Acute Surgical vs. Non-surgical Management for Ocular and Peri-ocular Burns: Oculoplastic Systematic Review and Meta-analysis

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ABSTRACT

Summary

Burn related injury to the face involving the structures of the eyes, eyelids, eyelashes, and/or eyebrows could result in multiple reconstructive procedures to improve functional and cosmetic outcomes, and correct complications following poor acute phase management. This systematic review and meta-analysis compared 272 surgical to 535 non-surgical interventions within one month of patients suffering burn-related injuries to 465 eyes, 253 eyelids, 90 eyelashes, and 0 eyebrows and evaluated associated outcomes and complications. The PubMed, EMBASE, Cochrane Library, Web of Science, and Scopus databases were systematically and independently searched. Patient and clinical characteristics, surgical and medical interventions, outcomes and complications were recorded. Eight of the 14927 studies queried for this study were eligible for the systematic review and meta-analysis, with results from 33 of the possible 58 outcomes and complications using PRISMA and Cochrane guidelines. In conclusion, this systematic review and meta-analysis found that compared to non-surgical interventions, acute surgical interventions for ocular, eyelid, and/or eyelash burns were found to have greater visual acuity on follow-up, shorter epithelial defect diameters on follow-up, greater changes in epithelial diameters from baseline, smaller epithelial defect areas on follow-up, greater changes in epithelial defect areas from baseline, greater numbers of healed epithelial defects, more keratitis infections, and a greater reduction in limbal ischemia, possibility preventing the need of a future limbal stem cell transplantation.

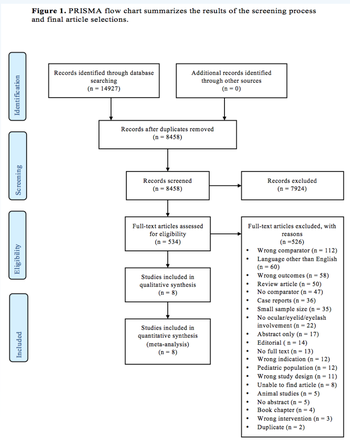
INTRODUCTION

Burn related injury to the face involving the structures of the eyes, eyelids, eyelashes, and/or eyebrows could result in multiple reconstructive procedures to improve functional and cosmetic outcomes, and correct complications following poor acute phase management. Burn injury to ocular structures requires patient transfer to specialized burn centers, where early evaluation by an oculoplastic surgeon may prevent long-term morbidity. [1] The majority of ocular burns do not require surgical interventions and rates of long-term morbidity have been reported as low as 4.5% with medical management alone. [2-4] Prior associated risk factors identified for surgical interventions after ocular burns have been deep eyelid burns, flame burns, increasing severity of corneal injuries, periorbital edema, visual loss on presentation, and keratitis. [2]

This new systematic review and meta-analysis compared surgical to non-surgical interventions within one month of patients suffering burn-related injuries to the eyes, eyelids, eyelashes, and/or eyebrows. This review is an attempt to organize the literature to create a uniform set of data for clinical interpretation and management to optimize outcomes and minimize complications. Based on peer-reviewed literature, it was hypothesized that early surgical interventions for severe burn-related injury to the eye, eyelid, eyelash, and/or eyebrow would result in better patient-related outcomes and lower risks of complications, compared to non-surgical interventions alone.

MATERIAL AND METHODS

Figure 1. PRISMA flow chart summarizes the results of the screening process and final article selections.



RESULTS

▪*Results and Risk of Bias of Individual Studies*

Table 1 summarizes the years, study designs, sample sizes, burn etiologies, group characteristics, burn depth classifications, outcomes, and complications assessed by each individual study from the 8 articles included in our study. Tables 2-3 summarize the details for outcomes and complications of interest assessed for each individual study. All seven risks of bias domains were assessed for each study using the Cochrane risk of bias tool (Figure 2).

Figure 2. Risk of bias graph and summary: review authors' judgments about each risk of bias item for each included study

Study Selection and Characteristics

The search resulted in 14927 citations; after removing 6469 duplicates, 8458 unique citations remained. Following title/abstract review, 534 articles were eligible for full-text review. Following full-text review, 8 articles were eligible and included in the systematic review (Table 1). [2,14-20] All 8 articles were eligible for final data extraction and meta-analysis (Figure 1).

