Review Article

Full-thickness Skin Graft Fixation Techniques: A Review of the Literature

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Abstract

Multiple techniques for skin graft fixation have been proposed, but the evidence underlying these techniques is unclear. This study aimed to review the literature for full-thickness graft fixation techniques. PubMed was electronically searched to identify relevant studies. The search strategy identified 91 relevant articles. These consisted of 2 randomised controlled trials (RCTs), 10 observational cohort studies (8 retrospective, 2 prospective), and 79 descriptive studies (case series, case reports, or expert opinion articles). Both identified RCTs compared the tie-over dressing against a modified tie-over dressing. The tie-over dressing was also included in all identified observational studies, and comparisons were made against quilting/mattress suturing (4 studies, 181 grafts in total), simple pressure dressings (3 studies, 528 grafts), non-tie-over dressings non-specifically (1 study, 71 grafts), hydrocolloid dressings (1 study, 62 grafts), and double-tie over dressings (1 study, 43 grafts). No significant differences were found between fixation methods for graft take, haematoma rate, and infection rate. No studies have found a significant difference between tie-over dressings and alternative graft fixation technique, with the most evidence for simple pressure dressings and quilting/mattress suturing. However, the evidence base consists mostly of small, retrospective observational studies. This article describes the current evidence base and this should be considered when planning future reports in the field.

Keywords: Cyanoacrylates, negative-pressure wound therapy, silicones, skin transplantation, sutures

Key messages:

- There is a paucity of evidence for full-thickness skin graft (FTSG) fixation techniques.
- No studies have found significant benefit for tie-over dressings compared to simpler skin graft fixation techniques such as quilting/mattress suturing (4 studies, 181 grafts in total) and simple pressure dressings (3 studies, 528 grafts).

Introduction

For a skin graft to survive on its wound bed, adequate stabilization of the graft is imperative. The most frequently used technique for graft fixation has been the tie-over dressing, in which threads are individually tied to their opponent threads over a bolus dressing after suturing. Despite evidence suggesting that it is not needed first arising more than three decades ago,[1] the tie-over dressing is frequently reported in the contemporary literature.

Many alternative graft fixation techniques have been proposed, but there is no consensus as to which is the optimal graft fixation method. This review aimed to assess the evidence base for skin graft fixation techniques in order to help inform current practice and future studies.

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Materials and Methods

Search strategy

PubMed was electronically searched to identify relevant studies. A broad search strategy was used, with a search term of: *(Graft[title/abstract] or grafts[title/abstract] or grafting[title/abstract] or FTSG[title/abstract]) AND skin[title/abstract] AND (technique[title] OR*

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techniques[title] OR fixation[title] OR application[title] OR suture[title] OR suturing[title] OR bolster[title] OR tie-over[title/abstract] OR mattress[title/abstract] OR quilting[title/abstract] OR thermoplastic [title/abstract] or negative-pressure[title/abstract] or staple[title/abstract] or stapling[title/abstract] OR success[title] OR successful[title] OR take[title] OR octyl cyanoacrylate[title] OR adhesive[title] OR strip[title] or tape[title] or glue[title] OR aquaplast[title] OR band[title] OR rubber[title] OR hydrocellular[title]). Web of Science was used to identify further papers from the citing literature of papers included from the search (data of last electronic search 19 May 2019). Using the same search term on Embase identified no additional full texts.

Selection criteria

Abstracts and full papers were reviewed independently by two authors (LS and FX). Full-text studies were included if they reported on the effect of graft fixation method for full-thickness skin grafts. If both full-thickness and partial-thickness skin grafts were included, this was made clear in the presentation of results. Only English articles, human studies, and full-text articles were included. Studies assessing radial forearm, penile, and buccal flaps, or areolar graft fixations alone, were excluded.

Data extraction

For analytic studies, the authors recorded the study design; the graft fixation methods assessed; the number of grafts included; the site of grafts; randomization; blinding; and the outcomes for graft take, hematoma/seroma formation, and infection. For descriptive studies, the study type, technique reported, number of patients, and site of graft fixation were recorded.

