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Peripheral Nerve

Comparative Effectiveness Systematic Review and Meta-analysis of Peripheral Nerve Repair Using Direct Repair and Connector-assisted Repair

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Background: This clinical literature systematic review and meta-analysis were performed to assess differences in outcomes between nerves repaired with direct repair (DR) and connector-assisted repair (CAR).

Methods: A systematic literature review for DR and CAR was performed. Studies from 1980 through August 2023 were included if DR or CAR repairs were performed in upper extremities with nerve gaps less than 5 mm and reported sensory Medical Research Council Classification (MRCC) outcomes or equivalent. Comparative analyses were planned for meaningful recovery (MR) rate (at both S3 and S3+ or better), postsurgical neuroma, cold intolerance, altered sensation, pain, and revision rate.

Results: There were significant differences in MR rates for CAR and DR. At the MRCC S3 threshold, 96.1% of CAR and 81.3% of DR achieved MR ($P < 0.0001$). At the MRCC S3+ threshold, 87.1% of CAR and 54.2% of DR achieved this higher threshold of MR ($P < 0.0001$). There were no differences in neuroma rate or pain scores in our dataset. Altered sensation (dysesthesia, paresthesia, hyperesthesia, or hypersensitivity) was not discussed in any CAR studies, so no analysis could be performed. The revision rate for both procedures was 0%. The proportion of patients with cold intolerance was 46.2% in the DR studies, which was significantly higher than the 10.7% of patients in the CAR group.

Conclusions: Significantly more patients achieved sensory MR and fewer had cold intolerance when the CAR technique, instead of the DR technique, was performed to repair peripheral nerve injuries. *(Plast Reconstr Surg Glob Open 2024; 12:e5927; doi: 10.1097/GOX.0000000000005927; Published online 9 July 2024.)*

INTRODUCTION

Traumatic nerve injuries occur in almost 3% of all patients with limb trauma.[1] Nerve injury in the upper extremity, the most common type, is estimated at 43.8 cases per million each year.[2] The complexity of these injuries varies considerably, as do the techniques for nerve repair. For transected nerves, the surgeon can decide whether to use direct repair (DR), or nerve conduits or grafts. This decision typically depends on the size of the gap between the two nerve ends, the type of nerve, and the location of the injury.

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Although DR of two nerve ends in close proximity is the historical standard of peripheral nerve repair, suboptimal outcomes often occur. This was recently demonstrated in a systematic review that included 569 digital nerves repaired with DR. Static two-point discrimination (s2PD), the most frequently reported sensory outcome measure in the included studies (provided for 476 of the 569 repairs), was greater than 15 mm (equivalent to S3 or lower, depending on loss of protective sensation) in 38% of digital nerves treated with DR.[3] This suggests there are still opportunities to improve outcomes for DR.

The obstacles to optimal outcomes in DR are fascicular misalignment; axonal escape; excessive tension localized at the coaptation sutures; and rupture of the coaptation with flexion and extension, especially during postoperative rehabilitation. Fascicular malalignment may decrease the number of axons that reach their proper end organs, thus reducing the likelihood for meaningful recovery (MR) in patients.[4] Axons that escape the coaptation can lead to pain due to neuroma formation[5] or the axons

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can get trapped in scar.[6] Tension at the zone of regeneration can cause ischemia[7] that reduces nerve regeneration across a coaptation[8] and can even cause the coaptation to rupture.[9] This mechanical failure of the coaptation typically occurs by suture pull-out through the epineurium rather than suture failure.[10] The regenerating axons from ruptured or untreated proximal nerve ends, or axonal escape from the coaptation face, have a low chance of finding their distal targets and have a low probability of achieving MR.[11–13] Overcoming these obstacles may improve the likelihood of achieving MR.

