

Original Article

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Peter M. Vogt*, Seyed Arash Alawi and Ramin Ipaktchi

Free flaps in scar treatment

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Abstract

Introduction: Scar management needs defined concepts and an algorithm to restore functional and aesthetic units. After an unsuccessful conservative treatment, surgical measures provide a vast spectrum of possibilities for remediation. The spectrum of possibilities consists of excision and Z-plasty, regional flaps, vascularized pedicled flaps, tissue expansion, and finally free tissue transfer. Severe scarring and highly destructed tissues with inferior functional and aesthetic units can be effectively treated with radical excision and free flap reconstruction. The complexity of flap architecture and tissue qualities allows for an individualized approach. Specific attention should be paid to the long-term consequences of severe scarring with progressive loss of functionality.

Materials and methods: We worked out the most common surgical approaches and treatment algorithm for a stepwise and effective approach. Part of this algorithm is a seven-step surgical approach.

Results: This article provides modern plastic and reconstructive surgery concepts with an algorithm for scar management.

Discussion: The treatment of scars follows an algorithm with the level of complexity of techniques adjusted to the individual case and the conditions. Disabilities induced by scarring can lead to further functional loss. In these cases, surgical strategies have to be considered.

Keywords: flap; reconstruction scar; scar treatment; tissue transfer.

Introduction

The treatment of scars follows an algorithm with the level of complexity of techniques adjusted to the individual case

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and the conditions. After conservative measures, operative corrections are deemed necessary if severe functional and aesthetic deformities cannot be addressed otherwise [1, 2]. Thereby, aesthetic appearance is mainly determined by homogeneous skin texture, pliability, and pigmentation identical to or at least a proper match with the local tissue. Functionally normal skin and soft tissue allow for enough pliability and surplus to provide the necessary excursion in, for example, joint motion. However, in disabilities induced by scarring, these prerequisites have to be provided otherwise. In these cases, surgical strategies have to be considered. In this article, the concepts, an algorithm for scar management and an original catalogue of indications that apply to free flap transfer, are provided based on the German and international scar management guidelines [3–5].

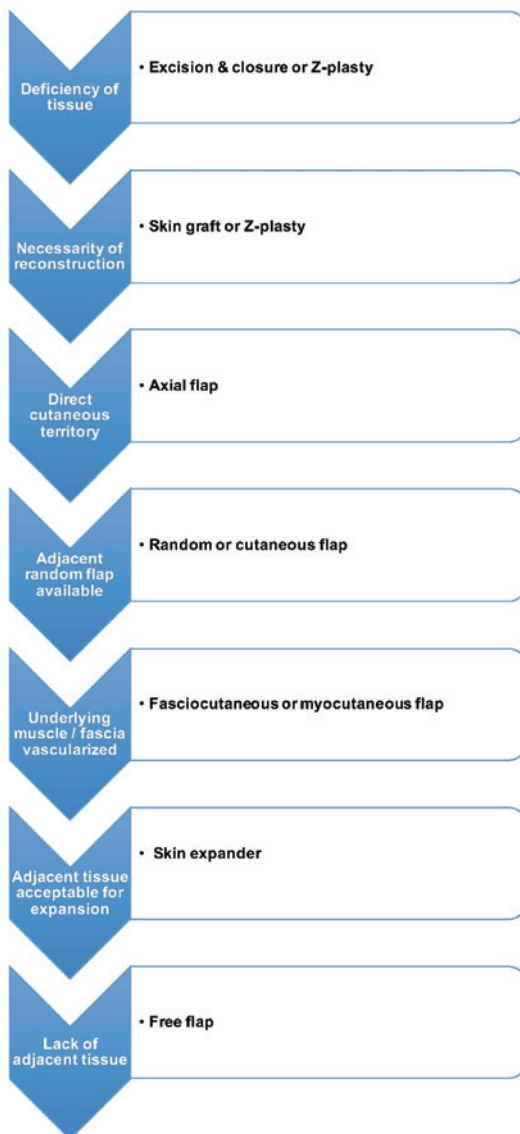
Indications for surgical scar revision

Surgical measures provide a vast spectrum of possibilities in the corrections after conservative options have been applied or had to be excluded in the first line. A useful algorithm has been described by Robson et al. [6] for burns. We have adjusted it to the necessities in scar revisions as it applies well for other scar problems. In general, a systematic surgical evaluation of skin and soft-tissue qualities allow for the best match according to the replacement by the “like with like” principle (Table 1). When considering surgical options predominantly, the local conditions do have an impact on the decision making. Soft tissue and skin of high quality in the proximity of the scarred area will determine the choice out of the wide spectrum of possibilities depending on the availability.