Results

The literature search identified 1619 unique abstracts. A total of 151 reports were considered: 46 were subsequently excluded because they assessed split-thickness skin grafts only,[2-48] and 14 abstracts could not be accessed—none of which were analytic studies.[49-62] The final 91 papers studied consisted of 12 analytic studies and 79 descriptive studies (case series, case reports, or expert opinion articles).

Analytic studies

Of the included 12 analytic studies, 2 were randomized controlled trials (RCTs) and 10 were observational studies [Table 1]. One RCT was not adequately powered and blinding was not consistently performed.[63] The other did not assess graft take or hematoma rate.[64] Both RCTs assessed a tie-over dressing against a modified tie-over dressing rather than an alternative graft fixation technique. As such, the relevance and reliability of these RCTs was limited.

Of the 10 observational studies, 8 were retrospective and 2 were prospective. Sample sizes ranged from 40 to 266 (mean 89; median 66). The most common site assessed for graft fixation was the head and neck region. All studies included the tie-over dressing as one of the comparator groups [Table 1].

Four observational studies compared the tie-over dressing to quilting/mattress suturing.[1,65-67] These studies included 181 grafts in total, and no significant differences were found between groups for graft take, hematoma/seroma formation, and infection.

Three observational studies compared tie-over dressings to simple pressure dressings.[68-70] These studies included a total of 528 grafts and did not find any significant differences in graft take, hematoma/seroma formation, nor infection. Although it has been proposed that pressure dressings may provide less adherence at anatomically complicated sites compared to tie-over dressings, De Gado *et al.*[68] assessed grafts at these "high-risk areas" and found no benefit for tie-over dressings.

The remaining three studies compared the tie-over dressing against "non-tie-over dressings" (n = 71),[71] hydrocolloid dressings (n = 62),[72] and double-tie over dressings (n = 128).[73] No significant differences were found between groups.

Descriptive reports

For descriptive reports, 29 were case series and 50 were case reports/expert opinions (Table S1). These reports included some graft fixation methods that have not yet been assessed in analytic studies, including cyanoacrylate glue, negative-pressure dressings, and silicone net dressings. There was duplicity in the reporting of graft fixation techniques, especially for the tie-over dressing (or variants), which made up the bulk of reports (53.2%)—even in the contemporary literature [Table 2].

In most studies graft success was measured by clinical assessment of the healing graft, but there was heterogeneity in this grading. This included grading into good, moderate, and poor:[74] defining partially taken as those with >60–<100% graft take rate;[65] rating graft take as 0%–100%;[68] and separating graft take into groups, such as 0%–24%, 25%–49%, 50%–74%, and 75%–100%, with the latter group defined as complete take.[63,69]

Discussion

The most commonly assessed graft fixation method was the tie-over dressing technique. This was assessed in all analytic studies and made up the majority of descriptive reports. No studies have shown superiority for the tie-over dressing compared to alternative graft fixation techniques, but the evidence base is limited. There are no RCTs