The connector-assisted repair (CAR) technique is performed by placing closely approximated nerve ends within a coaptation aid. The use of a coaptation aid aims to mitigate each of the risks identified above and visually improves both the quality and consistency of the repair.[14] Using a coaptation aid permits the surgeon to purposefully leave two nerve ends a few millimeters apart to allow for axonal regeneration across the nerve gap with minimal tension at the repair site, while minimizing the risk of fascicular misalignment.[15] In addition, the coaptation aid provides a physical barrier that blocks axonal escape while containing the neurotropic milieu, which may contribute to the reduction in pain experienced by patients with wrapped coaptations and allows for axonal regeneration to the appropriate target organs.[16,17] The coaptation aid is also sutured away from the zone of regeneration and off-loads tension from the coaptation face,[18] which presumably alleviates regeneration-blocking ischemia and inflammatory reaction from that critical zone of regeneration. Furthermore, the use of a coaptation aid allows for fewer sutures at the repair site while providing mechanical integrity similar to that of a DR with more sutures.[10] Finally, preclinical models have found less intraneural scarring in wrapped versus unwrapped nerve repairs.[19]

As some of the mechanisms of failure of DR can be mitigated by the CAR technique, we hypothesized that functional outcomes improve with use of a coaptation aid relative to DR alone. This study investigated the sensory functional recovery outcomes [British Medical Research Council Classification (MRCC) scale, s2PD, Semmes-Weinstein monofilaments (SWMF), or Von Frey monofilament (VFM)] following either DR or CAR in the upper extremity through a systematic review and meta-analysis of clinical studies. Outcomes evaluation during recovery of peripheral nerve injuries can be categorized into tests of sensory function, motor function, pain and discomfort, neurophysiological and patient-reported outcomes. The MRCC scale was selected as an evaluation criterion in this meta-analysis, as it is commonly used for the evaluation of peripheral nerve recovery[20] and has been previously used as a conversion scale for other sensory nerve tests.[21]

We hypothesized that patients who underwent CAR would have significantly higher MR rates. Additionally, we evaluated sensory-related complications (neuroma, cold intolerance, pain, and altered sensation including dysesthesia, paresthesia, hyperesthesia, and hypersensitivity) and revision rate following either DR or CAR. We hypothesized that patients who underwent CAR would be less likely to exhibit sensory-related complications than patients who underwent DR.

Takeaways

Question: Is there a difference in clinical outcomes for upper extremity nerves repaired with direct repair (DR) compared with connector-assisted repair (CAR)?

Findings: The sensory meaningful recovery rate (≥S3) for CAR is 96.1%, which is significantly higher than DRs at 81.3%. The higher threshold meaningful recovery rate (≥S3+) for CAR is 87.1%, which is significantly higher than DR at 54.2%. The rate of cold intolerance following DR is 46.2%, which is significantly higher than CAR at 10.7%.

Meaning: The results from our systematic review and meta-analysis support the use of CAR over DR for nerves in the upper extremity.

METHODS

Literature Search and Data Extraction

The following string was executed to query PubMed for clinical studies related to DR or CAR: [(injury, peripheral nerve(MeSH Terms) OR (peripheral nerve(Title/Abstract)) OR (nerve injury(Title/Abstract)) AND (nerve conduit(Title/Abstract)) OR (nerve repair(Title/Abstract))]. To be considered for inclusion for functional sensory outcome evaluation, studies were screened by two independent reviewers per the following inclusion criteria: publication date January 1980–August 2023; evaluated by clinical means; upper extremity repairs (digit, hand, forearm, or arm); repair performed using DR or CAR (with gaps <5 mm); and outcomes able to be converted to discrete sensory MRCC categories (at least S0, S3, S3+, and S4), including MRCC, s2PD, SWMF, or VFM. To be considered for inclusion in sensory-related complications and revision rate analyses, studies were screened per the following inclusion criteria: publication date January 1980– August 2023; evaluated by clinical means; upper extremity repairs (digit, hand, forearm, or arm); and repair performed using DR or CAR (with gaps <5 mm).