Treatment algorithm

Conservative treatments

For scar treatment, first-line treatment should include conservative procedures such as scar massage. Depending on the type of scar, massage therapy has effects on

Table 1: Algorithm in the surgical treatment of scars.

scars. Further therapies such as pressure therapies as well as silicone gel or silicone sheet applications are possible treatment options. In addition, a combination of these parts is possible. Based on the treatment options, pressure and silicon therapy seem to have good evidence for hypertrophic scar formations and burn scars. By application of these treatments, scar thickness and scar pliability seem to improve [7]. Also, intralesional cortisone injections should be considered in hypertrophic scars and keloids [8].

With less evidence, further treatments such as scar massage with lotions, splinting, and casting as well as exercise and mobilization seem to have effects on pain, pruritus, and scar pliability. The indication for surgical treatment should include a conservative treatment

period of 6–12 months. Nevertheless, an individual indication should be considered depending on age, restriction of functionality, as well as individual patient burden. Especially, the patient should be explained that the risk of relapsing scars after surgical treatment is possible.

Excision and Z-plasty

If the deficiency of tissue cannot be corrected by simple excision and closure or Z-plasty, the surgeon will have to employ a skin graft or Z-plasty [9]. These techniques, however, depend on a certain quality of the local adjacent skin tissue. This can be a problem in extended scarring after burns or other traumatic causes such as degloving injuries.

Regional flaps

If skin grafts or Z-plasty are not considered to solve the scar problem, regional axial flaps with direct cutaneous territory should be used [10]. The prerequisite is an axial flap such as the forehead flap, the radial forearm flap, or a dorsal arm flap.

As can be appreciated from the anatomical requirements, their use is limited to few locations. However, if adjacent random flaps can be dissected, this tissue will provide random or cutaneous flaps of the closest proximity. Typically, this works well in the proximal extremities and the trunk.

Vascularized pedicled flaps

If no adjacent tissue is available, vascularized pedicled muscle or fascia flaps carrying fasciocutaneous or myocutaneous territories can be applied [6, 11]. As these operations require extensive dissection, their use is justified only in cases of severe functional or aesthetic impairment. Typical examples are pedicled groin flaps for the hand and pedicled transverse rectus abdominis myocutaneous (TRAM) flaps for the groin or thorax.

All the above-mentioned procedures entail single-step operations, except for the pedicled groin flap. Therefore, multistage procedures such as the skin expander or serial excisions with staged scar release are useful only if the soft tissue to be expanded is superior to the other options and if the patient is willing to undergo multiple procedures.

Table 2: Free Flaps and their tissue qualities in scar treatment.

Arterial flaps	<ul style="list-style-type: none"> • Skin, subcutis and fascia • (e.g. radial arm flap, dorsalis pedis flap)
Muscle and musculocutaneous flaps	<ul style="list-style-type: none"> • Skin, subcutis, muscle • (e.g. latissimus dorsi, TRAM)
Fascial, adipofascial and fasciocutaneous flaps	<ul style="list-style-type: none"> • Skin, subcutis, fascia (tendon) • (e.g. serratus fascia, parascapular flap)
Perforator flaps	<ul style="list-style-type: none"> • Skin, subcutis and subcutaneous fascia • (e.g. ALT, DIEP)
Specialized flaps	<ul style="list-style-type: none"> • Sensory tissue, differentiated structure and texture • (e.g. wrap around flap, composite tissue allografts)

Tissue expansion

Although expanders require a lot of effort and endurance from the patient, the aesthetic result is mostly superior to other options. Expanders typically provide quality skin with the best tissue and color match for the reconstruction of the scalp, face chest, and extremities. Expanders can be used to preexpand pedicled flaps in the chest area before transposition, for example, to the head, neck, or face. Typical examples for the latter are preexpanded supraclavicular flaps or super thin posterior thorax flaps [12]. Only if all of the above solutions fail or cannot be applied that free flaps come into consideration [13].

