability,[24,28,30,34] delayed patient presentation,[24,30] and injury severity.[26,28,34]

Trial Outcome Measures

Ten (67%) trials found no significant difference in time to surgery as defined by delayed and non-delayed groups. In addition, 80% of trials lacked an *a priori* power analysis for statistical analysis. Three trials conducted post hoc power analysis, leaving nine trials (60%) that were not powered.

Twelve (80%) utilized clinical outcome significance (e.g., complication rates, reoperation rates, range of motion), ten (67%) trials utilized patient reported outcomes measures, and four trials (27%) reported on radiographic significance. Nine trials (60%) used a combination of PROMs, radiographic, and/or clinical outcomes to assess significant differences between early and delayed surgical groups.

Among the five trials that found significant differences in time to surgery, four trials found significant differences at a surgical delay of greater than one week[23,28,33–34], and one trial found significant differences in patients with a surgical delay of greater than two weeks[20]. One study reported radiographic significance[28], three studies reported significant differences among PROMs[23,28,33], and all five studies reported differences in clinical outcomes[20,23,28,33–34] (Table III). The significant differences in PROMs were found at a surgical delay of seven days or more and two different PROM tools were utilized, DASH[28,33] and The Michigan Hand Outcomes Questionnaire.[23] Clinical outcomes included increased finger and thumb stiffness (>2 weeks delay),[20] decreased functional outcomes in flexion and ulnar deviation at a delay of greater than one week,[28] and more than triple the odds of experiencing chronic pain with a one-week delay to surgery.[34] One study found that surgeons reported greater procedural difficulty with a delay greater than one week.[23] Another study found that patients who had surgery within seven days of injury had better short-term PROMs and clinical outcomes, with the delayed group showing significantly worse DASH scores, grip strength, and wrist motion at twelve weeks, but at 48 weeks there were no significant differences between groups.[33] Of the four studies that conducted *a priori* power analyses, three found no significant differences between groups and one trial reported superior outcomes in patients with early surgery (within one week) with respect to DASH scores, range of motion, grip strength, radiographic results, and complications at 2 years.[28]

Discussion

This systematic review analyzes the literature for differences in patient outcomes due to time to surgery for distal radius fractures. A majority of studies did not find significant differences between groups defined as delayed and non-delayed. However, there was heterogeneity in which time to surgery threshold was used to define delay and the outcomes measured, as well as a lack of appropriate power calculations in a majority of studies. This review indicates there is conflicting data regarding the effect of time to surgery for distal radius fractures on patient outcomes. Understanding the impact of the timing of surgical management of distal radius fractures can have profound implications on clinical practice guidelines and on optimizing outcomes after surgical management for distal radius fractures.

Time to surgery and the definition of a delay to surgery for distal radius fractures varied greatly. Delays to surgical management and its impact on patient outcomes are well defined in other orthopaedic injuries. For instance, the definition of delay in the surgical management of hip fractures is established as greater than 24 to 48 hours after injury. Delays to surgical fixation of hip fractures consistently results in increased length of hospital stay, complications, and morbidity and mortality.[14,36] The lack of a clear definition of surgical delay for distal radius fractures limits the ability to understand and implement findings from studies and establish clinical practice guidelines. As investigation continues, defining the time interval of surgical delay for distal radius fractures will be vital to interpreting the impact of such delays on outcomes and implementing study findings to optimize patient outcomes.

A majority of studies used objective measures such as complication rates, range of motion, or reoperation rates as a primary endpoint. However, there are crucial aspects of the patient experience that are not accounted for using objective outcome measures alone, as these measures do not capture subjective patient experiences. For instance, patients achieving acceptable range of motion or patients not requiring revision operations may still be unable to carry out activities of daily living or return to work. Furthermore, it is well established that radiographic findings do not necessarily correlate with functional outcomes for distal radius fracture injuries.[37–39] Ultimately, the inclusion of both subjective and objective measures when evaluating the impact of time to surgery will provide improved patient-centered care and insight into success as defined by the patient.

From a health policy perspective, it is important to understand and mitigate delays in care, particularly if they are related to inequities in access and outcomes. Hooper et al. found that among patients with distal radius fractures who received early operative treatment, there were significantly greater numbers of patients who were employed full-time.[23] This reflects similar trends shown in other orthopaedic injuries that have found that patients of lower socioeconomic status are less likely to receive surgery and more likely to experience delays to surgery.[40] While delays to surgical management could be a result of patient preferences for initial non-operative treatment, there is a possibility that such delays may be a result of disparities in access to care or poor health literacy. Notably, only five studies included in this systematic review reported reasons for the delay to surgery, which highlights the need for future studies analyze patient and system level characteristics that may contribute to delays in surgical management of DRFs. Understanding the reasons for delay is a first step to quantifying disparities in hand and upper extremity surgery and to implementing evidence-based interventions to mitigate such variations in care.