Reports for sensory outcomes, sensory-related complications, and revision rate were screened and excluded for the following criteria: case studies/case series (n < 9), possibility of duplicated patients in other reports, complex injuries/repairs (eg, spaghetti wrist, replantation, transplantation), nerve transfers, brachial plexus repairs, studies with patients only under the age of 18, autologous nerve tubes (eg, vein grafts), novel repair materials (eg, conduits with scaffolding, doping of material with growth factor or Schwann cells), non-degradable nerve tubes (eg, silicone), nerve gaps equal to or greater than 5 mm, non-English reports or reports that were not available online, and abstract-only reports. Additionally, retrieved review publications were queried for references to any unique and eligible reports not returned by the original search criteria. If a report specified patient/repair level data, individual patients/repairs that met inclusion criteria were included from that study and other patients/repairs were excluded, which was applied to exclude nerve gaps 5 mm or greater. Patient age, nerve, nerve type, nerve location, and mechanism of injury were collected and compared between the two repair types.

Outcome Measures

Sensory MR, the primary outcome, was defined as recovery equal to or greater than S3 on the MRCC sensory scale (Table 1). Higher-threshold sensory MR was defined as recovery outcomes equal to or greater than S3+ on the MRCC sensory scale. Motor MR rates were not assessed, as motor data from mixed nerve repairs were only available in three studies, two studies in the DR group[22,23] and one study in the CAR group.[24] Percentage of patients with postrepair neuroma, cold intolerance, altered sensation, and revision surgery, as well as average pain scores, were analyzed for differences between DR and CAR groups.

Statistical Analysis

Sensory MR rates were compared using the two-sided Fisher exact test. Patient sex, nerve, nerve type, nerve location, and mechanism of injury proportional data were also compared using two-sided Fisher exact tests. Each factor was compared with the total for these proportional tests. Sensory-related complication rates were also compared using Fisher exact tests. Patient age and pain scores were compared using unpaired t tests. The threshold alpha value to determine statistical significance was a P value less than 0.05.

RESULTS

Study Screening

A total of 4199 studies were identified by MEDLINE (via PubMed), 3760 studies were screened, and 291 studies were assessed for eligibility (Fig. 1). There were 25 studies and 1442 nerve repairs identified for sensory MR evaluation. Only one of these studies reported on both DR and CAR.[25] DR was reported in 20 studies (Table 2) and 1264 repairs.[11–13,22,23,25–39] CAR was reported in six studies (Table 3) and 178 repairs.[24,25,40–42,45]

Sixty-two studies met inclusion criteria for the analysis of sensory-related complications and revision rate. However, 26 of these publications did not discuss any sensory-related complications or revision rate. Of the remaining 36 studies (32 DR studies and four CAR studies) none reported on all sensory-related complications and revision rate. Thirteen studies (11 DR[25–27,35,38,43,44,46–49] and two CAR[25,42]) reported on postsurgical neuromas or lack thereof. Thirteen studies (10 DR[27,36,38,43,44,46,48,50–52] and three CAR[24,40,42]) reported on cold intolerance or lack thereof. Thirteen studies (13 DR[30,35,36,43,44,46,51–57] and zero CAR) reported on altered sensation (dysesthesia, paraesthesia, hyperesthesia, or hypersensitivity) or lack thereof.

Table 1. Conversion of SWMF, VFM, and s2PD to Sensory MRCC Scores

	MRCC		SWMF		
Level of Recovery	MRCC Score	Definition	Force (g)	Monofilament No.	s2PD
Not MR	S0	Absence of sensibility in the autonomous area of the nerve	100–300	6.10–6.65	Loss of protective sensation
Not MR	S1	Recovery of deep cutaneous pain sensibility within the autonomous area of the nerve	10–60	5.07–5.88	
Not MR	S2	Return of some degree of superficial cutaneous pain and tactile sensibility within the autonomous area of the nerve	4–8	4.56–4.93	
MR	S3	Return of superficial cutaneous pain and tactile sensibility throughout the autonomous area, with disappearance of any previous over response	0.6–2	3.84–4.31	> 15 mm with recovery of pain and touch sensibility
Higher-threshold MR	S3+	Return of sensibility as in S3; in addition, there is some recovery of two-point discrimination within the autonomous area (7–15 mm)	0.16–0.4	3.22–3.61	7–15 mm
Higher-threshold MR	S4	Complete recovery (two-point discrimination, 2–6 mm)	<0.07	1.65–2.83	≤6 mm