Free tissue transfer

Due to their versatility, free flaps have almost entirely replaced the unsuccessful reconstructive attempts that had dominated the first three quarters of the 20th century. Flap geometry and staged tubed pedicles as well as flap delay were replaced by new options to provide vast quantities of tissue that could be transferred to the most distant locations of the human body. Free flaps provide all sorts of the desired tissue quality, including skin, fat, fascia, muscle, tendon, and bone (Table 2). Due to the availability of various vascular patterns, the size and design can be tailored to the individual requirements. The only indispensable requirement, however, is an adequate vascular supply by the recipient vessels. If this is not available either in case of

occlusive arterial disease, severe scarring after trauma or irradiation venous grafts or arteriovenous loops can be applied to provide adequate vasculature by connecting the flap to appropriate distant vessels [14, 15]. Regarding the anatomical constitution of patients, the “flap architecture” is variable. Depending on different vascular and soft-tissue anatomies, the applicability of flaps differs. For that reason, an initial evaluation and consideration of further diagnostic steps such as magnetic resonance imaging (MRI) or computed tomography (CT)-angiography is indicated. A deep knowledge of anatomical structures such as muscle origin and insertion as well as vascular variability and perforator location is essential.

Indications for free tissue transfer

In the clinical setting, the following indications require free flap transfer for scar correction or enhancement of the local tissue quality. We therefore propose a systematic approach of flap selection oriented at the requirements after scar excision (Table 3).

Lipofilling-Coleman technique

Autologous fat grafting has been frequently used in aesthetic and reconstructive surgery. This is based on the fact that, beside the physical effects, fat grafts produce a considerable high amount of growth factors and seem to have

Table 3: Indications for free flaps in scar treatment.

-
1. Augmentation of the subcutaneous plane to correct scarring in the skin over bony prominences
 2. Replacement of large scarred skin and subcutaneous territories
 3. Release of scars and soft tissue augmentation in functionally impaired body regions
 4. Replacement of scarred tissue in body regions that contain highly specialized tissue
 5. Replacement of scarred areas in the growing skeleton
 6. Prevention of scar induced impairment
-

regenerative effects induced by adipose-derived stem cells. There are different techniques for fat grafting. The Coleman technique, for example, is mainly based on harvesting with a 15- or 23-cm two-hole cannula with a blunt tip and dull distal openings [16–18]. It is placed onto a Luer-Lok syringe. By creating a slightly negative pressure and movement through the tissue, it allows fat parcels to move through the cannula and through the Luer-Lok aperture. To receive pure fat, the refinement of the harvested subcutaneous tissue is essential for a successful fat grafting. Components like oil must be cleared. By centrifugation, a separation of denser and less dense components is created consisting of oil, blood, and further fluid components. The middle part consists of potentially most viable parcels of fatty tissue. The densest level is made of blood, water, and the liposuction solution. Absorbent material can be used to remove the oil from the upper separation. The refined fat can be placed very regularly into and below the scar. Placement is best accomplished with a blunt Coleman infiltration cannula. Diffusion can take place if a large surface area is created by placing the fat highly dispersed to the recipient tissue.

Surgical scar excision

Once the indication for surgical treatment of the scar has been set, it is mandatory to have a clear understanding of the extent of correction. All fibrosed tissue that contributes to the problem has to be removed. This may entail extensive excision beyond the primarily visible margins. Also, it has to be anticipated how large the defect will be after surgery. This will largely determine the selection of appropriate flaps. Also, the possible growth of the skeleton in children has to be accounted for to plan for extra tissue and skin. Furthermore, unstable chronic scars should always be treated surgically. Marjolin's ulcers present in unstable scars, which are chronically inflamed or traumatized. These unstable scars appear

after burn injuries with planar scarring representing an aggressive squamous cell carcinoma [19, 20]. It leads to local destruction and can spread locally. A radical surgical excision with histopathological free margins should be the objective.

Adaptability of techniques

A decision for a defined technique should be considered in regard of functional restriction, aesthetic consideration in conjunction with culture and social background, as well as anatomical location and further surgical risk evaluation. Especially, the patient should be extensively enlightened about all surgical risks and the possibility of scar relapses.