Table 1: Analytic studies identified assessing full-thickness skin grafts

Name	Study type	Intervention 1	Intervention 2	Significant difference in graft take ($P < 0.05$)	Graft take intervention 1	Graft take intervention 2	Hematoma/ seroma	Infection	Sample size	Location	Blinding (evaluator)	Randomized
Atherton *et al.*[63]	RCT	Tie-over dressing with Jellonet/ proflavin	Tie-over dressing with Allevyn	NS	63.3% complete	62.1% complete	Not assessed	NS (3.3% vs. 3.4%)	51 (plus 8 partial thickness)	Head and neck Limbs	When able but not always possible	Yes
Saleh *et al.*[64]	RCT	Tie-over dressing soaked with polyhexamethylene biguanide (PHMB)-based solution	Tie-over dressing soaked with sterile water	Not assessed	Not assessed	Not assessed	Not assessed	Significantly favored intervention 2 (40% vs. 10%)	40	Face	Yes	Yes
Davenport *et al.*[1]	Prospective observational	Tie-over dressing	Mattress/ quilting	NS	95% complete	95% complete	NS (5% vs. 5%)	Not assessed	40	Head and neck	No	Yes
Keh *et al.*[65]	Retrospective observational	Tie-over dressing	Mattress/ quilting	NS	76% complete	82% complete	Not assessed	NS (0% vs. 0%)	125	Head and neck	No	No
Dhillon *et al.*[66]	Retrospective observational	Tie-over dressing	Mattress/ quilting	NS	80% complete (94% partial)	89% complete (100% partial)	Not assessed	NS (9% vs. 26%)	70	Head and neck	No	No
Akhavani *et al.*[67]	Retrospective observational	Tie-over dressing	Mattress/ quilting	NS	90% complete	100% complete	NS (10% vs. 0%)	Not assessed	40	Hand	No	No
De Gado *et al.*[68]	Prospective observational	Tie-over dressing	Simple pressure dressing	NS	89.6% graft success	97.1% graft success	Not assessed	Not assessed	212	"High-risk areas" Nose dorsal hand, tibial plane Wrist Neck	No	Yes (poorly described)
Yuki *et al.*[69]	Retrospective observational	Tie-over dressing	Simple pressure dressing	NS	90% (defined complete as 75 + % take)	88% (defined complete as 75 + % take)	NS (7% vs. 10%)	NS (6% vs. 3%)	220 (plus 46 partial thickness)	Head and neck Trunk Limbs Hands + feet	No	No
Shimizu and MacFarlane[70]	Retrospective observational	Tie-over dressing	Simple pressure dressing	NS	85.1% complete	83.70%	Not assessed	Not assessed	96	Head and neck Trunk Arm + hand	No	No
Jeong *et al.*[72]	Retrospective observational	Tie-over dressing	Hydrocolloid dressing	NS	74.2% complete	100% complete	NS (9.7% vs. 0%)	NS (3.2% vs. 0%)	62 (including partial thickness)	Not specified	No	No
Goto *et al.*[71]	Retrospective observational	Tie-over dressing	Non tie-over dressing	NS	70% success rate	75% success rate	Not assessed	Not assessed	71	Foot	No	No
Lee and Kim[73]	Retrospective observation	Tie-over dressing	Double tie-over dressing	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	43 (plus 85 split thickness)	All	No	No

NS = no significant difference ($P \geq 0.05$)

Table 2: Graft fixation techniques reported in descriptive articles pre-2010, since 2010, and overall

Graft fixation technique		*n* (%) before 2010	*n* (%) since 2010	% of descriptive reports
Tie-over dressing modification	Series	4 (7)	6 (24)	53.2
	Case reports or expert opinion	26 (48)	6 (24)	
Quilting sutures (± ointment)	Series	3 (6)	1 (4)	10.1
	Case reports or expert opinion	3 (6)	1 (4)	
Cyanoacrylate glue	Series	1 (2)	3 (12)	6.3
	Case reports or expert opinion	1 (2)	0 (0)	
Polyurethane foam dressing / sponge bolster or gauze and tape	Series	1 (2)	1 (4)	5.1
	Case reports or expert opinion	2 (4)	0 (0)	
Thermoplastics	Series	1 (2)	0 (0)	5.1
	Case reports or expert opinion	3 (6)	0 (0)	
Silicone net dressing	Series	0 (0)	1 (4)	3.8
	Case reports or expert opinion	1 (2)	1 (4)	
External wire frame	Series	1 (2)	1 (4)	3.8
	Case reports or expert opinion	1 (2)	0 (0)	
Negative-pressure dressing	Series	1 (2)	0 (0)	2.5
	Case reports or expert opinion	0 (0)	1 (4)	
Steri-Strips/sterile adhesive tape	Series	1 (2)	0 (0)	2.5
	Case reports or expert opinion	0 (0)	1 (4)	
Fibrin glue	Series	1 (2)	0 (0)	2.5
	Case reports or expert opinion	1 (2)	0 (0)	
Circumferential suture	Series	0 (0)	0 (0)	2.5
	Case reports or expert opinion	1 (2)	1 (4)	
Antibiotic ointment ± light dressing	Series	1 (2)	0 (0)	1.3
	Case reports or expert opinion	0 (0)	0 (0)	
Surgical glove	Series	0 (0)	1 (4)	1.3
	Case reports or expert opinion	0 (0)	0 (0)	