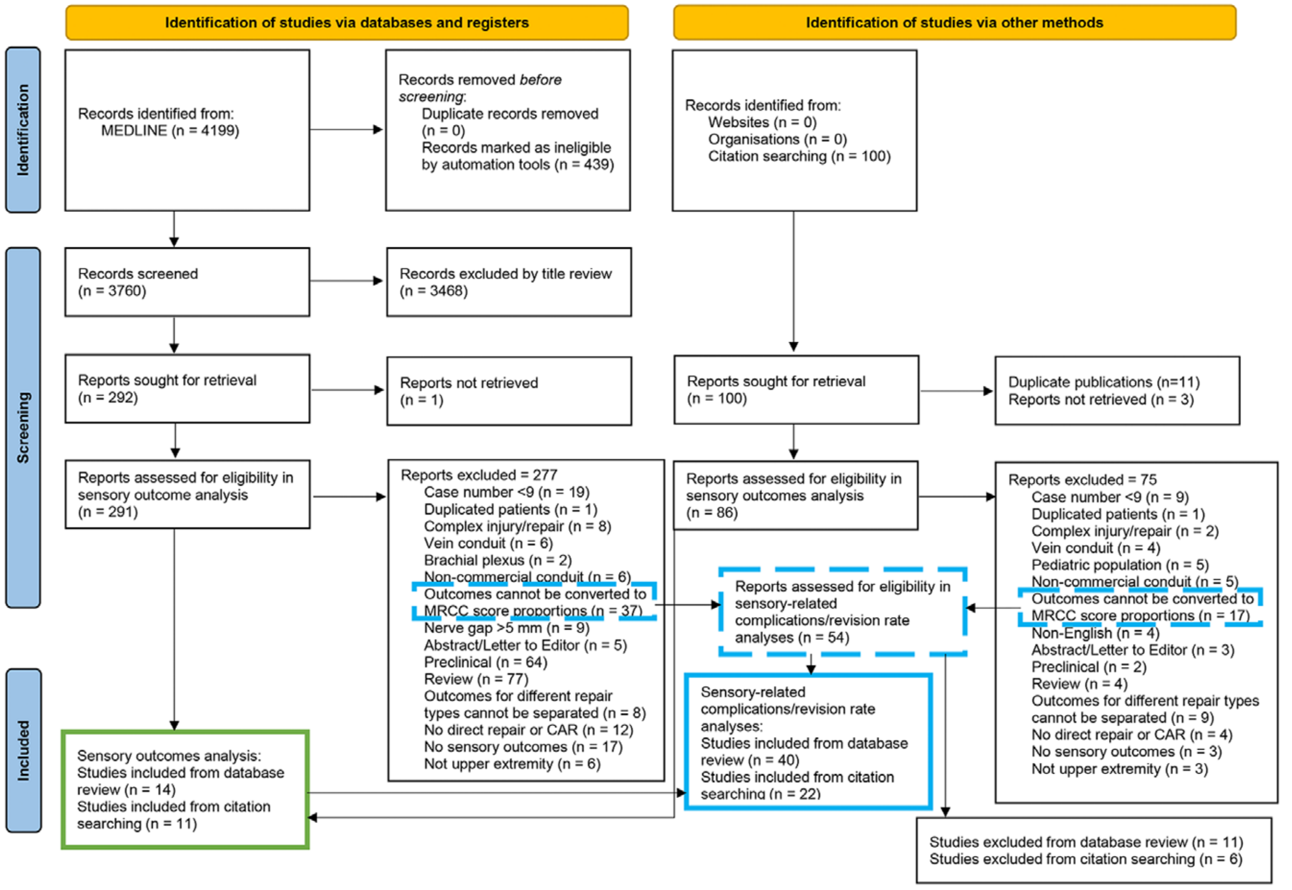

Fig. 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 flow diagram demonstrating the screening and selection process for all studies. Green line indicates studies included for MRCC sensory outcomes analysis. Blue dotted line indicates reports identified for screening sensory-related complications and revision rate. Solid blue line indicates reports and studies included for sensory-related complications and revision rate analysis.