It is important to acknowledge the limitations associated with the findings of this study. An inherent limitation to systematic reviews is the reliance on subjective screening. To minimize this, we used strict inclusion and exclusion criteria, followed PRISMA guidelines, and had multiple reviewers for each article. Our results are also limited by the design and quality of the studies included for analysis, which were primarily retrospective and lacked appropriate power analyses. However, to account for this, we assessed the quality of each paper using the MINORS criteria. Lastly, the studies in this review also included heterogeneous definitions of time to surgery and delay in treatment and further, utilized different outcome measures, which impeded our ability to conduct a meta-analysis.

Conclusion

The importance of surgical timing has been established for multiple musculoskeletal injuries; however, there is lack of consensus regarding the optimal timing of surgical intervention for the treatment of distal radius fractures. This review found great heterogeneity not only in the definition of surgical delays, but also in how surgical outcomes were measured. Notably, a majority of studies were retrospective and underpowered. Further research is needed to examine the association of time to surgical management for DRFs and subsequent adverse outcomes. These studies should be larger, prospective, and appropriately powered on patient-centered outcomes.

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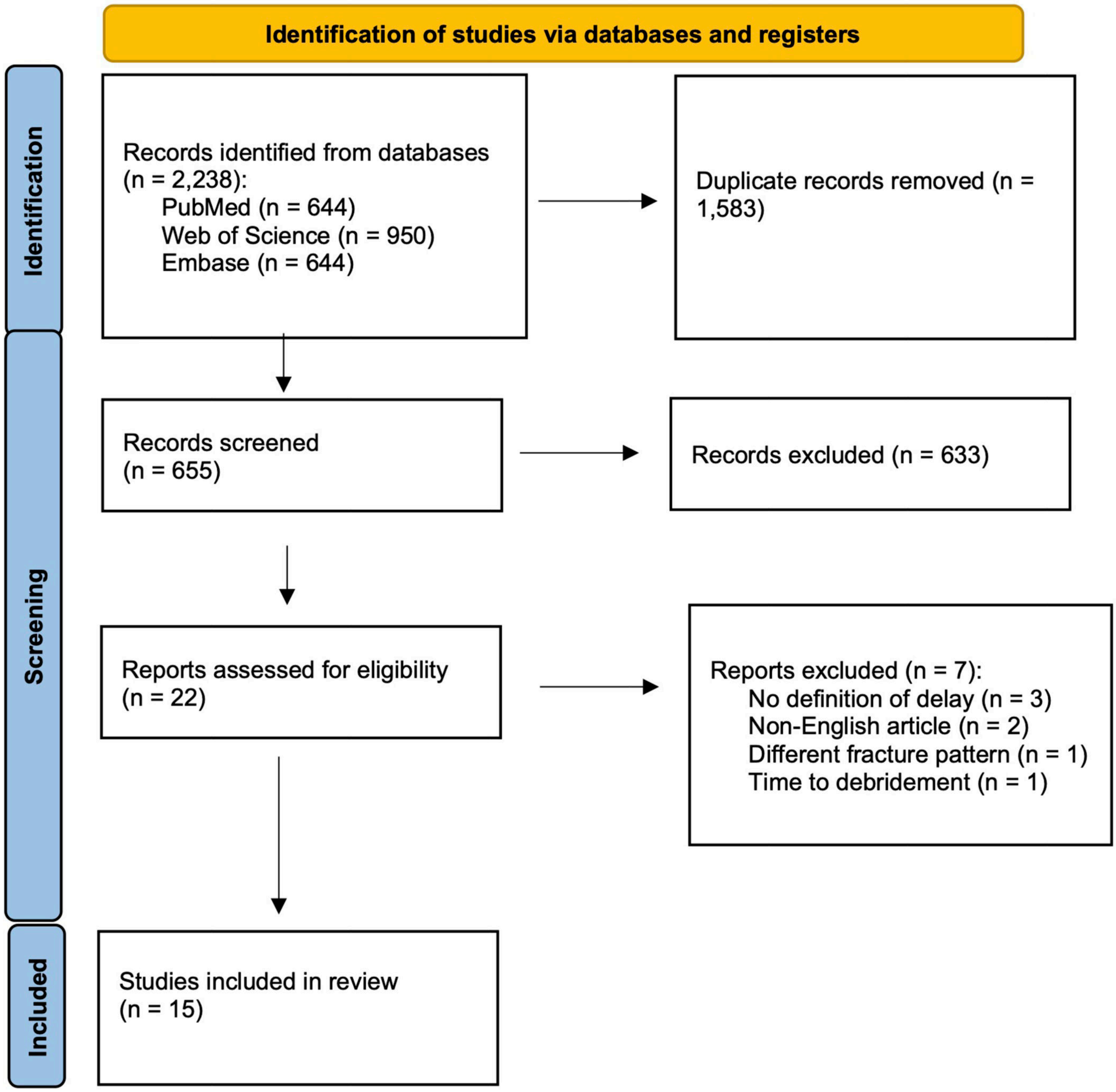

Figure1.

Flowchart utilizing PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) criteria for inclusion and exclusion of studies. Adapted From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71. For more information, visit: http://www.prisma-statement.org/

Table I.

