Dermal Regeneration
Improving Function and Cosmesis in Skin Grafting

Experience and Best Practice

2nd European Symposium

Westin Hotel
Dublin
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Introduction

Over 60 delegates from 13 countries worldwide attended the second European Symposium in Dermal Regeneration, hosted by Johnson & Johnson Wound Management.

The focus for the two-day meeting was the considerable experience accrued using INTEGRA® Dermal Regeneration Template since the launch in Europe in 1996 and the sharing of best practice.

During the meeting, delegates were introduced to the science of dermal regeneration. They explored successes and failures in clinical experience through a series of presentations, which examined acute burns cases as well as new approaches in non-healing wounds, non-burn trauma and in reconstructive surgery. The forum allowed good information exchange and lively, open discussion around best practice and further indications for dermal regeneration. Highlights of the meeting are set out in this report.

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The science of dermal regeneration
Contributors: Ben Walthall PhD, Naiem Moiemen FRCS, David Herndon MD

In the sessions on the science of dermal regeneration, Dr Walthall compared inflammatory wound healing with tissue regeneration using a dermal regeneration template. He presented recent clinical work examining how INTEGRA Dermal Regeneration Template minimises contraction and inflammatory response.

Mr Moiemen described a series of histological analyses undertaken with James D Frame FRCS, FRCS (Plastic), in reconstruction cases using the INTEGRA template, and Dr Herndon presented data relating to the management of hypermetabolic response after dermal injury.

Wound healing compared with tissue regeneration using a dermal regeneration template

A full thickness skin wound in man elevates the risk of concentrated infection and can adversely affect fluid and temperature regulation and metabolic rate.

While the epidermis regenerates spontaneously where it is able to migrate from wound margins over an intact dermis or dermal-like matrix, the dermis does not. In deep dermal injury, unassisted wound closure is achieved via an inflammatory process that causes contraction. The resultant scar tissue often compromises function and aesthetic outcome.

Unassisted wound closure leads to contraction and scar formation

Well-remodelled, mature INTEGRA skin, with the classic scar along the seams, suggests that healing with INTEGRA Dermal Regeneration Template – the biosynthetic, implantable, bilayer membrane system that allows immediate closure of a wound – differs from closure via contraction

Metabolism

Over time, the mortality rate for major burns has decreased markedly – for example, from 32 to 18 per cent in children with burns over 60 per cent total body surface area (TBSA) during the last decade. It is even possible now for a child with a 98 per cent burn to survive.

Healing and recovery may be complicated by the hypermetabolic response that occurs after injury, which has a significant impact on patient morbidity lasting well into the rehabilitation period. It causes an elevated heart rate and an increase in resting energy expenditure and may result in impaired immune function and wound healing or even death.

Studies have demonstrated that in patients with burns greater than 40 per cent TBSA, the metabolic response is so severe that resting energy expenditure is elevated 180 per cent above normal at leaving hospital and remains 140 per cent above normal six and nine months post injury. At one-year post injury it is still 20 per cent above normal. Patients make no bone up to one-year post injury and in the case of those that are still growing, there is a height and velocity loss. This increased metabolic rate is paralleled by glucose delivery to the anaerobic burn wound causing patients to gather central fat and to lose total body nitrogen.

Early burn wound excision and coverage plays an important role in managing the hypermetabolic rate. Compared to early excision and grafting, delaying excision one to eight days in burns patients increases the metabolic rate by 50 per cent throughout hospital stay and up to one year post injury. In addition, early excision and grafting reduces the risk of burn wound sepsis.
Anabolic agents, elevated temperature and early enteral feeding can also influence the hypermetabolic rate. However, early excision and coverage seem to be the most effective way to control the hypermetabolic response.

Dr Herndon described how a current study is examining hypermetabolic rate and the effect on patients with burns over 40 per cent TBSA of undergoing total excision within 24-48 hours. It aims to demonstrate how excision and coverage with a dermal regeneration template can improve control of metabolic rates to give a better outcome for patients with extensive burns.

INTEGRA Dermal Regeneration Template design and development

Yannas and Burke developed the concept for INTEGRA template in the 1970s, aiming to develop a device that provides the immediate closure achieved with a thick skin graft and which confers the functional benefits of non-fibrotic healing. Initial criteria were set out around physical properties, biological compatibility and fibrosis.

Dermal regeneration matrix

In a series of experiments in a guinea pig model, the investigators examined scar and contracture control using biological material that could be implanted and had controllable degradation rates.

Collagen was chosen for its long clinical history, the availability of the highly purified raw material and because cross-linking can control the rate of degradation. It can also be processed to remove prions.

Highly cross-linked collagen alone allows cells to integrate and degrade the matrix, but is extremely inflammatory. The addition of specific glycosaminoglycans increases resistance to degradation, improves elasticity and has a higher energy to fracture, although it should be noted that not all collagen-glycosaminoglycan copolymers act as a contraction control agent.

The INTEGRA matrix uses ‘biocompatible’ cross-linked collagen/glycosaminoglycan (GAG) with specific biochemistry made up of bovine collagen type I from tendon and the glycosaminoglycan chondroitin-6-sulfate. It suppresses inflammation by inhibiting the collagen-induced platelet aggregation driving the production of cytokines that are implicated in the inflammatory wound healing process and the formation of granulation tissue.

Collagen-glycosaminoglycan also has a significantly more open pore structure when freeze dried than collagen alone. This open porosity with controlled pore size and resorption rates permits dermal cellular ingrowth and remodelling without contraction and scarring.
Epidermal function on the scaffold was achieved via a second, silastic layer of a defined thickness to prevent excess moisture loss. This silicone layer also prevented the formation of granulation tissue on the surface of the matrix. The resultant bi-layer device – INTEGRA Dermal Regeneration Template – controlled contraction and fibrosis in vitro and in pre-clinical models.

**Inflammatory wound healing**

In the classic definition of inflammatory wound healing, there are four phases: coagulation, inflammation, fibroplasia and remodelling.

The coagulation stage is characterised by the aggregation and degranulation of platelets around naked collagen and fibrin clot. This causes the release of cytokines. The principal two for wound healing are platelet derived growth factor (PDGF) and transforming growth factor beta (TGF–β).

- **PDGF is often described as a growth factor although it has little mitogenic potential.** It acts by taking quiescent fibroblasts in tissue or in cell cultures and promotes their migration into an activated state in an open area, ready to respond to available mitogenic growth factors.

- **TGF–β is heavily implicated in fibrosis because it is a recruitment agent primarily for monocytes, but also more generally for inflammatory cells.** As TGF–β levels are increased, the number and types of cells that migrate into the area increases.

The presence of these cytokines creates an infiltrate of immune cells and triggers their inflammation and fibroblast infiltration, activation and proliferation. Fibroblasts are activated by TGF–β and also produce it via an autocrine mechanism. This cycle triggers further activation, which means there is a driver for TGF–β as the wave of activated fibroblasts responsible for the synthesis, deposition and remodelling of the new extracellular matrix enters the wound.