Table 2. DR Clinical Studies for Assessment of Sensory MR

Reference	Country of Origin	Study Design	Nerve	Nerve Type	Reported Metric	No. Nerve Repairs
Andelkovic[12]	Serbia	Retrospective case series	Digit	Sensory	MRCC	193
Bulut[13]	Turkey	Retrospective case series	Digital	Sensory	SWMF	96
Cheng[26]	China	Prospective case series	Digital	Sensory	MRCC	65
Chow[11]	Hong Kong	Prospective case series	Digital	Sensory	MRCC	72
Duteille[27]	France	Retrospective case series	Median, ulnar	Mixed	MRCC	20
Galanakos[28]	Greece	Prospective case series	Median, ulnar	Mixed	MRCC	94
Gürbüz[23]	Turkey	Retrospective case series	Radial	Mixed	MRCC	18
He[29]	China	Prospective clinical trial	Digital	Sensory	SWMF	123
Hirasawa[30]	Japan	Retrospective case series	Digital	Sensory	S2PD	10
Kallio[31]	Finland	Retrospective case series	Digital	Sensory	MRCC	151
Mailänder[32]	Germany	Retrospective case series	Digital, common palmar digital, median, ulnar, radial	Sensory, Mixed	MRCC	140
Manoli[33]	Germany	Retrospective case series	Digital	Sensory	SWMF	22
Meek[34]	The Netherlands	Retrospective case series	Median	Sensory	SWMF	25
Neubrech[25]	Germany	Prospective randomized clinical trial	Digital, common palmar digital	Sensory	SWMF	38
Pereira[35]	England	Retrospective case series	Digital	Sensory	VFM	24
Polatkan[36]	Turkey	Retrospective case series	Median	Mixed	MRCC	28
Segalman[37]	USA	Retrospective case series	Digital	Sensory	SWMF	19
Tadjalli[38]	Canada	Retrospective case series	Digital	Sensory	SWMF	37
Vordemvenne[22]	Germany	Retrospective case series	Median, ulnar	Mixed	MRCC	63
Yu[39]	USA	Retrospective case series	Digital	Sensory	SWMF	26

Table 3. CAR Clinical Studies for Assessment of Sensory MR

Reference	Country of Origin	Study Design	Nerve	Nerve Type	Implanted Material	Reported Metric	# Nerve Repairs	Gap Length (Range mm; Average mm)
Arnaout[40]	France	Prospective case series	Digital	Sensory	Collagen	MRCC	27	0; 0
Bucknam[41]	USA	Retrospective case series	Median, ulnar	Mixed	Unknown	S2PD	49	0; 0
Chiriac[42]	France	Prospective case series	Digital, median, ulnar, radial, musculocutaneous	Sensory, Mixed	Caprolactone	S2PD, SWMF	15	2–3; 2.6
Gao[43]	China	Prospective randomized clinical trial	Digital, ulnar, radial, median, peroneal	Sensory, Mixed	Collagen	S2PD, SWMF	54	0; 0
Neubrech[34]	Germany	Prospective randomized clinical trial	Digital, hand	Sensory	Chitosan	SWMF	41	0; 0
Thomsen[44]	France	Retrospective case series	Digital	Sensory	Collagen	S2PD, SWMF	2	0; 0

Table 4. Primary Outcomes Population Characteristics per Nerve Repair Technique for Assessment of Sensory MR

	DR	CAR
Male	81.2%	62.7%
Female	18.8%	37.3%
Age, y (mean ± SD)	34.2 ± 13.1	36.0 ± 10.5
Laceration injuries (eg, knife)	81.9%*	62.1%
Jagged injuries (eg, saw)	10.7%	37.9%†
Crush injuries	7.4%	0%
Gap length, mm (mean ± SD)	NA	0.07 ± 0.44

*$P < 0.05$.
†$P < 0.001$.