Modern reconstructive approach

Augmentation of the subcutaneous plane to correct scarring in the skin over bony prominences

Although the skin envelope may appear to be sufficient in the average daily situation, it can become necessary to provide an extra quality of mobile tissue in the subcutaneous plane [21]. Although fat injection has become very popular for scar correction, this option may not be applicable in complex situations and when simultaneous surgical procedures are applied that may interfere with lipotransfer. Also, a dead space or cavity underneath the scar area may prevent proper engraftment of the applied fat cells.

In this case, thin muscle, fascial, or adipofascial flaps will provide the most stable soft-tissue replacement.

Replacement of large areas of scarred skin and subcutaneous tissue

This condition requires flaps with safe perfusion of a large skin and fascial territory and enough softness to compensate for the loss of subcutaneous tissue. In these cases, either musculocutaneous, fasciocutaneous or perforator skin flaps are used. For the patients comfort the plastic surgeon should assure primary closure of the donor site. This can be accomplished by choosing flaps that are harvested in areas of excessive tissue (Figure 1).

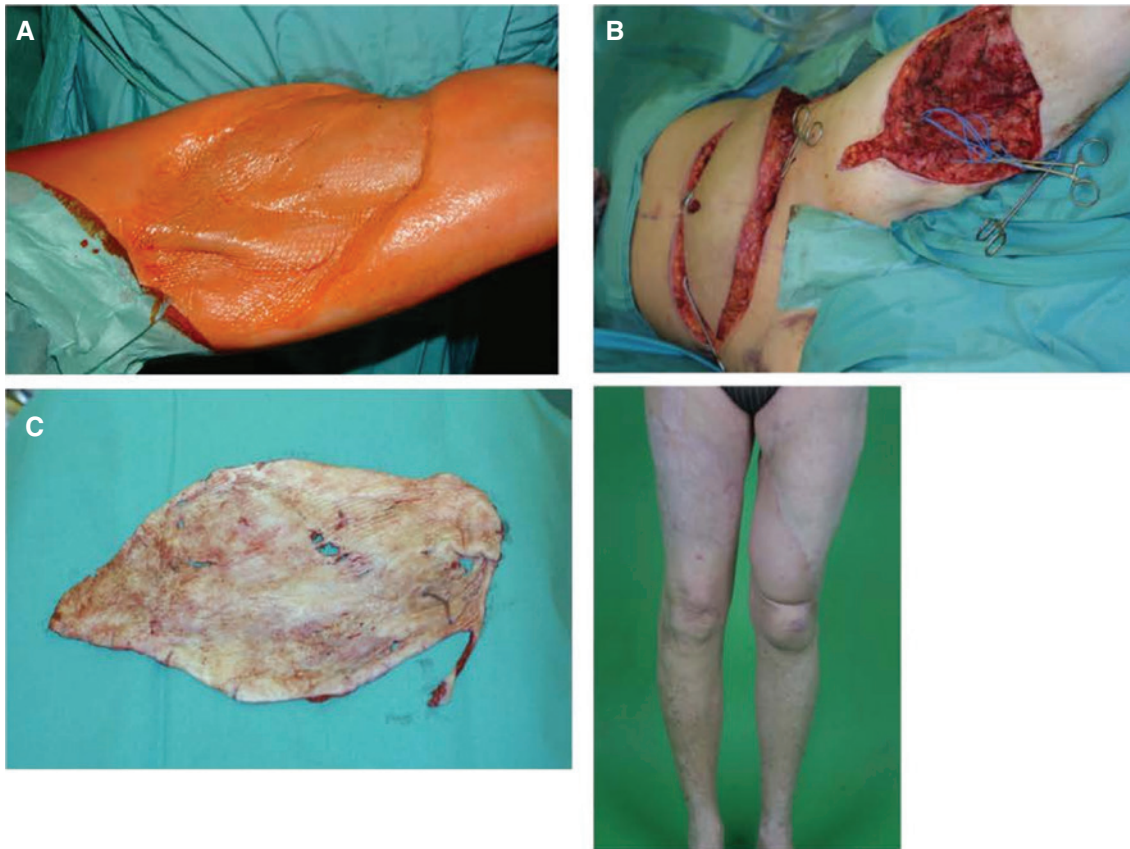


Figure 1: Scar excision and free flap reconstruction.