The final step is the induction of myofibroblasts, an activated fibroblast phenotype containing smooth muscle actin proteins. These myofibroblasts bundle random collagen fibres, cross-link them into large collagen bundles and, in conjunction with the actin inside the cells, bind to the extracellular matrix to create the tensile forces that drive wound contraction.

During this contraction process, waves of fibroblasts and capillary endothelial cells die, either due to nutritional or other factors affecting apoptosis. The outcome is scar tissue that is relatively acellular and avascular compared to skin and very high in collagen fibres.

It is difficult to have wound contraction without myofibroblasts. If myofibroblast activation and proliferation is tracked back, the cytokine cascade that is originally triggered by platelet degranulation is implicated.
Mechanism of INTEGRA Dermal Regeneration Template

INTEGRA template modulates the wound healing response to allow tissue regeneration. The phases of wound healing in this context are based on research into the biochemistry and histology by Stern and colleagues in the mid 1980s and the histological examination of INTEGRA matrix integration in patients undergoing reconstructive surgery by Moiemen and colleagues. The four distinct phases are similar to the inflammatory wound healing process. The key difference is the blocking of platelet aggregation by the glycosaminoglycan. This diminishes platelet degranulation and reduces cytokine levels and the inflammatory process and immune cell infiltration.

Normal response of platelets to naked collagen

When a wound is created naked collagen fibrils are present. Platelets recognise these fibrils and bind. Following aggregation and degranulation, cytokines are released, which are a principal driver in the inflammatory wound healing process.

Coating collagen with glycosaminoglycans can abolish the normal response of platelets to naked collagen, suppressing the process of inflammatory healing.

As a result the inflammatory phase of dermal regeneration is characterised by low levels of inflammatory cells and is diminished and shorter in time compared to the formation of granulation tissue.

Fibroblast migration and proliferation is controlled and cellular density and the number of cells and capillaries is more comparable to normal skin than the granulation tissue of classic inflammatory wound healing. In assays, the number of myofibroblasts is at least 10 times lower in the INTEGRA wound bed than in granulation tissue. (Ten-fold is the current limit of detection in assays.)

Assays also show that fibroblasts moving into the matrix begin to lay down proteins and collagen and build up an extracellular matrix. A few myofibroblasts move in and bind to this extracellular matrix in an attempt to bundle and contract, but their activity is limited to small pockets in each pore of the INTEGRA matrix. At the same time, the INTEGRA matrix, which is essentially non-contractible at this time, competes with the extracellular matrix for the myofibroblasts.

A current hypothesis under examination is that the specific glycosaminoglycans used in the INTEGRA template may also bind the growth factor TGF-β, which would suggest a biological effect in blunting the cascade that results in contraction.

At the remodelling stage contraction apoptosis is replaced by the creation of a loose connective tissue, known as ‘neodermis’, with an overlaid epidermal layer. It is a co-maturation phase where rete ridges and rete pegs are restored with a multi-layered epithelial layer.

From a histological perspective, with the exception of ancillary structures such as sweat and sebaceous glands and hair follicles, regenerated tissue resembles normal dermis.
When the INTEGRA template is compared to other inactive scaffolds with similar physical properties but a different biological composition, a distinct difference in cell migration and density and subsequent wound contracture is apparent. This confirms that the INTEGRA matrix composition modulates the cellular response.

INTEGRA template creates neodermis with significantly better tissue quality than the inactive scaffolds. The biosynthetic extracellular matrix allows tissue regeneration to predominate by blunting and blocking the inflammatory wound healing.

Phases of tissue regeneration with INTEGRA Dermal Regeneration Template
Courtesy of Ben Walthall PhD

Histology images
Courtesy of Naiem Moiemen FRCS

Tangential section of INTEGRA template and the inactive scaffolds. At day seven there is low cell infiltration in the INTEGRA template, while significant numbers of capillaries and cells and an inflammatory reaction are seen in the inactive scaffolds
Courtesy of Ben Walthall PhD

At day 21, the INTEGRA scaffold has moderate cell density and resembles an immature dermis; there is no granulation tissue. In the inactive scaffolds granulation tissue is clearly visible, in and underneath the matrix, demonstrating that an inflammatory reaction has taken place
Courtesy of Ben Walthall PhD
The science of dermal regeneration
Contributors: Ben Walthall PhD, Naiem Moiemen FRCS, David Herndon MD

Histological Evaluation

Mr Moiemen described a series of histological analysis undertaken since 1997. This work confirms the mechanism of INTEGRA template where four distinct phases of dermal regeneration similar to the phases of graft take can be observed. The outcome is neodermis formation with well-organised collagen and a well-anchored epidermal layer with defined rete ridges.

**Phase 1 – Imbibition**

Within minutes of the application of INTEGRA template to the wound bed, a microscopic examination shows the interstices filling with exudate containing red blood cells and platelets in a similar process to that which follows the application of a skin graft. The matrix is shown here with blood cells around the sides of the collagen of the matrix.

*Courtesy of Naiem Moiemen FRCS*

**Phase 2 – Migration**

Migration starts during the first week, by day three or four. The first cells to enter the matrix are fibroblasts. Under electron microscopy, a fibroblast (red arrow) can be seen using the matrix (black arrow) as a scaffold to move in, in preparation for the production of collagen later.

*Courtesy of Naiem Moiemen FRCS*

**Phase 3 – Neovascularisation**

At day 12 the first columns of cells are seen in the lower third of the matrix.

*Courtesy of Naiem Moiemen FRCS*

At day 28, the vascular channels have opened and there is lumen – required to supply blood and nutrients to the fibroblasts - within the endothelial clusters of cells. The capillaries have reached the surface of the scaffold. As a result of this finding the time for epidermal grafting was delayed and now takes place when there is evidence of neo-vascularisation and capillaries at the surface of the matrix.

*Courtesy of Naiem Moiemen FRCS*
In around 90 per cent of the cases examined there were no inflammatory cells in the matrix. Occasionally, investigators saw groups of multi-nucleated cells, but it was unusual and they hypothesised that it might be due to foreign bodies from the dressings or other external sources. One patient had a cluster of plasma cells and this patient complained of itching.

The end result, mature neodermis is not distinguishable from native dermis apart from the absence of skin appendages.

A few centres have undertaken work to examine the effect of seeding fibroblasts and epidermal cells – keratinocytes – into the INTEGRA matrix. Seeding of hair follicles into the matrix, as done by James D Frame, after neovascularisation is initiated may result in some epithelialisation, possibly from residual dermal cells around the follicle at the time of grafting, although experience in this field is currently very limited.

INTEGRA template seeded with both keratinocytes and fibroblasts seems to give the best results with regards to cell proliferation and the formation of a confluent epidermal layer on the surface

Courtesy of Naiem Moiemen FRCS
Summary of key points

- The inflammatory wound healing process interrupts the continuous process of regeneration in the normal dermis.