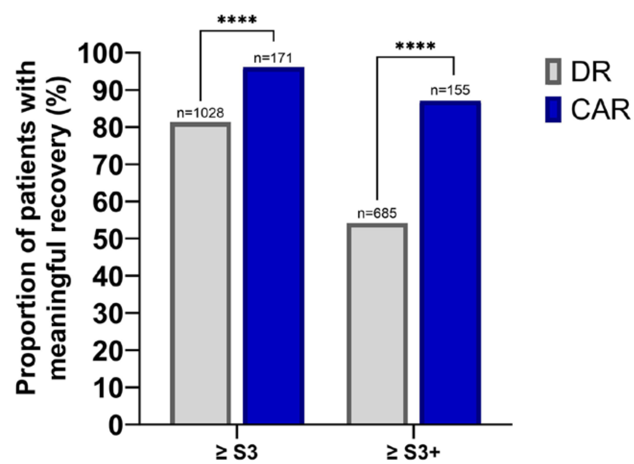

Fig. 2. MR and higher-threshold meaningful recovery rates for DR and CAR. ****$P < 0.0001$.

Six studies (four DR[25,56,58,59] and two CAR[25,40]) reported pain scores (visual analog scale or numerical rating scale). Eight studies (five DR[11,25,29,56,59] and three CAR[25,40,42]) reported revision rate.

Patient and Injury Characteristics for MR Rate Comparison: DR

The DR studies included three prospective case series, two prospective clinical trials, and 15 retrospective case series. Patients in the DR studies were predominantly men (81.2%) and the pooled mean age of patients in the studies was 34.2 ± 13.1 years (range of 2–77 years of age; Table 4). In the DR studies, 81.9% of the nerve injuries were attributed to lacerations.

Patient and Injury Characteristics for MR Rate Comparison: CAR

The CAR studies included two prospective case series, two prospective randomized clinical trials, and two retrospective case series. The mean nerve gap length was 0.07 ± 0.44 mm (range 0–3 mm). Patients in the CAR studies were predominantly men (62.7%), and the pooled mean age was 36.0 ± 10.5 years (age range 13–71 years). Mechanism of injury was only reported in two of the six publications,[42,45] but in those two publications, 62.1% of the nerve injuries were attributed to lacerations.

Table 5. Nerve Characteristics for Studies Included in Sensory MR Analyses

	Total (n)	DR n (%)	CAR n (%)
Repaired nerve type			
Sensory nerves	1094	989 (78)*	105 (59)
Mixed/motor nerves	348	275 (22)	73 (41)
Location of nerve repair			
Repairs in the digit	1012	945 (75)*	67 (38)
Repairs in the hand	90	49 (3)	41 (23)*
Repairs in the forearm	300	248 (20)	52 (29)†
Repairs in the arm	23	22 (2)	1 (0.5)
Unspecified repair locations in the forearm or arm	17	0 (0)	17 (9.5)
Nerve			
Digital	1012	945 (75)*	67 (38)
Common palmar digital	6	6 (0.5)	0 (0)
Median	187	157 (12)	30 (17)
Ulnar	126	93 (7)	33 (18)*
Radial	32	25 (2)	7 (4)
Unspecified (digital or common digital)	79	38 (3)	41 (23)
Total no. studies	25‡	20	6
Total no. repairs	1442	1264	178

*$P < 0.0001$.
†$P < 0.01$.
‡One study included both DR and CAR.

Sensory MR

The sensory MR rate (≥S3) rate for CAR was 96.1% and was significantly higher than the sensory MR rate for DR at 81.3% ($P < 0.0001$; Fig. 2). The higher-threshold sensory MR rate for CAR was 87.1% and was significantly better than the higher-threshold sensory MR rate for DR at 54.2% ($P < 0.0001$).