Large scar area on the thigh of a 65 years old female after decollement injury with impaired knee motion and significant disability (A). An orthopedic joint release was planned that required sufficient soft tissue. This was accomplished by completely excising the scar and transferring a muscle sparing free TRAM flap connected to the femoral vessels (B, C). Besides the gain of function the patient was pleased by the excellent aesthetic appearance.

Release of scars and soft-tissue augmentation in functionally impaired body regions

If the skin appears to be sufficient in quantity and treatment by less invasive measures such as lipotransfer is not an option, buried free fascial, adipofascial, or muscle flaps can be applied. Clinical indications are frequently given in the facial region or the thorax [22].

Replacement of scarred tissue in body regions that contain highly specialized tissue

In areas of damage of highly specialized tissue such as scarred pulp of the thumb or fingertips, only an appropriate replacement by similar tissue will improve the condition. Typically, this will be achieved by sensate wrap around flaps from the great toe or second toe transfer if additional length has to be achieved [23]. Recently, significant aesthetic and functional improvement has been

made in facial reconstruction by the use of composite tissue allografts [24]. In those cases, where only scarred soft tissue has to be replaced, preexpanded thin flaps of the proximity will still solve the problem.

Replacement of scarred areas in the growing skeleton

Topical scarring over joints and other extremity areas may prevent proper joint movement as well as bone growth. The detrimental effects are mostly appreciated in the long-term follow-up of pediatric burns. In these cases, once the tissue deficit has been recognized, the deliberate use of free flaps provides enough tissue for further growth [25].

Prevention of scar-induced impairment

As scar tissue is neither flexible nor elastic, the effects of long-term scar instability have been recognized a

long time ago. Karasoy Yesilada et al. [26] have already described the onset of malignant degeneration of burn scars. Therefore, an aggressive approach is warranted. Typically, the areas that require free flaps are located in the lower extremity and the elbow joint. The younger the patient at the time of the burn, the longer the time required for the cancer to develop (weeks to decades). Along with the local destruction by the tumor, lymphatic spread may occur after a few decades and renders the condition to a deadly disease.

Provision of soft tissue for future reconstruction

Lastly, a certain number of patients will undergo future surgery such as functional reconstruction [27]. To provide for adequate gliding planes for tendon transfer or prosthetic replacement tissue, free flaps can deliver enough tissue to this end.

Conclusion

In the surgical correction of severe scarring, free flaps play an essential role in modern treatment. The complexity of flap architecture and tissue qualities allows for an individualized approach. However, risks for free flap surgery should be considered in diseases that possibly compromise the vessel quality, such as peripheral arterial occlusive disease (PAD), diabetes, and congenital tendency to bleeding or thrombosis. However, these diseases are by no means an absolute contraindication for free flap plastic surgery but require precise preoperative diagnostics.

Specific attention should be paid to the long-term consequences of severe scarring. Therefore, a treatment algorithm should be based on first-line conservative treatment option and go further to extended reconstructive procedures. An early and aggressive approach is recommended in unstable scars where malignancy should be excluded.

The prevention of scar development should also be included in every surgical procedure. The consideration of relaxed skin tension lines and by a traumatic intraoperative approach will have good effects on wound healing. Additionally, the use of stitching material should be carefully considered as suture granuloma will have effects on the scar development. Preventive treatment with silicone wound dressing after primary wound healing should be considered in high-risk patients. Also, perioperative intralesional corticosteroid injections should be considered in patients with high risk for keloids [28].

Author Statement

Research funding: Authors state no funding involved. Conflict of interest: Authors state no conflict of interest. Informed consent: Informed consent is not applicable. Ethical approval: The conducted research is not related to either human or animals use.

Author Contributions

Peter M. Vogt: Conceptualization; Data curation; Formal analysis; Funding acquisition; Investigation; Methodology; Project administration; Resources; Software; Supervision; Validation; Visualization; Writing – original draft; Writing – review and editing. Seyed Arash Alawi: Conceptualization; Methodology; Project administration; Writing – review and editing. Ramin Ipaktchi: Conceptualization; Data curation; Formal analysis; Funding acquisition; Investigation; Methodology; Project administration; Resources; Software; Supervision; Validation; Visualization; Writing – original draft; Writing – review and editing.

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Supplemental Material: The article (DOI: 10.1515/iss-2017-0014) offers reviewer assessments as supplementary material.