The 8 studies included in the systematic review were published from 1983 through 2017 (Table 1). A total of 465 eyes, 253 eyelids, 90 eyelashes and 0 eyebrows were reported in 271 males and 102 females evaluated within one month of burn-related injury. Surgery was performed in 182/465 eyes, 75/253 eyelids, and 15/90 eyelashes. These 272 surgical cases were compared to 535 non-surgical cases. The most reported anatomical structure was the eye (7/8 studies), [2,15-20] surgical intervention was AMT (5/8 studies), [15-17,19,20] outcome was visual acuity on initial evaluation and at follow-up (5/8 studies), [15,16,18-20] and complication was corneal vascularization at follow-up (6/8 studies). [15-20] The eyebrow was reported in 0/8 studies. There were three RCTs, [17,19,20] one prospective cohort, [15] and four retrospective cohort studies, [2,14,16,18] published in English. Five studies were performed in India, [16-20] one in Spain, [15] one in Australia, [2] and one in the United States. [14]

Classification of burns

The following data for eyelid and eyelash burns was totaled for burn depth: Surgery 3 SPT, [2] 9 DPT, [2] 5 FT, [2] 32 DPT/FT. [2,14] No surgery: 60 DPT. [14] The following data for ocular burns was totaled after conversion of Roper-Hall to Dua's burn classification: Surgery: 17 Grade II, [18,20] 57 Grade III, [15-18,20] 9 Grade II/III, [19] 42 Grade IV, [15-17,20] 18 Grade V, [16,17,20] 11 Grade VI, [20] 31 Grade IV/V/VI. [18,19] No surgery: 17 Grade II, [18,20] 63 Grade III,[15-18,20]15 Grade II/III, [19] 22 Grade IV, [15-17,20] 14 Grade V, [16,17,20] 11 Grade VI, [20] 29 Grade IV/V/VI.[18,19]

Table 1. Summary of studies included in systematic review and meta-analysis

Author	Year	Design	Sample size	Etiology	Group Characteristics	Burn classification	Outcomes	Complications
Frank et al.	1983	Retrospective cohort	92	• ----	• Eyelid surgery • Eyelid no surgery	• DPT • FT	• ----	• Corneal ulceration • Vision loss • Ectropian • Eye perforation
Tamhane et al.	2005	Prospective, randomized trial	44	• Thermal • Acid • Alkali	• Eye surgery • Eye no surgery	• Dua's grade II-VI	• Visual acuity • Pain • Epithelial defect area • Schirmer • TBUT	• Wound/ocular infection • Symblepharon • Corneal vascularization
Lopez-Garcia et al.	2000	Prospective cohort	24	• Alkali	• Eye surgery • Eye no surgery	• Dua's grade III, IV	• Visual acuity	• Corneal ulceration • Corneal vascularization
Singh et al.	2008	Retrospective cohort	100	• Acid • Alkali • Chemical	• Eye surgery • Eye no surgery	• Dua's grade II-VI	• Visual acuity • Corneal haze	• Symblepharon • Corneal vascularization
Tandon et al.	2011	Prospective, randomized trial	153	• Thermal • Acid • Alkali	• Eyelid surgery • Eyelid no surgery • Eye surgery • Eye no surgery	• Dua's grade II, III	• Time to management • Visual acuity • Corneal haze • Epithelial defect area • Time to epithelialization • Limbal ischemia	• Symblepharon • Corneal vascularization
Sharma et al.	2015	Retrospective cohort	28	• Acid • Alkali	• Eye surgery • Eye no surgery	• Dua's grade III-V	• Time to management • Visual acuity • Corneal haze • Epithelial defect diameter • Epithelial defect area • Schirmer • TBUT • Time to epithelialization • Healed epithelial defect	• Symblepharon • Ectropian • Ecropian • Corneal vascularization
Sharma et al.	2016	Prospective, randomized trial	30	• Acid • Alkali	• Eye surgery • Eye no surgery	• Dua's grade III-V	• Time to management • Pain • Corneal haze • Epithelial defect diameter • Epithelial defect area • Schirmer • TBUT • Time to epithelialization • Healed epithelial defect • Limbal ischemia	• Symblepharon • Corneal vascularization
Cabalag et al.	2017	Retrospective cohort	326	• Thermal • Chemical	• Eyelid surgery • Eyelid no surgery • Eye surgery • Eye no surgery • Eyelash surgery • Eyelash no surgery	• SPT • DPT • FT • Dua's grade I, II	• %TBSA • Time to management • LOS • Rate of intubation • Inhalation injury	• Wound/ocular infection • Eyelid contracture • Corneal ulceration • Vision loss • Ectropian