Considering the significant differences in sensory MR rates, factors that have been previously reported to have a significant effect on MR rates[60–64] were analyzed for potential differences in proportionality between the DR and CAR groups. These factors were nerve type, nerve location, nerve, mechanism of injury, and patient age. The proportion of sensory and mixed nerves were significantly different between the two groups ($P < 0.0001$; Table 5). The DR group had a significantly higher proportion of sensory nerves than the CAR group. There were also significant differences in the proportion of injuries in the digit ($P < 0.0001$), hand ($P < 0.0001$), and forearm ($P < 0.01$). The DR repair group had a significantly higher proportion of repairs in the digit and a significantly lower proportion of repairs in the hand and forearm compared with the CAR group. There were no significant differences in the proportion of repairs in the arm between the two repair groups. Likewise, there were significant differences in the proportion of digital nerve ($P < 0.0001$) and ulnar nerve injuries ($P < 0.0001$) between the DR and CAR groups. The DR group had a significantly higher proportion of digital nerves repaired and a significantly lower proportion of ulnar nerves repaired compared with the CAR group. There were no significant differences in the proportion of common palmar digital, median, or radial nerves between the two groups. There were differences noted in the proportion of laceration injuries and jagged/saw injuries between the two groups. DR had a significantly higher proportion of laceration injuries ($P < 0.05$) and a significantly lower proportion of jagged/saw injuries ($P < 0.001$) compared with the CAR group. Lastly, patient age was not significantly different between the two groups ($P > 0.05$).

The DR studies included in this meta-analysis were published as early as 1985; however, the earliest CAR study included in this meta-analysis was published in 2010. Reported outcomes should presumably improve over time, as surgical techniques and understanding of the science of nerve repair have enhanced over the years. To evaluate these potential differences over time, MR of DR and CAR were collated by group and separated by publication date. The proportion of patients reporting MR in the DR group seemed stable over time, ranging between 75.7% and 89.4% reported recovery of S3 or greater (Fig. 3A). Independent of publication date, the CAR group consistently exhibited a higher proportion of patients reporting MR and higher-threshold MR versus the DR group (Fig. 3B).

Sensory-related Complications and Revision Rate

Overall, the reporting rate for sensory-related complications and revision rate was low. The data that were available for neuroma and pain scores showed nonsignificant differences between the DR and CAR groups (Table 6). There was a significant difference in the rate of cold intolerance ($P < 0.0001$). The DR group had a significantly higher rate (46.2%) compared with the CAR group (10.7%). Although the rate of altered sensation (dysesthesia, paresthesia, hyperesthesia, and hypersensitivity) was quite high in the DR group (40.7%), there were no CAR studies that specifically reported on altered sensation, and hence, no statistical test could be performed. The revision rate for both DR and CAR groups was 0%.

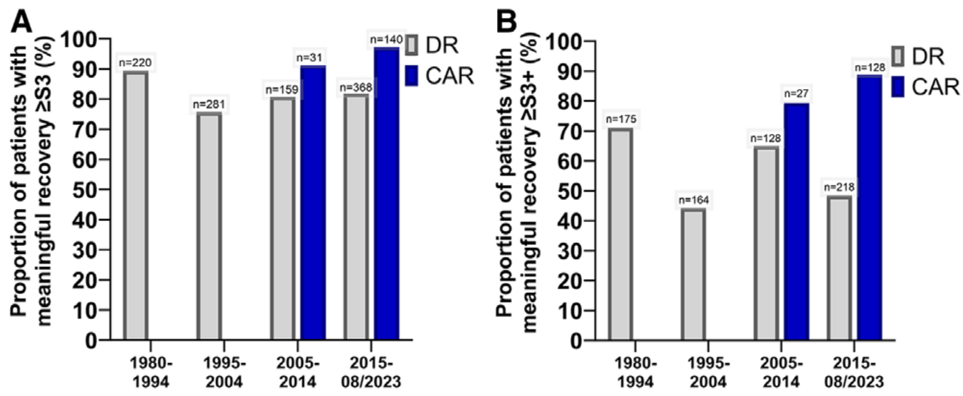

Fig. 3. Comparing repair technique outcomes over time based on the year of study publication. A, MR of DR and CAR over time. B, Higher-threshold MR of DR and CAR over time.