Reviewer Assessment

Open Access

Peter M. Vogt*, Seyed Arash Alawi and Ramin Ipaktchi

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Reviewers' Comments to Original Submission**Reviewer 1: anonymous**

Mar 10, 2017

Reviewer Recommendation Term: Accept with Minor Revision
Overall Reviewer Manuscript Rating: 40

Custom Review Questions	Response
Is the subject area appropriate for you?	5 - High/Yes
Does the title clearly reflect the paper's content?	3
Does the abstract clearly reflect the paper's content?	2
Do the keywords clearly reflect the paper's content?	3
Does the introduction present the problem clearly?	2
Are the results/conclusions justified?	3
How comprehensive and up-to-date is the subject matter presented?	3
How adequate is the data presentation?	2
Are units and terminology used correctly?	3
Is the number of cases adequate?	N/A
Are the experimental methods/clinical studies adequate?	N/A
Is the length appropriate in relation to the content?	3
Does the reader get new insights from the article?	1 - Low/No
Please rate the practical significance.	3
Please rate the accuracy of methods.	3
Please rate the statistical evaluation and quality control.	N/A
Please rate the appropriateness of the figures and tables.	3
Please rate the appropriateness of the references.	3
Please evaluate the writing style and use of language.	4
Please judge the overall scientific quality of the manuscript.	3
Are you willing to review the revision of this manuscript?	Yes

Comments to Authors:

This article is a reflect of surgical techniques proposed in scars
 However Coleman technique is not described and there is no indications of the need for a fine tuning reflexion and adaptability of techniques to the objective, depending on age, anatomical location, etc...

Reviewer 2: anonymous

Mar 25, 2017

Reviewer Recommendation Term: Accept with Minor Revision
Overall Reviewer Manuscript Rating: 80

Custom Review Questions

	Response
Is the subject area appropriate for you?	5 - High/Yes
Does the title clearly reflect the paper's content?	5 - High/Yes
Does the abstract clearly reflect the paper's content?	4
Do the keywords clearly reflect the paper's content?	5 - High/Yes
Does the introduction present the problem clearly?	5 - High/Yes
Are the results/conclusions justified?	5 - High/Yes
How comprehensive and up-to-date is the subject matter presented?	5 - High/Yes
How adequate is the data presentation?	4
Are units and terminology used correctly?	5 - High/Yes
Is the number of cases adequate?	4
Are the experimental methods/clinical studies adequate?	N/A
Is the length appropriate in relation to the content?	5 - High/Yes
Does the reader get new insights from the article?	4
Please rate the practical significance.	5 - High/Yes
Please rate the accuracy of methods.	4
Please rate the statistical evaluation and quality control.	N/A
Please rate the appropriateness of the figures and tables.	5 - High/Yes
Please rate the appropriateness of the references.	4
Please evaluate the writing style and use of language.	5 - High/Yes
Please judge the overall scientific quality of the manuscript.	5 - High/Yes
Are you willing to review the revision of this manuscript?	Yes

Comments to Authors:

The authors present their opinion on the value of free flaps in scar management. They develop an algorithm that entails the preservation of functional and aesthetic units of the Body when dealing with scars.

Although it is clear that surgical options are discussed I would suggest that the whole spectrum of conservative treatment methods should be discussed a little more to better clarify the frontier between conservative and surgical indications. It is a well known phenomenon that for instance scar excisions and z- or running-W-plasties can well carry the risk of relapsing scars.

The authors nicely report the variety of common technical surgical options and standard techniques in scar surgery.

Due to the standardization of free flap transfer this surgical technique has become comparatively safe in high volume centers. It needs to be acknowledged that the authors point out the influence of the anatomical constitution of various flaps and their respective „flap architecture“.

I would suggest that the authors include a few Details on Marjolin´s ulcers in longstanding instable scars.

Please comment why an early and aggressive approach is recommended? given the fact that scars may mature up to 1 1/2 or even 2 years (and become softer and more pliable etc. etc.) it is not quite clear why an early and aggressive approach should be the gold Standard in general. Conservative measures often lead to an improvement but this takes time and it seems important that surgery will not come in the first place. What exactly is meant with early?