RESULTS

Surgical intervention

Mean ages ranged from 18 to 41.8 years. Studies that reported sex had significantly more males (RR: 3.32, 95% CI: 1.18, 9.35, I^2 = 88%, p = 0.02). [2,18-20] The most common surgery performed for acute ocular burns was AMT for 115 eyes in 5/8 studies, [15-17,19,20] followed by DALK for 50 eyes in 1/8 studies. [18] The most common surgery for acute eyelid burns was a full-thickness skin graft for 44 eyelids in 2/8 studies, [14,17] followed by tarsorrhaphy for 16 eyelids in 2/8 studies, [14,17] and split-thickness skin grafts for 3 eyelids in 1/8 studies. [2] No surgical interventions were described for the acute management of eyelashes and eyebrows. Direct closure, CLAT, keratolimbal allograft transplantation, penetrating keratoplasty skin substitutes, and tissue flap techniques were not available with our criteria in the literature.

Non-surgical intervention

Mean ages ranged from 16 to 40.5 years. Studies that reported sex had significantly more males (RR: 3.27, 95% CI: 1.34, 7.98, I^2 = 91%, p = 0.009). [2,18-20] Medical interventions were provided to all patients for the management of acute burns. Medications included topical medications (corticosteroids prednisolone or dexamethasone, sodium ascorbate, sodium citrate, EDTA), [2,15-20] topical lubricants/irrigation (0.9% NaCl, lactated ringers solution, preservative-free drops), [2,15-20] topical antimicrobial (oxafloxacin, oxytetracycline, tetracycline, moxifloxacin), [2,15-20] topical anti-glaucoma (timolol, homatropine, atropine), [2,15-20] oral medication (vitamin C), [16-20] oral antimicrobial (doxycycline), [18] oral anti-glaucoma (acetazolamide). [15-17,19,20]

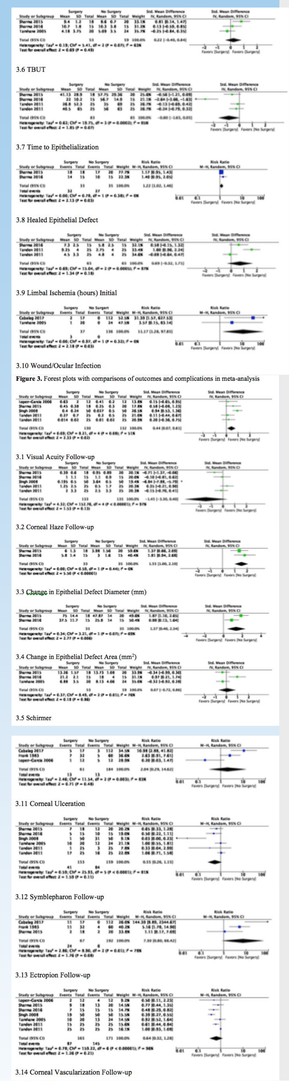


Figure 3. Forest plots with comparisons of outcomes and complications in meta-analysis

Table 2. Acute surgical and non-surgical study outcomes *(values rounded to fit table)*