- Epidermal regeneration occurs from the edges of a wound, the dermis is not able to regenerate after injury.

- Many types of scaffolds can be constructed that will induce cell proliferation and tissue formation; not all will block the inflammatory response and allow tissue regeneration. The critical parameters for driving the quality of regeneration are:
  - Biochemistry
  - Degradation rate of the matrix
  - Pore size
  - Pore volume ratio.

- Early excision and coverage and a reduced inflammatory response has a role in reducing the post injury hypermetabolic rate that can affect patient progress well into rehabilitation.

- INTEGRA template uses biocompatible, cross-linked collagen/ glycosaminoglycan with specific biochemistry to block the inflammatory response.

- Epidermal function is achieved on the matrix via a second silastic layer of defined thickness.

- There are four distinct phases of regeneration with INTEGRA Dermal Regeneration Template, which are similar to the inflammatory wound healing process. The key difference is the blunting of the inflammatory cascade by the INTEGRA template.

- In neodermis regenerated with INTEGRA template, the cellular density and the number of cells and capillaries is more comparable to normal skin than the granulation tissue of classic inflammatory wound healing. From a histological perspective with the exception of ancillary structures such as sweat and sebaceous glands and hair follicles, it resembles normal dermis.
Indications and techniques for INTEGRA Dermal Regeneration Template

Contributors: Sigrid Blome-Eberwein MD, Eric Dantzer MD, Peter Dziewulski FRCS, Roger Huckfeldt MD, Jean-Michel Rives MD

During the symposium a variety of indications for INTEGRA Dermal Regeneration Template were presented, ranging from acute full thickness and partial thickness burns to scar reconstruction, non-burn trauma wounds, carcinoma and other surgically excised defects. Surgeons shared best practices for application and postoperative care.

Techniques

Excision

The surgical steps in preparing the wound bed for INTEGRA Dermal Regeneration Template follow the same basic principles as for autograft.

ACUTE CASES

In burns patients or others with extensive deep dermal injury, the hypermetabolic response can have a severe impact through hospitalisation and into rehabilitation. Complete and early excision and closure with INTEGRA template – ideally within four or five days of admission – confers long-term benefits:

- Lower potential for infection
- Blood loss is minimised
- Metabolic rate is reduced as the silicone sheet convinces the body that it has a closed wound

It is critical to obtain a viable wound bed removing all eschar to the level of living tissue. Well vascularised fat, fascia, muscle and bone with periosteum are all suitable wound beds. Cases have been reported where coverage of small areas of bone without periosteum was achieved with INTEGRA template. It can also be grafted on to tangentially excised deep partial thickness burns.

Generally, INTEGRA Dermal Regeneration Template is applied immediately after excision to the viable wound bed. In some cases, particularly in extensive burns and unclean wound beds, it may be advisable to use a temporary covering after excision for 24-72 hours before applying the INTEGRA template in a second procedure. This technique may help to ensure that a viable wound bed with good haemostasis is achieved.

Mr Dziewulski reported on a retrospective review over a two-year period at St Andrews, Chelmsford, UK on the timing of excision and application of INTEGRA template.

Patients with a mean age of 18 (one-60 years) and mean total body surface area burned (TSBA) of 46 per cent (10-88 per cent) underwent early excision, which was usually within 24 hours of admission and 48 hours of injury. In six patients INTEGRA template was applied immediately after excision and in six, application was delayed and the wound closed temporarily with allograft or Biobrane before INTEGRA template was applied 48-72 hours later.

In those patients with burns over 40 per cent TBSA, first and second stage outcomes were much better in the delayed application group, with around 90 per cent take. It is thought that this may be in part because delay permits better control of haemostasis and allows oedema to settle, improving INTEGRA template take. It was also noted that inpatient stays per percentage of TBSA burned were all lower in the group undergoing delayed application.

At this centre, immediate wound excision within 24 hours followed by delayed application of INTEGRA template is now a standard treatment for patients with extensive burns.

RECONSTRUCTIVE SURGERY

In scar reconstruction, full release of the entire scar must be achieved for a satisfactory aesthetic and functional outcome. Aggressive incision and excision of the whole scar may be required. For example in the neck, it may be necessary to remove rather than release the platysma muscle to ensure that there is no recurrence of the contracture.
Indications and techniques for INTEGRA Dermal Regeneration Template

Contributors: Sigrid Blome-Eberwein MD, Eric Dantzer MD, Peter Dziewulski FRCS, Roger Huckfeldt MD, Jean-Michel Rives MD

Haemostasis

Complete haemostasis must be achieved to ensure a dry wound bed before INTEGRA template is applied.

Prevention of Infection

Pre-procedure

In acute cases monitoring and controlling the bacteriological status of the wound bed prior to application of INTEGRA template is advisable.

Stage one – post INTEGRA template application

To control cross colonisation and infection an antimicrobial barrier should be created over and around the INTEGRA template. Dressings containing povidone iodine cream or a silver release dressing such as Acticoat are widely used.

INTEGRA template edges and joins are particularly vulnerable to infection. If they abut non-viable tissue, a barrier should be created using, for example, allograft or a silver release dressing.

Microbial status should be assessed regularly from week one to four.

Stage two – epidermal grafting

Care to avoid cross colonisation is the same as for a split thickness skin graft and it may be useful to take further swabs to identify the wound bed colonisation cartography prior to grafting.

Application of INTEGRA template

INTEGRA template should be shaped to fit the wound. It is important that the INTEGRA sheet maintains intimate contact with the wound bed, avoiding wrinkles and gaps, and is protected from shearing forces or mechanical dislodgement. It should be applied in sections as large as possible to minimise the number of seams, even in areas such as the face where smaller aesthetic units may be considered an option.

Staples or monofilament sutures should be used to fix the template, with quilting in difficult anatomical areas.

Dr Rives reported that in acute cases, for two days prior to application he takes biopsies of the areas where INTEGRA template will be used to tailor the antimicrobial approach. After excision swabs are taken from the wound bed and for final asepsis prior to the application of INTEGRA template, he routinely applies wet gauzes soaked in saline solution with Betadine® (povidone iodine) for 10 minutes. In a similar protocol described by Dr Blome-Eberwein the wound bed is rinsed with iodine solution then saline, prior to the application of INTEGRA template.

At the Hyères Burn Centre, France, Dr Dantzer reported that no antimicrobials are used unless there are complications with infection. First line dressings are sterile gauze and bandages and the site is monitored every two days using microbial swabs, with silver release dressing used in the case of complications. However, this approach is the exception and success is likely to relate to environmental circumstances as well as a strict care regime.
Stacking

There is some experience of stacking INTEGRA template over tendons or in areas that need added protection due to deep tissue loss. In some centres the silicone is removed from the template and it is stacked at one procedure. Other centres were reported to stack sequentially, applying one layer of INTEGRA template and awaiting revascularisation before peeling back the silicone and applying a further layer, until the required depth is achieved prior to grafting.