Quality Assessment of Included Studies Using MINORS Criteria

First Author	Year	Study Design	MINORS Criteria[a,b]												Total	% Maximum
			1	2	3	4	5	6	7	8	9	10	11	12		
Ashdown[20]	2021	Retrospective cohort	2	1	2	2	1	2	1	1	2	2	2	2	20	83
Howard[24]	2021	Retrospective cohort	2	1	2	2	0	2	1	2	2	2	2	2	20	83
Tareen[30]	2019	Retrospective review	2	1	2	2	0	2	1	2	2	2	2	2	20	83
Sirino[28]	2019	Prospective RCT	2	1	2	2	0	2	1	2	2	2	2	2	20	83
Yoon[34]	2020	Secondary RCT analysis	2	1	1	2	0	2	1	1	2	2	2	2	18	75
Lee[25]	2020	Retrospective matched cohort	2	1	2	2	1	2	0	1	2	2	2	0	17	71
Henry[22]	2020	Retrospective cohort	2	1	2	2	0	2	1	0	2	2	2	0	16	67
Hooper[23]	2021	Retrospective chart review	2	1	1	2	0	2	0	1	2	2	2	1	16	67
Sirino[29]	2018	Retrospective review	2	1	2	2	0	2	0	1	2	2	0	2	16	67
Yamashita[33]	2015	Retrospective cohort	2	1	2	2	0	2	2	0	2	2	1	0	16	67
Weil[32]	2014	Retrospective matched cohort	2	2	2	2	0	2	0	0	2	2	1	0	15	63
Malige[27]	2020	Retrospective chart review	2	1	2	2	0	2	0	0	2	2	1	0	14	58
MacFarlane[26]	2015	Retrospective review	2	1	2	2	0	2	0	0					9*	56
Chilelli[21]	2013	Retrospective chart review	2	1	2	2	0	2	0	0	2	1	1	0	13	54
Ward[31]	2011	Retrospective chart review	2	1	2	1	0	2	0	0					8*	50

[a] The blank spaces are not applicable

[b] MINORS[35] global ideal score is 24 for comparative studies and 16 for non-comparative studies. There are two non-comparative studies.

* Items are scored as 0 (not reported), 1 (reported but inadequate) or 2 (reported and adequate). (1) A clearly stated aim (2) Inclusion of consecutive patients (3) Prospective collection of data(4) Endpoints appropriate to the aim of the study. (5) Unbiased assessment of the study endpoint(6) Follow-up period appropriate to the aim of the study (7) Loss to follow up less than 5% (8) Prospective calculation of the study size(9) An adequate control group (10) Contemporary groups(11) Baseline equivalence of groups(12) Adequate statistical analysis

Table II.

Demographic Characteristics of patients in included studies

Author	Year	Number of patients	Cases defined as delayed, n (%)	Mean age, years, (range)	% Male
Ashdown[20]	2021	158	77 (49%)	57 (26–86)	42%
Chilelli[21]	2013	46	42 (46%)	52.5 (21–83)	63%
Henry[22]	2020	24	7 (29%)	63 (47–73)	25%
Hooper[23]	2021	184	96 (52%)	68.4	12%
Howard[24]	2021	380	34 (9%)	64.3 (17–87)	16%
Lee[25]	2020	75	25 (33%)	49.55 (18–87)	40%
MacFarlane[26]	2015	187		57.3 (16–93)	
Malige [27]	2020	495		62.45	25%
Sirino[28]	2019	80	42 (53%)	63 (50–82)	
Sirino[29]	2018	881		58.7 (16–92)	23%
Tareen[30]	2019	92	30 (32%)	41 (16–64)	72%
Ward[31]	2011	92		48.4 (21–88)	39%
Weil[32]	2014	115	40 (35%)	53 (22–85)	43%
Yamashita[33]	2015	106	30 (28%)	67.45 (51–80)	0%
Yoon[34]	2020	146		68.9	12.4%

[a]The blank spaces represent information that was not reported in the study

Table III.

Radiographic, patient reported outcomes measures (PROMs), and clinical outcome significance of included studies

Author	Year	Definition of Delay	Level of Evidence	Radiographic Significance	Patient Reported Outcome Significance	Clinical Significance	Time to follow up at significance
Ashdown[20]	2021	> 2 weeks	IV			X	36 months
Chilelli[21]	2013	> 2 weeks	III				
Henry[22]	2020	7 days	III				
Hooper[23]	2021	> 1 week	III		X	X	6 weeks PROM, immediate post-op clinical outcome
Howard[24]	2021	> 2 weeks	III				
Lee[25]	2020	> 3 weeks	III				
MacFarlane[26]	2015	> 2 weeks	III				
Malige [27]	2020	> 1 week	III				
Sirino[28]	2019	> 1 week	I	X	X	X	24 months
Sirino[29]	2018	> 1 week	IV				
Tareen[30]	2019	4 days	III				
Ward[31]	2011	> 1 week	III				
Weil[32]	2014	> 3 weeks	II				
Yamashita[33]	2015	> 1 week	III		X	X	3 months
Yoon[34]	2020	> 1 week	I			X	12 months