Table 6. Secondary-related Complications and Revision Rate

Complication	Group	No. Studies Reporting Complication	No. Patients in Studies Reporting Complication	Percentage or Average (SD)
Neuroma	DR	11	508	6.9%
	CAR	2	39	0%
Cold intolerance	DR	10	1951	46.2%*
	CAR	3	56	10.7%
Altered sensation (dysesthesia, paresthesia, hyperesthesia, and hypersensitivity)	DR	14	551	40.7%
	CAR	0	NA	NA
Pain VAS or NRS (reported on 0–10 scale)	DR	4	92	0.84±0.84
	CAR	2	42	1.1 ± 1.1
Revision rate (not including rupture of repaired tendon, tenolysis, or arthrodesis)	DR	5	204	0%
	CAR	3	44	0%

*$P < 0.0001$.

DISCUSSION

The use of DR has been the historical standard in peripheral nerve repair. However, this meta-analysis has shown that more patients achieve sensory MR and higher-threshold sensory MR with the use of CAR. Our findings are similar to that of Ducic et al. (2017) who found that the rate of positive outcomes increased from 83% of patients who underwent DR to 93% of patients who underwent CAR.[65]

The sensory MR rate after nerve repair may be impacted by the nerve type,[60] location of the injury,[64] nerve,[61] mechanism of injury,[62] and patient age.[61] Typically, sensory nerves have a better likelihood of achieving MR than mixed nerves.[60] Nerve repairs in the digit typically result in better functional outcomes than more proximal repairs,[64] and likewise, digital nerve repairs result in better functional outcomes than ulnar nerve repairs.[63] In this dataset, the DR group had a disproportionately higher number of sensory nerves, repairs in the digit, and digital nerve repairs. The DR group also had a disproportionately lower number of ulnar nerve repairs. This study limitation is an artifact of the meta-analysis data output. Future studies should address potential differences in outcomes based on type of nerve injured and location. Despite these demographic differences and a corresponding expectation that the DR group would outperform the CAR group, the MR rate for DR was significantly lower than that for CAR in our analysis.

Our analyses of sensory-related complications and revision rates were restrained by low reporting rates. This study limitation was driven by different reporting methods in clinical literature. Future clinical nerve repair studies should include specific complication reporting metrics. We found that cold intolerance and neuroma formation may provide beneficial measurements of clinically meaningful postoperative complications in peripheral nerve repair. Despite this limitation, the data clearly showed a significant difference in the rate of cold intolerance following the two nerve repair techniques. Nearly half of all patients reported cold intolerance following DR, which was a significantly higher proportion than following CAR. Unfortunately, cold intolerance does not decrease over time[66] and continues to have a notable effect on quality of life.[67] Although the percentage of patients with postrepair neuroma was not statistically different between the groups, the rates of neuroma development may be clinically meaningful. There were no reports of postrepair neuroma development in the CAR group, whereas 6.9% of patients in the DR group developed a neuroma.

This study offers information that may guide surgical decision-making for the repair of peripheral nerve injuries. During our analysis, we encountered a heterogeneity in reported outcome measures due to the lack of standardization in the field. An inherent limitation of studying nerve repair is the potential bias of subjective interpretation of qualitative nerve recovery outcomes and assessments. These are limitations in this meta-analysis, as with many other clinical literature reviews. To address these limitations, we included studies that used quantitative outcomes for evaluation and converted them to MRCC scores. This led to a limited number of studies included for review, but the data collected allowed for appropriate statistical analysis of differences between the two repair types.

CONCLUSIONS

This systematic review compared outcomes of DR and CAR techniques. The CAR technique resulted in a better sensory MR rate and higher-threshold sensory MR rate, as well as a lower rate of cold intolerance compared with DR. A purposeful gap seen in the CAR technique seems to maintain favorable outcomes while mitigating risks seen in the DR technique. This may be attributed to better nerve alignment, minimal tension at the site of regeneration, improved consistency, and a physical barrier around the nerve coaptation that contains the neurotropic milieu and regenerating axons. The results of this systematic review and meta-analysis thus support the use of the CAR technique over DR, when performing nerve repair on nerve ends that can be closely approximated.

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DISCLOSURE

Amber Leis, Brandon S. Smetana, Adam B. Strohl, and Joseph F. Styron are paid consultants for Axogen, Inc. No funding was provided for this study.

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