that have compared tie-over dressings to non-tie over techniques, and only a small number of observational studies are available.

The original purported advantage of the tie-over dressing was downward pressure, to promote revascularization and prevent hematoma and seroma formation.[75] However, it has been suggested that the downward pressure of the tie-over dressing does not exceed capillary pressure, thus not reducing complications.[76] Further criticisms of the tie-over dressing are that it is complex, prolongs operative time, often requires an assistant, and may hinder inspection and wound care in the postoperative period.

A strength of this study is that it included all methods of full-thickness graft fixation. A previous review assessed the evidence for only two fixation techniques: tie-over dressings and quilting/mattress suturing.[77] Our study is novel in reporting at least equal evidence for simple pressure dressings, which were not included in this previous review. A further strength of this study is that it defines the current evidence base for full-thickness skin graft fixation techniques. A significant factor contributing to research waste is that researchers are unaware of the available evidence,[78] leading to unnecessary duplication of existing studies. The presented body of evidence should thus be considered when future research is reported in this field.[79]

Limitations of the study are that the evidence for split-thickness skin grafts were not assessed, although these differ from full-thickness skin grafts in that they can survive in conditions with less vascularity.[75] The authors also did not analyze other parts of the study methodology that may affect reliability of results, such as number of surgeons, experience of surgeons, and number of centers. The search was also restricted to English language publications, although no relevant non-English publications were identified from the search.

To improve standards in evaluating surgical methods, the Idea, Development, Exploration, Assessment, Long-term (IDEAL) study framework has been developed.[79] This study did not identify any of the alternative study designs suggested—such as controlled interrupted-time series studies, step-wedge design studies, and tracker trials. There was also a failure to progress evidence through the phases of the IDEAL framework, with multiple case series for tie-over dressings reported and a paucity of comparative studies.

In conclusion, the most commonly assessed skin graft fixation technique is the tie-over dressing. The current evidence base does not suggest a benefit for tie-over

dressings compared to simpler fixation methods for full-thickness skin grafts, most frequently for mattress/quilting sutures and simple pressure dressings. A caveat of this is that the current evidence base is limited. Future studies are needed to ensure practice is evidence-based, and these should consider the existing evidence base to prevent duplicity and ensure future research is most informative.

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Conflicts of interest

There are no conflicts of interest.

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Supplementary

For descriptive reports, 29 were case series and 50 were case reports/expert opinions (Table S1).