Author	Group	Sample size (n)	Surgery	Time to management (days)	Visual acuity		Pain (0-10)		Corneal haze		Epithelial defect diameter (mm)		Epithelial defect area (mm²)		Time to epithelialization	Healed epithelial defect	Schirmer	TBUT (s)	Limbal ischemia (hours)	
					I	F	I	F	I	F	I	F	I	F					I	F
Frank et al.	Surgery	22	FTG	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Surgery	10	FTG, T	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	No surgery	60	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Tamhane et al.	Surgery	20	AMT	2.5±1	0.02±0	0.3±4	8.8±2	2.5±0.3	---	---	---	---	97±39	---	---	---	7±4	4±4	---	---
	No surgery	24	---	---	0.1±0.2	0.6±0.4	8.6±2	5.5±1	---	---	---	---	61±47	---	---	---	8±4	5±4	---	---
Lopez-Garcia et al.	Surgery	12	AMT	---	0.2±0.2	0.63±0.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	No surgery	12	---	---	0.2±0.2	0.4± 0.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Singh et al.	Surgery	50	DALK	---	0.3±0.6	0.4±0.2	---	---	3.7±0.2	0.2±0.5	---	---	---	---	---	---	---	---	---	---
	No surgery	50	---	---	0.3±0	0.03±0.5	---	---	3.7±0.5	3.6±0.5	---	---	---	---	---	---	---	---	---	---
Tandon et al.	Surgery	38	AMT	5±12	0.1±0.3	0.3±1	---	---	3±2	1.3±3	---	---	47±80	---	27±52	---	---	---	4.5±3	---
	No Surgery	36	---	7±17	0.04±1	0.2±0.5	---	---	2.5±3	0.5±2	---	---	48±116	---	35±69	---	---	---	3±4	---
	Surgery	38	AMT	7.5±12	0.005±0	0.014±0	---	---	1.5±3	2±3	---	---	114±99	---	41±65	---	---	---	9±4	---
	No Surgery	41	---	7.5±12	0.01±0	0.01±0	---	---	1.3±3	2.5±3	---	---	112±106	---	56±63	---	---	---	4.8±4	---
Sharma et al.	Surgery	18	AMT	7±3	0.03±0	0.5±0.4	---	---	2.3± 1	0.4±1	7.7± 1	1.7±1	76±27	1±2	41±29	18	13.3±2	9.4±1	---	---
	No surgery	20	---	6.6±2	0.03±0	0.3±0.3	---	---	2.4±1	1± 1	7.2± 2	3.2±2	54±22	6±5	57.8±29	17	13.7±1	8.6±1	---	---
Sharma et al.	Surgery	15	AMT	4±2	---	---	6.4±1	2.4±1	1.8±1	1±1	6±2	0.2±1	38±22	0.4±1	22±10	14	21.2±2	10.7±2	7±3	1.5±2
	No surgery	15	---	4.2±1	---	---	5.8±1	2.2±2	1.7±1	1.1±1	5.6± 2	2.6±1	33±20	6.8±8	56.7±15	10	18±4	10.3±4	6±3	3.7±3
Cabalag et al.	Surgery	49	STG, FTG, T	1±2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	No Surgery	277	---	0.6±1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

AMT: amniotic membrane transplantation, DALK: deep anterior lamellar keratoplasty, STG: split-thickness graft, FTG: full-thickness graft, T: tarsorrhaphy, I: Initial evaluation, F: follow-up

RESULTS

Table 3. Acute surgical and non-surgical study complications

Author	Group	Sample size (n)	Surgery	Wound/ocular infection	Eyelid contracture	Corneal ulceration	Vision loss	Symblepharon		Entropian	Ectropian	Corneal vascularization		Eye perforation
								I	F			I	F	
Frank et al.	Surgery	22	FTG	---	---	7	1	---	---	---	7	---	---	0
	Surgery	10	FTG, T	---	---	0	0	---	---	---	4	---	---	1
	No surgery	60	---	---	---	5	---	---	---	---	4	---	---	0
Tamhane et al.	Surgery	20	AMT	1	---	---	---	5	10	---	---	0	10	---
	No surgery	24	---	0	---	---	---	4	12	---	---	2	13	---
Lopez-Garcia et al.	Surgery	12	AMT	---	---	---	---	---	---	---	---	---	2	---
	No surgery	12	---	---	---	3	---	---	---	---	---	---	4	---
Singh et al.	Surgery	50	DALK	---	---	---	---	---	1	---	---	---	19	---
	No Surgery	50	---	---	---	---	---	---	31	---	---	---	50	---
Tandon et al.	Surgery	38	AMT	---	---	---	---	1	1	---	---	0	15	---
	No Surgery	36	---	---	---	---	---	0	3	---	---	0	25	---
	Surgery	38	AMT	---	---	---	---	5	17	---	---	0	25	---
	No Surgery	41	---	---	---	---	---	5	16	---	---	0	25	---
Sharma et al.	Surgery	18	AMT	---	---	---	---	---	7	1	2	1	9	---
	No surgery	20	---	---	---	---	---	---	12	2	2	2	13	---
Sharma et al.	Surgery	15	AMT	---	---	---	---	---	5	---	---	---	7	---
	No surgery	15	---	---	---	---	---	---	10	---	---	---	15	---
Cabalag et al.	Surgery	49	STG, FTG, T	2	8	5	7	---	---	---	---	---	11	---
	No Surgery	277	---	0	0	3	10	---	---	---	0	---	---	---