Roger Huckfeldt described the effective use of up to five layers of INTEGRA template in one procedure, peeling off the silicone and layering the sheets. As with INTEGRA template applied in single layers, revascularisation is indicated by colour change but when stacking it usually takes longer. On average, an additional week should be allowed for two layers, although revascularisation may take place more quickly in children.

Dressings

To enhance fixation an elastic net dressing should be applied under tension over the INTEGRA template area. Where appropriate, tie-over bolster dressings ensure uniform pressure and reduce the risk of mechanical dislodgement or silicone separation.

As discussed above, an antimicrobial layer is recommended to isolate the treated area and prevent infection. Silver release dressings, povidone iodine and other agents are used for this purpose.

Dr Blome-Eberwein reported on the use of a vacuum therapy device over INTEGRA template to facilitate its immobilisation and integration with the wound bed. It has proven effective in improving drainage of fluid at the edges of the wound bed. Bulky secondary dressings or a splint should be used for immobilisation, to protect INTEGRA template from shearing forces and secure the template to promote neovascularisation.
Indications and techniques for INTEGRA Dermal Regeneration Template

Contributors: Sigrid Blome-Eberwein MD, Eric Dantzer MD, Peter Dziewulski FRCS, Roger Huckfeldt MD, Jean-Michel Rives MD

Dressing change protocols

While protocols in different centres vary, particularly in acute cases, an early first dressing change on postoperative day one is advisable to ensure there is no infection or haematoma underneath the INTEGRA template. Care with the dressing change is critical to avoid complications and it must be under the regimented and direct control of the surgeon.

Where the INTEGRA template is stable and bacteriological control is achieved, dressing change intervals can be increased over the course of the treatment until the neodermis has formed.

Potential complications include infection, fluid collection, haematoma and silicone separation.

The INTEGRA template must be monitored carefully for these during dressing changes and they must be treated appropriately to ensure a successful outcome.

Managing complications

Haematoma

If a haematoma occurs it should be evacuated and the area irrigated via an incision in the silicone before re-stapling the INTEGRA template. Where necessary with a large and persistent haematoma, a section can be cut from the INTEGRA template and replaced with a new sheet after the wound has been washed and haemostasis achieved.

A haematoma in the template
Courtesy of Jean-Michel Rives, MD

Infection

Areas of infection may result in loss of the neodermis and granulation tissue formation, which will lead to scarring if the infection is not controlled.

If pus or unclear liquid is observed under the silicone it should be opened immediately and swabs of the exudate taken and cultured. The area should be washed meticulously with an antiseptic. Following application of antimicrobial dressings the area should be carefully monitored.

At each dressing change, swabs should be taken to monitor colonisation, the edges of the INTEGRA template should be carefully cleaned using an antimicrobial such as povidone iodine solution or chlorhexidine, and the antimicrobial barriers should be replaced.

Where INTEGRA template is used on the face, secretions from the mouth and nose, particularly in intubated patients, should be closely monitored as they may cause failure. In the event of a build up of fluid, the area should be controlled with daily rinsing using an antiseptic such as povidone iodine.

Silicone separation

Where there is mechanical dislodgement without infection, it may be possible to reattach the silicone. In the later stages, silicone separation is likely to be an indicator of maturation of the neodermis.

Where the silicone is lost due to infection or shear, neodermis remaining underneath may be cleaned and protective coverage achieved with allograft until full revascularisation is achieved and epidermal grafting can take place.
Indications and techniques for INTEGRA Dermal Regeneration Template

Contributors: Sigrid Blome-Eberwein MD, Eric Dantzer MD, Peter Dziewulski FRCS, Roger Huckfeldt MD, Jean-Michel Rives MD

Grafting – stage two

Revascularisation time varies according to the individual patient and is usually from around day 21 after application of INTEGRA template. It is indicated by colour changes from red to a peachy tone that blanches when pressure is applied. Revascularisation is more rapid in children than in adults. Where INTEGRA template is stacked, revascularisation is likely to take longer.

Once vascularisation is achieved, the silicone is removed. The neodermis should be brushed gently with a sterile brush to remove the dead surface cells, then rinsed with antiseptic and saline.

Graft thickness

It is important to ensure that the graft contains basal membrane to give proliferative cells and experience shows a good outcome with a graft of approximately 0.15mm/0.006 inch. This is slightly thicker than the ultra thin epidermal graft recommended in the early days of INTEGRA template use.

Meshing

It is possible to mesh the graft. A ratio up to 1:3 provides optimum results and there may be problems in achieving closure with wider ratios. The Meek technique can also be used.

When resurfacing for cosmetic reasons, it may be preferable to use a sheet graft rather than a mesh.

The grafting procedure is very similar to that using a conventional skin graft. Precautions must be taken to ensure correct colonisation control.

Use of cultured cells

Patient with deep full thickness burns over his entire body except the top of his scalp, a small portion of buttocks, the lower back and the tips of his fingers. INTEGRA template was used with CEAs applied early at three weeks. Five weeks later, there is almost 90 per cent take of the CEA over the INTEGRA template.

Cultured cells have been used in some cases to cover the neodermis. However CEAs are fragile and it is a challenge to achieve consistent take. Their use in combination with a widely meshed thin autograft (1:6) may improve outcomes.

Postoperative care and rehabilitation

It is important that the same postoperative care is taken with INTEGRA template as after a standard split or full thickness skin graft, including skin hydration and early physical therapy, which can make a significant difference in functional outcome.

Normal range of motion in reconstruction cases may be achieved as early as one to three months post procedure, according to the time that rehabilitation commenced and the intensity of the physiotherapy regime. Pressure garments and splints should be worn for between six to eight months after healing to achieve the best functional and cosmetic results.

Redness of the grafted skin should start to fade within six to eight months post procedure and may take up to 12 months.
Indications and techniques for INTEGRA Dermal Regeneration Template

Contributors: Sigrid Blome-Eberwein MD, Eric Dantzer MD, Peter Dziewulski FRCS, Roger Huckfeldt MD, Jean-Michel Rives MD

Summary of key points

- Use of INTEGRA template in acute burns is well established. More recently, it has been used in a variety of indications including reconstructive surgery, trauma and wounds.

- In acute cases, early excision and closure with INTEGRA template is recommended to:
  - Lower potential for infection
  - Minimise blood loss
  - Reduce the hypermetabolic response.

- Where INTEGRA template is to be used, it is critical to obtain a viable wound bed. This may be fat, fascia, muscle, periosteum or bone.

- In contracture release, aggressive incision and excision may be required to fully release contractures including deep planes.

- Complete haemostasis must be achieved to ensure a dry wound bed before INTEGRA template is applied.

- Generally INTEGRA template is applied immediately following excision. Some centres delay application of INTEGRA template using a temporary coverage for 24-72 hours after excision.