Maybe the authors could discuss other reviews from German authors in this context, such as for instance: Arco G, Horch RE: Chirurgie der Narben Grundlagen, Prävention und Behandlungsmethoden. Chirurgische Allgemeine CHAZ (2009) 10,1:17-30 [2009;10(1):17 -30; ISSN:1615-5378].

After answering the queries this article seems suitable for ISS because it provides a fine summary of modern plastic and reconstructive surgical concepts along with a proposed algorithm for scar Management and could therefore be helpful for surgeons of all surgical specialties.

Authors' Response to Reviewer Comments

Mar 30, 2017

Reviewer #1:

1.1 "This article is a reflect of surgical techniques proposed in scars However Coleman technique is not described and there is no indications of the need for a fine tuning reflexion and adaptability of techniques to the objective, depending on age, anatomical location, etc..."

1.1 Response

Thank you very much for your thorough review and comments.

To complete the whole spectrum of possible therapies we added a description of the Coleman technique on page 5-6. In addition, we extended the manuscript and added a passage "adaptability of techniques" on page 7. Here we described important influences on surgical outcome.

Reviewer #2:

2.1 "The authors present their opinion on the value of free flaps in scar management. They develop an algorithm that entails the preservation of functional and aesthetic units of the Body when dealing with scars.

Although it is clear that surgical options are discussed I would suggest that the whole spectrum of conservative treatment methods should be discussed a little more to better clarify the frontier between conservative and surgical indications. It is a well known phenomenon that for instance scar excisions and z- or running-W-plasties can well carry the risk of relapsing scars. "

2.1 Response

Thank you very much for your review and your comments.

We agree, surely conservative treatments should stand at first-line. We added an overview of conservative treatment options on page 2.

2.2 "The authors nicely report the variety of common technical surgical options and standard techniques in scar surgery. Due to the standardization of free flap transfer this surgical technique has become comparatively safe in high volume centers. It needs to be acknowledged that the authors point out the influence of the anatomical constiution of various flaps and their respective "flap architecture"."

2.2 Response

Thank you for emphasizing this important point. We added a passage on page 4-5 regarding flap architecture and anatomical variability.

2.3 "I would suggest that the authors include a few Details on Marjolin´s ulcers in longstanding instable scars."

2.3 Response

Thank you for emphasizing this important point. We added an passage and outlined the clinical relevance of Marjolins ulceration on page 7.

It is included in the point of surgical scar excision. A radical excision with histopathological free margins should be the aim. We also mentioned the aggressive approach regarding Marjolin ulcer on page 10.

2.4 "Please comment why an early and aggressive approach is recommended? given the fact that scars may mature up to 1 1/2 or even 2 years (and become softer and more pliable etc. etc.) it is not quite clear why an early and aggressive approach should be the gold Standard in general. Conservative measures often lead to an improvement but this takes time and it seems important that surgery will not come in the first place. What exactly is meant with early?"

2.4 Response

Thank you for emphasizing this important point. Treatment priority should be in first line the application of conservative treatment options.

A radical and early surgical treatment should be considered in instable scars. We corrected the statement in part of our conclusion and focused more on Majolins ulceration to be treated aggressively.

Kind regards

Reviewers' Comments to Revision

Reviewer 1: anonymous

Apr 01, 2017

Reviewer Recommendation Term:	Accept with Minor Revision
Overall Reviewer Manuscript Rating:	60

Custom Review Questions	Response
Is the subject area appropriate for you?	4
Does the title clearly reflect the paper's content?	3
Does the abstract clearly reflect the paper's content?	3
Do the keywords clearly reflect the paper's content?	3
Does the introduction present the problem clearly?	3
Are the results/conclusions justified?	3
How comprehensive and up-to-date is the subject matter presented?	3
How adequate is the data presentation?	3
Are units and terminology used correctly?	5 - High/Yes
Is the number of cases adequate?	N/A
Are the experimental methods/clinical studies adequate?	N/A
Is the length appropriate in relation to the content?	4
Does the reader get new insights from the article?	3
Please rate the practical significance.	3
Please rate the accuracy of methods.	3
Please rate the statistical evaluation and quality control.	N/A
Please rate the appropriateness of the figures and tables.	4
Please rate the appropriateness of the references.	1 - Low/No
Please evaluate the writing style and use of language.	3
Please judge the overall scientific quality of the manuscript.	3
Are you willing to review the revision of this manuscript?	Yes

Comments to Authors:

This article is more in accordance with the consensus on scar management published in 2014 and 2016. However some references (german consensus, international consensus) are still lacking, as well as reference for the Coleman technique. The authors should better describe when a flap is needed and when it is contraindicated.