Table S1: Graft fixation techniques reported in descriptive articles

Study type	Intervention	Sample size	Site	Reference
Case series	Quilting sutures	327	Periocular	Kashkouli 2017[1]
Case series	Cyanoacrylate glue	5 full-thickness (4 partial)	Periocular	Jackson 2017[2]
Case series	Tie-over dressing modification (bottle cap)	4	Torso	Wani 2017[3]
Case series	Tie-over dressing modification (bottle cap)	8	Torso	Singh 2015[4]
Case series	Tie-over dressing modification (hydrogel-impregnated dressing)	2	Face	Choi 2015[5]
Case series	Silicone net dressing	50	Lower leg	Audrain 2015[6]
Case series	Tie-over dressing modification (barbed suture)	30 (including partial-thickness)	H+N Limbs	Joyce 2015[7]
Case series	2-octylcyanoacrylate and adhesive strips +/- basting suture	12	Face	Ranario 2014[8]
Case series	External wire frame fixation	5	Digits	Huang 2014[9]
Case series	Tie-over dressing modification (nylon tie strips and skin staplers)	20	Scalp Limbs	Praveen 2014[10]
Case series	Surgical glove dressing	6	Hand	Mashiko 2013[11]
Case series	Tie-over dressing modification (multiple loop silk sutures)	4	Scalp Limbs	Jo 2013[12]
Case series	Cyanoacrylate glue	5 (+ 7 split-thickness)	H+N	Habib 2013[13]
Case series	Multilayered polyurethane foam dressing	26	H+N 19	Nakamura 2012[14]
Case series	Quilting and chloromycetin ointment	92	Leg	Harvey 2009[15]
Case series	Simple polyurethane foam dressing	20 full thickness (5 partial)	Arm	Sakurai 2007[16]
Case series	External wire frame fixation	5	Digits	Ogawa 2007[17]
Case series	Quilting and chloromycetin ointment	82	H+N Hand	Patterson 2006[18]
Case series	Tie-over dressing modification (rubber bands)	1 (+1 partial thickness)	Neck	Dogan 2006[19]
Case series	Negative-pressure dressing	8 (full-thickness and partial)	Neck Torso/pelvis	Chang 2002[20]
Case series	Thermoplastic	38	Eyelid	White 2001[21]
Case series	Cardinal sutures and n-butyl-2-cyanoacrylate	21	Head and neck	Craven 1999[22]
Case series	Interrupted sutures, antibiotic ointment, +/- light dressing	30	Head and neck, finger	Langtry 1998[23]
Case series	Tie-over dressing modification (latex foam and staple fixation)	>100	Head and neck	Johnson 1998[24]
Case series	Autologous fibrin glue	50	Not stated	Chakravorty 1989[25]
Case series	Tie-over dressing modification (pressure disc)	15	Not stated	Silfverskiold 1986[26]
Case series	Tie-over dressing modification (stapled Renton material)	>150	Not stated	Weiner 1984[27]
Case series	Quilting (central and paracentral suture in addition to usual marginal sutures)	109	Periocular (oculoplasty)	Mehta 1979[28]
Case series	Steri-strips	27	Digits	Efron 1968[29]
Case report	Negative-pressure wound therapy	1	Finger	Niimi 2018[30]
Expert opinion	Tie over dressing modification (3-Way Stop-Cock)	Not stated	Not stated	Yontar 2017[31]
Case report	Silicone dressing	1	Face	Rennie 2016[32]
Case report	Sterile adhesive tape	1	Face	Ohn 2016[33]
Case report	Tie-over dressing modification (suture technique)	1	Finger	Patil 2016[34]
Expert opinion	Running suture and ointment	Not stated	Face	Chasapi 2016[35]
Expert opinion	Tie-over dressing modification (suture technique)	Not stated	Not stated	Macdonald 2014[36]
Expert opinion	Quilting sutures (through and through basting suture) with straight needle	Not stated	Ear	Travelute 2013[37]
Case report	Tie-over dressing modification (twist-over: stainless steel suture technique)	1	Scalp	Shokrollahi 2013[38]
Case report	Tie-over dressing modification (sandwich suture)	1	Nasal ala	Hussain 2012[39]
Expert opinion	Tie-over dressing modification (stapled bolster)	Not stated	Ear	Golda 2010[40]