- It is recommended that there is an antimicrobial layer over the template, followed by elastic dressing to apply gentle, even pressure and tie-over bolsters where appropriate. Bulky secondary dressings or a splint should immobilise the area to secure the template further.

- The INTEGRA template should be monitored for complications – infection, haematoma, and fluid collection - from day one after application as swift action to overcome complications can prevent failure.

- Revascularisation times vary according to the patient and the wound, but on average is 21 days after application. It is often more rapid in children than in adults.

- For epidermal grafting the graft has to include basal membrane to provide proliferative cells. Experience suggests that around 0.15mm/ 0.006 inch is a good thickness.

- The epidermal graft may be meshed although ideally not higher than 1:3. For cosmetic resurfacing a sheet graft is preferred.

- The same postoperative care should be taken after INTEGRA template as with a standard skin graft, including skin hydration, early physical therapy and pressure garments and splints.

- Redness of the grafted skin should begin to fade within six to 12 months.
Opening up the possibilities – dermal regeneration as an enabling technology in reconstructive surgery

Contributors: Eric Dantzer MD, Peter Dziewulski FRCS, Bernd Hartmann MD, Juan-Carlos Lopez-Gutierrez MD, Stefanie Mählheuser MD, Naiem Moiemen FRCS, R Palao MD and P A Gómez MD

Experience with INTEGRA template in reconstructive surgery is increasing.

INTEGRA template produces good functional and aesthetic results and enables reconstruction of large surfaces. It can provide a useful supplement or alternative to flaps, tissue expanders and full thickness skin grafts, decreasing the severity of donor sites scars for the patient and is an enabling technology for a new approach to reconstruction.

It is used for the release of contractures and hypertrophic scars to achieve normal range of motion and for skin resurfacing to improve aesthetic outcomes. For range of motion, it also confers the advantage that there is no adherence to the deep planes.

Dr Rives presented cases that demonstrated how the outcomes for patients with scar contractures may be improved through its use. He and Dr Dantzer highlighted the necessity to achieve a full release of the contracture including contractures of the deeper planes to give optimum outcomes.

Results of a series of reconstructions in the burned female breast using INTEGRA template were submitted by Dr Palao and Dr Gomez, which demonstrated how it is possible to release the constriction with minimal donor site morbidity.

Dr Lopez-Gutierrez described the differences in the way that reconstruction cases were treated before and after INTEGRA template was available. He and Dr Mählheuser both presented experiences in the hands, feet and legs.

Mr Dziewulski and Dr Hartmann demonstrated how it is possible to restore functionality using INTEGRA template. Mr Moiemen presented a series of reconstructive cases in post-burn scar contractures, tight and painful scars. He described how his approach has changed more recently as experience with INTEGRA template has increased to undertaking more extensive resurfacing.

There was also discussion about the way in which patients undergoing reconstruction can be treated as outpatients between the two stages of the procedure, where the surgeon and team have sufficient experience with the template.

Reconstruction in neck and face

Releases of neck contractures are challenging. During his presentation, Dr Rives highlighted a number of technical aspects important in achieving a successful outcome with INTEGRA template. The scar has to be completely released, including the deep planes. The platysma muscle must be cut and released or completely removed. It seems advisable to allow four weeks for neodermis formation to ensure good graft take and it is essential to use bulky tie over dressings with an antimicrobial layer to prevent shear and infection. Postoperative care must include physiotherapy, pressure and moisturising of the skin.
Opening up the possibilities – dermal regeneration as an enabling technology in reconstructive surgery

Contributors: Eric Dantzer MD, Peter Dziewulski FRCS, Bernd Hartmann MD, Juan-Carlos Lopez-Gutierrez MD, Stefanie Mărţheuser MD, Nailem Moiemen FRCS, R Palao MD and P A Gómez MD, Jean-Michel Rives MD

CASE 1a

Courtesy of Jean-Michel Rives MD

Male patient with scar contracture on the neck.

Treatment
The vertical portion of the neck was released and resurfaced with INTEGRA template.

Outcome
Following a successful outcome the patient returned to have the horizontal portion resurfaced as well.
Opening up the possibilities – dermal regeneration as an enabling technology in reconstructive surgery

Contributors: Eric Dantzer MD, Peter Dziewulski FRCS, Bernd Hartmann MD, Juan-Carlos Lopez-Gutierrez MD, Stefanie Märzheuser MD, Naim Moiemen FRCS, R Palao MD and P A Gómez MD

CASE 1b

Courtesy of Jean-Michel Rives MD

A female patient who had undergone several procedures to release the contracture caused by a burn scar, but still had a pull on the lateral part of the mouth.

Treatment

Aggressive excision was used to release the scar and the platysma muscle to ensure that the contracture did not recur. INTEGRA template was applied. A small triangle became infected and was treated until revascularisation was achieved. On removal of the silicone, the neodermis in this area was not usable. It was sectioned and the graft was applied directly over the wound bed in this area.

Outcome

Aside from a small area of shrinkage where there was no dermis under the graft, the contracture release has been successful with good skin quality.
Opening up the possibilities – dermal regeneration as an enabling technology in reconstructive surgery

Contributors: Eric Dantzer MD, Peter Dziewulski FRCS, Bernd Hartmann MD, Juan-Carlos Lopez-Gutierrez MD, Stefanie Mährleuser MD, Naiem Moiemen FRCS, R Palao MD and P A Gómez MD, Jean-Michel Rives MD

CASE 1c

Courtesy of Jean-Michel Rives MD

Female patient with visible mesh after healing of 1:2 mesh used at the acute stage of burn treatment and a slight vertical neck contracture. She requested an improved cosmetic outcome.

Treatment

The entire scar area was resurfaced and the neck contracture was released by incision of the platysma muscle before INTEGRA template was applied. After removing the silicone, there was an excellent neodermal bed and two large strips of non-meshed skin were grafted to achieve coverage of the defect.

Outcome

Good skin quality, no hypertrophic scarring, and nice neck contour without any shrinkage. As frequently occurs, there was redness for the first few months, which disappeared between six to eight months after the procedure.
Reconstruction in the burned breast

**CASE 2a**

**Courtesy of R Palao MD and P A Gómez MD**

The reconstruction of burn scars on the female breast is necessary to allow unrestricted breast development. Traditional treatment methods involve contracture release through incision and excision followed by split thickness skin grafting. Other techniques such as flaps and tissue expansion may also be used.

Work by Dr Palao and Dr Gómez shows that INTEGRA template offers a new technique for these patients.

**Treatment**

Over a 28-month period 12 female patients aged between 12 and 27 years with burn scars in the thoracic wall that affected one or both breasts underwent reconstructive surgery.

Patients were discharged after an average of 5.5 days after each stage of surgery and treatment under an outpatient protocol.

**Outcome**

Follow-up of up to 30 months showed that results are maintained over time with absent or minimal retraction. The appearance according to the Vancouver scar scale shows good or excellent results in pliability, height and vascularity, and fair in pigmentation. Patient satisfaction is high.