Reviewer 2: anonymous

May 29, 2017

Reviewer Recommendation Term:	Accept
Overall Reviewer Manuscript Rating:	70

Custom Review Questions	Response
Is the subject area appropriate for you?	5 - High/Yes
Does the title clearly reflect the paper's content?	5 - High/Yes
Does the abstract clearly reflect the paper's content?	5 - High/Yes
Do the keywords clearly reflect the paper's content?	5 - High/Yes
Does the introduction present the problem clearly?	5 - High/Yes
Are the results/conclusions justified?	5 - High/Yes
How comprehensive and up-to-date is the subject matter presented?	5 - High/Yes
How adequate is the data presentation?	5 - High/Yes
Are units and terminology used correctly?	5 - High/Yes
Is the number of cases adequate?	5 - High/Yes

Are the experimental methods/clinical studies adequate?	N/A
Is the length appropriate in relation to the content?	5 - High/Yes
Does the reader get new insights from the article?	4
Please rate the practical significance.	5 - High/Yes
Please rate the accuracy of methods.	N/A
Please rate the statistical evaluation and quality control.	N/A
Please rate the appropriateness of the figures and tables.	5 - High/Yes
Please rate the appropriateness of the references.	4
Please evaluate the writing style and use of language.	5 - High/Yes
Please judge the overall scientific quality of the manuscript.	5 - High/Yes
Are you willing to review the revision of this manuscript?	No: not necessary

Comments to Authors:

The authors have now responded adequately to the reviewer's comments and the paper is acceptable in the current form.

Authors' Response to Reviewer Comments

Jun 04, 2017

Reviewer #1:

1.1 Response

Thank you very much for your comments and the revision. We agree to add the mentioned citations regarding current consensus of national and international scar treatment.

On page 1, we added following citations :

3. "Monstrey S, Middelkoop E, Vranckx JJ, Bassetto F, Ziegler UE, Meaume S, et al. Updated scar management practical guidelines: non-invasive and invasive measures. *Journal of plastic, reconstructive & aesthetic surgery : JPRAS.* 2014;67(8):1017-25."
4. „Arco G, Horch R. Chirurgie der Narben Grundlagen, Prävention und Behandlungsmethoden. *Chirurgische Allgemeine CHAZ.*10(1):17 -30.“
5. "Nast A, Eming S, Fluhr J, Fritz K, Gauglitz G, Hohenleutner S, et al. Leitlinie AWMF- Therapie pathologischer Narben (hypertrophe Narben und Keloide). *AWMF.* 2016;013/030."

Furthermore, we inserted citations regarding the Coleman technique for fat grafting.

16. Coleman SR. Structural fat grafting. *Aesthetic surgery journal.* 1998;18(5):386, 8.
17. Pu LL, Yoshimura K, Coleman SR. Fat grafting: current concept, clinical application, and regenerative potential, part 1. *Clinics in plastic surgery.* 2015;42(2):ix-x.
18. Pu LL, Yoshimura K, Coleman SR. Fat Grafting: Current Concept, Clinical Application, and Regenerative Potential, Part 2. Preface. *Clinics in plastic surgery.* 2015;42(3):xiii-xiv.

Regarding free flap surgery, we believe that we explicitly described the indications and characteristics. On Page 4 and 5 as well as page 9 and 10 we provided a detailed description for free flaps with explanation of the flap architecture and localization of free flap reconstruction. With special consideration in the growing skeleton we described also one further indication of free flaps. Finally, we conclude that free flap surgery takes an "essential role" in modern plastic surgery treatment (Page 11).

Nevertheless, we conducted to consider risks of free flap surgery (page 11) :

"However, risks for free flap surgery should be considered in diseases, which possibly compromise the vessel quality, like peripheral arterial occlusive disease (PAD), diabetes, congenital tendency to bleeding or thrombosis. However, these diseases are by no means an absolute contraindication for free flap plastic surgery, but require precise preoperative diagnostics."

Reviewer #2:

2.1 Response

Thank you very much for your review and your comments.

Kind regards