Table S1: Continued

Study type	Intervention	Sample size	Site	Reference
Expert opinion	Tie-over dressing modification (Lilliputian technique)	Not stated	Not stated	Srivastava 2009[41]
Expert opinion	Silicone net dressing	Not stated	Not stated	Roh 2008[42]
Case report	Tie-over dressing modification (U-shaped stitches)	1	Ear	Cigna 2008[43]
Case report	Tie-over dressing modification (star tie-over)	1	Scalp	Coban 2007[44]
Expert opinion	Thermoplastic bolster dressing	Not stated	Not stated	Meads 2006[45]
Expert opinion	Tension suture	22	Limbs Trunk	Ergen 2006[46]
Expert opinion	Quilting	Not stated	Not stated	Nassab 2006[47]
Expert opinion	Tie-over dressing modification (rubber bands and bra hooks)	N/A	N/A	Cheng 2006[48]
Expert opinion	Tie-over dressing modification (Speedo technique)	N/A	N/A	Lapid 2005[49]
Expert opinion	Tie-over dressing modification (criss cross suture)	N/A	N/A	Gandhi 2005[50]
Expert opinion	Tie-over dressing modification (running suture)	N/A	N/A	Adams 2004[51]
Expert opinion	Tie-over dressing modification (running suture)	N/A	N/A	Skouge 2004[52]
Expert opinion	Interrupted waved round block suture	N/A	N/A	Gargano 2004[53]
Expert opinion	Cyanoacrylate	1	Foot	Kilic 2002[54]
Expert opinion	Tie-over dressing modification (loop suture)	1	Hand	Misra 2002[55]
Expert opinion	Fibrin glue	Not stated	Not stated	Kubo 2000[56]
Expert opinion	Tie-over dressing modification (herniotomy approach)	1	Face	Choudhary 1999[57]
Expert opinion	Sponge bolster and adhesive dressing	N/A	N/A	Egan 1998[58]
Expert opinion	Gauze dressing and Steri-strips	N/A	N/A	Orengo 1998[59]
Expert opinion	Tie-over dressing modification (staples on foam)	N/A	N/A	Pennington 1998[60]
Expert opinion	Tie-over dressing modification (staples on Renton foam)	N/A	N/A	Saltz 1997[61]
Expert opinion	Thermoplastic dressing	N/A	N/A	Ducic 1997[62]
Expert opinion	Tie-over dressing modification (shortened disposable syringe)	N/A	N/A	Amir 1996[63]
Expert opinion	Tie-over dressing modification (double bolster)	N/A	Ear	Manstein 1996[64]
Expert opinion	Tie-over dressing modification (staple on polyurethane foam)	Not stated	Not stated	Wells 1995[65]
Expert opinion	Tie-over dressing modification (transparent gasbag)	N/A	N/A	Ren 1995[66]
Expert opinion	Thermoplastic dressing	N/A	N/A	Fish 1994[67]
Expert opinion	Tie-over dressing modification (stopper)	N/A	N/A	Koldas 1992[68]
Expert opinion	External wire frame fixation	N/A	N/A	Hirai 1991[69]
Expert opinion	Tie-over dressing modification (Staples on Renton foam)	N/A	N/A	Larson 1990[70]

Table S1: Continued

Study type	Intervention	Sample size	Site	Reference
Expert opinion	Tie-over dressing modification (Stapled Telfa bolster)	N/A	N/A	Hoffman 1989[71]
Expert opinion	Tie-over dressing modification (Stapled foam dressing)	N/A	N/A	Kaplan 1989[72]
Expert opinion	Tie-over dressing	N/A	N/A	Iacobucci 1987[73]
Expert opinion	Basting suture	N/A	N/A	Adnot 1987[74]
Case report	Tie-over dressing modification (aluminium collar and plastic bead)	1	Scalp	Niranjan 1985[75]
Expert opinion	Tie-over dressing modification (pressure button)	N/A	N/A	Burd 1984[76]
Expert opinion	Tie-over dressing modification (stent and tape)	N/A	N/A	Thomas 1982[77]
Expert opinion	Tie-over dressing modification (foam rubber sponge)	N/A	N/A	Wexler 1972[78]
Expert opinion	Tie-over dressing modification (rubber bands)	N/A	Chest wall	Rees 1969[79]

H+N = head and neck. N/A = not applicable

References for Supplementary Table 1

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