The quality of the new scar is more similar to original breast skin than with other techniques and there is low morbidity to the donor site.

Breast reconstruction patient  Patient being prepared for release of the contracture  Excision of the scar until the breast recovers its original volume and shape  Tissue defect covered with INTEGRA template  14 months follow-up shows good contour restoration
Opening up the possibilities – dermal regeneration as an enabling technology in reconstructive surgery

Contributors: Eric Dantzer MD, Peter Dziewulski FRCS, Bernd Hartmann MD, Juan-Carlos Lopez-Gutierrez MD, Stefanie Märzheuser MD, Naiem Moiemen FRCS, R Palao MD and P A Gómez MD, Jean-Michel Rives MD

CASE 2b

Courtesy of R Palao MD and P A Gómez MD

Scar contracture

Semi-lateral view shows how breast development is impaired

Six months after the procedure the breast is able to develop

The breast is able to develop

Example of a donor site for the thin epidermal graft at six months – there is hardly any scarring
Reconstruction in the hands and lower extremities

Dr Dantzer presented a case series where INTEGRA template was used in reconstructive surgery on the hands.

**CASE 3a**

**Courtesy of Eric Dantzer MD**

Patient with bilateral scars on the hands and forearms that were resurfaced with INTEGRA template.

**Treatment**

Dr Dantzer emphasised the need for full scar release, including the deep planes, until full range of motion is achieved intra-operatively.

**Outcome**

INTEGRA template can improve the final functional outcome by providing skin suppleness and elasticity and avoiding adherence to the deep planes.

Splinting and physiotherapy are important factors in post-operative care in these patients.
Opening up the possibilities – dermal regeneration as an enabling technology in reconstructive surgery

Contributors: Eric Dantzer MD, Peter Dziewulski FRCS, Bernd Hartmann MD, Juan-Carlos Lopez-Gutierrez MD, Stefanie Mährheuser MD, Naimen Molemen FRCS, R Palaio MD and P A Gómez MD, Jean-Michel Rives MD

CASE 3b

Courtesy of Eric Dantzer MD

53-year-old male patient treated 12 months after a burn had left deep palmar scarring on both hands resulting in thumb adduction and extended fingers.

Treatment

The first hand was treated conventionally with incision of the scar and application of full thickness skin graft. The other hand was treated later, when INTEGRA template was available, by resurfacing the scar with INTEGRA template and a thin split thickness graft.

Outcome

Hypertrophic scarring reoccurred on the right hand but not on the left hand where INTEGRA template was used. The skin on the right hand also showed normal pliancy without adherence to the deep planes.
Opening up the possibilities – dermal regeneration as an enabling technology in reconstructive surgery

Contributors: Eric Dantzer MD, Peter Dziewulski FRCS, Bernd Hartmann MD, Juan-Carlos Lopez-Gutierrez MD, Stefanie Märzheuser MD, Naim Moiemen FRCS, R Palao MD and P A Gómez MD, Jean-Michel Rives MD

CASE 3c

Courtesy of Dr S Märzheuser

An 11 year-old girl who was transferred to the centre after a 30 per cent scald burn healed with severe hypertrophic scarring to the forearm and restricted joint movement.

Treatment
The hypertrophic scar was fully excised and INTEGRA template applied prior to grafting.

Outcome
The skin is smooth, joint movement is absolutely free and there is a nice cosmetic outcome.

CASE 3d

Courtesy of Juan-Carlos Lopez-Gutierrez MD

A deep dermal contraction of the forearm, wrist and hand.

Treatment
This is a preferred indication for excision and application of INTEGRA template with the postoperative care performed on an out-patient basis.

Outcome
A good functional and cosmetic result.
Opening up the possibilities – dermal regeneration as an enabling technology in reconstructive surgery

Contributors: Eric Dantzer MD, Peter Dziewulski FRCS, Bernd Hartmann MD, Juan-Carlos Lopez-Gutierrez MD, Stefanie Mährheuser MD, Naiem Moiemen FRCS, R Palao MD and P A Gómez MD, Jean-Michel Rives MD

CASE 3e
Courtesy of Juan-Carlos Lopez-Gutierrez MD

Giant congenital naevi have been traditionally excised using tissue expanders and skin grafts. More recently INTEGRA template has been successfully used in this indication. Use of dermal regeneration procedures allows a more even outcome than is achieved with other procedures.

Reconstruction to restore functionality

CASE 4a
Courtesy of Peter Dziewulski FRCS

Female patient requiring extensive axillary release.

Treatment
This was resurfaced with INTEGRA template and at the second stage the neodermis has contoured right up into the muscles in the apex of the axilla.

Outcome
Very good functional result.
CASE 4b

Courtesy of Bernd Hartmann MD

28-year-old male with limited range of motion in his back due to a scald burn of the dorsal trunk received over 25 years ago.

**Treatment**

Due to the size of the scar, the release was carried out in two stages. The first and most significant release was done first and when a good result was obtained it was agreed to undertake the second procedure. There was incision and some excision to remove and release the scar and INTEGRA template was used at both stages with good revascularisation and no infection. Povidone iodine was used as a barrier at the edges of the dressing and tie-over pressure bandages applied. After revascularisation of the dermis a 1:3 meshed split thickness skin graft was applied.

**Outcome**

Very elastic neodermis where the scar was removed and good range of motion for the back.
CASE 4c

Courtesy of Naiem Moiemen FRCS

A 12-year-old boy with scarring following previous resurfacing of extensive deep dermal burns as an infant. Areas of skin graft had shrunk, as had a previous attempt to release a contracture in the stomach area. He had restricted range of motion in the shoulder.

Treatment
Prior to INTEGRA template no technique was available that would have been suitable to release the contractures, given that previous resurfacing had resulted in remaining areas of contracture. The entire area was excised and resurfaced with INTEGRA template.

Outcome
Despite poor compliance due to his age, the result was reasonable.
Reconstruction to resolve painful scars

**CASE 5a**

**Courtesy of Naiem Moiemen FRCS**

13 year-old male patient whose previous multiple releases were effective, but had left the patient suffering localised pain at the elbow.

**Treatment**

It was believed that the pain could be due to nerves in the scar tissue and the patient agreed to a full excision and resurfacing using INTEGRA template. This is one of the first patients where overlapping of the INTEGRA template was used to achieve a blend with normal skin at the wound edge.

**Outcome**

Two months later the full range of movement is identical and the pain has resolved.