AMT: amniotic membrane transplantation, DALK: deep anterior lamellar keratoplasty, STG: split-thickness graft, FTG: full-thickness graft, T: tarsorrhaphy, I: initial evaluation, F: follow-up

Table 4. Summary of Findings

Surgical Compared to Non-surgical Management for Acute Ocular, Eyelid, Eyelash, and/or Eyebrow Burns

Patient or population: Ocular, eyelid, eyelash, eyebrow burns
Settings: Inpatient or outpatient
Intervention: Surgery
Comparison: Medical management alone

	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk No Surgery Group	Corresponding risk Surgery Group				
3.7 Visual Acuity Follow-up	The mean visual acuity on follow-up ranged across control groups from 0.01 to 0.41	The mean visual acuity on follow-up in the intervention groups was 0.44 higher (0.07 to 0.81 higher)	**SMD 0.44** (0.07 to 0.81)	262 (4 studies)	⊕⊕⊖⊖ Low[1,2,3,4]	
3.28 Change in Epithelial Area (mm²)	The mean change in epithelial area ranged across control groups from 26mm² to 48mm²	The mean change in epithelial area in the intervention groups was 1.37 higher (0.4 to 2.34 higher)	**SMD 1.37** (0.40 to 2.34)	68 (2 studies)	⊕⊕⊖⊖ Low[1,3]	
3.24 Healed Epithelial Defect	**Medium risk population** **758 per 1000**	**925 per 1000** (773 to 1000)	**RR 1.22** (1.02 to 1.46)	68 (2 studies)	⊕⊕⊖⊖ Low[1,3]	
3.26 Wound/Ocular Infection	**Medium risk population** **0 per 1000**	**0 per 1000** (0 to 0)	**RR 11.17** 1.28 to 597.85)	173 (2 studies)	⊕⊕⊕⊖ Moderate[1,3]	
3.30 Symblepharon Follow-up	**Medium risk population** **610 per 1000**	**336 per 1000** (159 to 701)	**RR 0.55** (0.26 to 1.15)	312 (5 studies)	⊕⊕⊕⊖ Moderate[2,3]	
3.31 Ectropion Follow-up	**Medium risk population** **67 per 1000**	**487 per 1000** (53 to 1000)	**RR 7.30** (0.80 to 66.42)	259 (3 studies)	⊕⊕⊖⊖ Low[1,2,3]	
3.32 Corneal Vascularization	**Medium risk population** **42 per 1000**	**17 per 1000** (3 to 105)	**RR 0.64** (0.32 to 1.28)	336 (6 studies)	⊕⊕⊕⊖ Moderate[2,3]	

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: Confidence interval; **RR:** Risk Ratio; **SMD:** Standard Mean Difference
GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.
1. Risk of bias
2. Inconsistency: heterogeneity > 50%
3. Indirectness: low diversity of patient population
4. Imprecision: small event size
5. Publication bias: small study effects

CONCLUSION

Patients having surgery for ocular, eyelid, and/or eyelash burns were found to have greater visual acuity on follow-up, shorter epithelial defect diameters on follow-up, greater changes in epithelial diameters from baseline, smaller epithelial defect areas on follow-up, greater changes in epithelial defect areas from baseline, greater numbers of healed epithelial defects, more keratitis infections, and a greater reduction in limbal ischemia, possibility preventing the need of a future limbal stem cell transplantation.

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