Patient had localised pain in the region of previous scar releases at the elbow

Post procedure there was no loss of range of movement and the pain was resolved. The INTEGRA template was overlapped to blend the margins of the wound with the surrounding skin. This picture shows the early result after two months.
Opening up the possibilities – dermal regeneration as an enabling technology in reconstructive surgery

Contributors: Eric Dantzer MD, Peter Dziewulski FRCS, Bernd Hartmann MD, Juan-Carlos Lopez-Gutierrez MD, Stefanie Mährheuser MD, Naiem Moiemen FRCS, R Palao MD and P A Gómez MD, Jean-Michel Rives MD

CASE 5b

Courtesy of Naiem Moiemen FRCS

A 27 year-old male who had undergone excision of the groin area, lower abdomen and the left upper thigh with skin grafts directly onto muscle and the femoral vein as a result of necrotising fasciitis three years earlier. The patient had many neuromas.

Treatment

The large neuromas were excised, but the smaller ones were not traceable and the patient agreed to a full excision of the affected area and the use of INTEGRA template for resurfacing.

Outcome

There was no recurrence of pain and the patient was so satisfied with the cosmetic outcome that he has requested resurfacing of the upper thigh area with INTEGRA template.

The groin, lower abdomen and thigh three years after a necrotising fasciitis and reconstruction with a conventional skin graft

After excision and resurfacing of the groin area with INTEGRA template there was no recurrence of pain and the patient has requested to have the remaining areas resurfaced as well
Summary of key points

- Reconstructive indications include contractures and hypertrophic scars, congenital dermal defects such as giant naevi, as well as painful scars and neuromas, flap donor sites and cancer excisions.

- INTEGRA template provides a useful supplement and alternative to flaps, tissue expanders and full thickness skin grafts in patients undergoing reconstructive surgery and decreases the severity of donor sites for the patient.

- This enables resurfacing of large areas and opens up treatment options for extensively scarred patients.

- There is no adherence of INTEGRA template to the deep planes and good range of motion can be achieved.

- Full release of the contracture including deep planes is necessary to prevent recurrence. This includes excision of scar tissue and in neck reconstruction consideration of the platysma muscle is critical – either releasing or removing it.

- Donor site morbidity is lower when INTEGRA template is used in reconstruction.

- After resurfacing, redness frequently occurs for the first few months, but this should disappear within six to eight months and up to one year after the procedure.
Use of INTEGRA template in acute burns is well established since 1981.

During the symposium surgeons reported on how the use of INTEGRA template improves burn patient treatment beyond achieving immediate wound closure. Dermal regeneration improves long-term functional and cosmetic outcomes particularly when being used in difficult anatomic areas such as the face, hands and joints.

Key issues in the treatment of extensive deep dermal burns are resuscitation, surgical excision and the need for skin coverage where the donor sites are often small. Dr Rives described how INTEGRA template has changed his practice.

Dr Huckfeldt highlighted the usefulness of INTEGRA template in paediatric burns to improve cosmetic and functional outcomes and, in particular, short-term benefits conferred in the reduction of the hypermetabolic response and infection rates, resulting in earlier recovery and rehabilitation of the patient. He also showed cases where INTEGRA template was used over tangentially excised deep dermal burns and epithelialised spontaneously without scarring or functional impairment.

Mr Moiemen talked about experience of acute burns in the feet, where INTEGRA template was used directly over tendons, Dr van Brussel presented work undertaken with a colleague – Dr Massage – treating facial and neck burns and Dr Dantzer reported on the use of INTEGRA template in burns of the hand.

Where epidermal coverage after extensive injury promotes life, regenerating the dermis provides quality of life.
Paediatric burns

**CASE 6a**

*Courtesy of Jean-Michel Rives MD*

A young boy with 70 per cent full thickness burns on the neck, trunk and left arm.

**Treatment**

After excision, conventional grafting technique was used for the face and INTEGRA template was applied on the neck and trunk and arm. There was insufficient skin for grafting the neodermis and while the upper trunk was grafted non-meshed, the main part of the trunk was meshed 1:3 and 1:4 and Meek technique was used on the lower trunk.

**Outcome**

There was good healing in all INTEGRA template areas with little visible difference between non-mesh and meshed epidermal grafts. The functional result is also good and there is no hypertrophic scarring or contraction and good suppleness and pliability in the reconstructed skin.

Compared with the excellent result using INTEGRA template on the neck, the conventional technique used on the face led to hypertrophic scarring in this area.

Several months post procedure and the cosmetic and functional results are good considering the extent of the patient’s burns. There is no contraction and good pliability of the skin.

Young boy with 70 per cent full thickness burns to the neck, trunk and left arm.
Dermal regeneration – more than just wound closure in acute cases
Contributors: Eric Dantzer MD, Roger Huckfeldt MD, Naiem Moiemen FRCS
Jean-Michel Rives MD, Michel van Brussel MD

CASE 6b
Courtesy of Jean-Michel Rives MD

36-month-old girl with extremely deep burns of the lower limbs, abdomen and the hands.

Treatment
Her feet could not be saved and required amputation. INTEGRA template was applied on all areas and after revascularisation, the limbs and abdomen were grafted with 1:3 meshed skin and non-meshed skin was used on the hands.

Outcome
The reconstructed skin is of good quality and strong enough to enable the girl to walk with prosthesis.

Extremely deep burns to the lower limbs, abdomen and the hands
Prior to grafting - a good wound bed has been achieved with the INTEGRA template
After several weeks
Several months later after rehabilitation and the girl is walking with prosthesis
Dermal regeneration – more than just wound closure in acute cases
Contributors: Eric Dantzer MD, Roger Huckfeldt MD, Naiem Moiemen FRCS
Jean-Michel Rives MD, Michel van Brussel MD

CASE 6c
Courtesy of Roger Huckfeldt MD

A 12-year-old boy who sustained full thickness burns to both legs due to a gasoline fire and also had very deep partial thickness burns extending from his hands to his elbows. Deep dermal burns scar as severely or more severely than full thickness burns, which has resulted in a change of practice and early use of INTEGRA template.

Treatment
The patient was excised two days post burn and INTEGRA template applied to the arms and legs.

Outcome
INTEGRA template take was good. On the forearms, where there were partial thickness burns, the silicone peeled off after seven days and the wounds had healed underneath without skin grafting. On the legs wound closure was achieved with a thin graft over the neodermis. Six months later this patient will have little scarring and no change in function.

![Full thickness burns to both legs](image1)
![Deep partial thickness burns from the hands to the elbows](image2)
![Seven days after INTEGRA template was applied, the wound has healed under the silicone](image3)

![Legs at the patient’s first follow-up after grafting over the INTEGRA template](image4)
Dermal regeneration – more than just wound closure in acute cases

Contributors: Eric Dantzer MD, Roger Huckfeldt MD, Naiem Moiven FRCS, Jean-Michel Rives MD, Michel van Brussel MD

CASE 6d

Courtesy of Roger Huckfeldt MD

A 12 year-old boy who sustained extensive burns to the lower extremities. He was admitted with deep escharotomies down to and including fascia that caused concern in terms of the potential for impaired function.

Treatment

The patient was excised and INTEGRA template applied. To fill the cavity created by the escharotomy and fasciotomy, INTEGRA template was layered by removing the silicone from the matrix and stacking several sheets with standard INTEGRA template on the surface. The knees were deep partial thickness burns that were tangentially excised to viable tissue and also covered with INTEGRA template.

Outcome

The area over the knee epithelialised spontaneously by day 11 with no functional impairment. Where INTEGRA template was stacked, the neodermis took four rather than three weeks to develop, but provided good depth of coverage in the cavities without deep dermal scarring. After 10 months the patient enjoys full function and range of motion and is able to play football at school.

Deep escharotomy to the legs. The knees have deep partial thickness burns and were excised back to vital tissue.

INTEGRA template day 11 — spontaneous epithelialisation on the knees. In the deep escharotomy cavities several layers of INTEGRA template were stacked.

At four weeks post INTEGRA template placement and after skin grafting.

Two months after skin grafting. Patient has full function and the escharotomy sites have been filled.
Burns in the hands and feet

**CASE 7a**

**Courtesy of Jean-Michel Rives MD**

A young boy with deep burns to the lower limbs.

**Treatment**

INTEGRA template was used on the feet and the toes.

**Outcome**

Post grafting, the skin is of good quality with no hypertrophic scarring and the boy was walking several months later. Importantly, he suffered very little scarring at the donor site.

![Deep burns to the lower limbs](image1)

![The foot and toes after INTEGRA template is applied](image2)

![Epidermal grafting](image3)

![After several months and the boy is now able to walk](image4)
Dermal regeneration – more than just wound closure in acute cases
Contributors: Eric Dantzer MD, Roger Huckfeldt MD, Naiem Moiemen FRCS
Jean-Michel Rives MD, Michel van Brussel MD

CASE 7b

Courtesy of Naiem Moiemen FRCS

A patient with acute burns to both feet.

Treatment
The instep of the left foot was shaved and a split thickness skin graft applied. The right foot required excision to tendon where skin graft does not take well. A silver release dressing was used after INTEGRA template was applied and so after a few days it was possible to release the patient until revascularisation was achieved.

Outcome
Complete closure was achieved and both grafts took well, although the patient has an ongoing need for good scar management.

Dr Dantzer has performed a series of acute hand burns covered with INTEGRA Dermal Regeneration Template. INTEGRA template is grafted immediately following excision and a thin epidermal graft is applied after neodermis is vascularised. Full range of motion is restored one to three months after surgery following physiotherapy, and functional and cosmetic results are considered superior compared to conventional techniques and are stable over time. Notable is the fact that there is no adherence of the regenerated dermis to the deep planes.
Dermal regeneration – more than just wound closure in acute cases
Contributors: Eric Dantzer MD, Roger Huckfeldt MD, Nailem Moiemen FRCS
Jean-Michel Rives MD, Michel van Brussel MD

CASE 7c
Courtesy of Eric Dantzer MD

A 41 year-old female patient with deep burns to the hand and forearm.

Treatment
Wound was debrided and INTEGRA template applied.

Outcome
Good function and skin quality.

CASE 7d
Courtesy of Eric Dantzer MD

A 54 year-old male patient with deep burns to the hand.

Treatment
INTEGRA template was applied and there was excellent revascularisation of the dermis. This was followed by grafting with a thin autograft.

Outcome
Good long term cosmetic and functional results were achieved.
Dermal regeneration – more than just wound closure in acute cases
Contributors: Eric Dantzer MD, Roger Huckfeldt MD, Naiem Moiemen FRCS, Jean-Michel Rives MD, Michel van Brussel MD

Facial burns

CASE 8a
Courtesy of Jean-Michel Rives MD

A young girl with full thickness burns to the face.

Treatment
Excision was required to varying depths leaving areas of fat and muscle, and periosteum on the forehead. A large sheet of INTEGRA template was applied on the right and left sides of the face with a classical split thickness skin graft used on the eyelids. There was a perfectly revascularised neodermis when removing the silicone layer three weeks later and where there were varying levels of excision on the cheek and forehead, it appears the same as the rest of the face.

Outcome
After grafting there was good healing and the skin is supple with no hypertrophic scarring or functional problems.

Full thickness facial burn
On the lower cheek excision is to fat, higher up on the cheekbone it is to muscle. On the forehead, only periosteum remains after excision
During revascularisation of the INTEGRA template, the colour changes from the red seen around the chin area to a peach tone as seen on the cheek, indicating good quality neodermis

Follow-up after six months
Three years - no hypertrophic scarring, good function, suppleness and restoration of the facial contours
Dermal regeneration – more than just wound closure in acute cases

Contributors: Eric Dantzer MD, Roger Huckfeldt MD, Naiem Moiemen FRCS
Jean-Michel Rives MD, Michel van Brussel MD

CASE 8b

Courtesy of Michel van Brussel MD, P Massage MD, Vincent Druez MD and Bert Vandenhoff MD

Male with full thickness burns to the neck and face after a fuel tank exploded.

Treatment

The platysma muscle was removed and Integra template applied after excision at day seven after injury. The template revascularised and was grafted with a split thickness graft at around day 21.

Outcome

The results are very good and the patient has returned to work.

CASE 8c

Courtesy of Michel van Brussel MD, P Massage MD, Vincent Druez MD and Bert Vandenhoff MD

A woman with 41 per cent burn including the face and neck.

Treatment

The patient was excised at day three after injury and Integra template was applied to the face and neck area where a good outcome was considered most important. It was grafted with a split thickness graft at day 21.

Outcome

Despite poor patient compliance quite a good result has been achieved. There is a remarkable difference in outcome compared to the arm and shoulder, which were treated conventionally. In retrospect, Integra template could also have been used on the arm and shoulder.
Dermal regeneration – more than just wound closure in acute cases
Contributors: Eric Dantzer MD, Roger Huckfeldt MD, Naiem Moiemen FRCS, Jean-Michel Rives MD, Michel van Brussel MD

CASE 8d
Courtesy of Michel van Brussel MD, P Massage MD, Vincent Druez MD and Bert Vandenhoff MD

Boy aged 17 years with 70 per cent burns due to a fire in a confined space.

Treatment
Tracheotomy and total excision were performed on day nine and INTEGRA template was applied. Many staples were used to create impenetrable borders to protect against infection, although on day three after application, there was a small pus collection under the INTEGRA template. It was opened, cleaned and rinsed with povidone iodine solution and restapled closed. After three weeks the face was grafted with an unmeshed split thickness skin graft of 0.008 inch – slightly thicker than usually recommended for INTEGRA template.

Outcome
Compared to the spontaneously healed regions as well as the regions not treated with INTEGRA template, there was less hypertrophic scarring when INTEGRA template was used.
Dermal regeneration – more than just wound closure in acute cases

Contributors: Eric Dantzer MD, Roger Huckfeldt MD, Naiem Moiemen FRCS, Jean-Michel Rives MD, Michel van Brussel MD

CASE 8e

Courtesy of Michel van Brussel MD, P Massage MD, Vincent Druez MD and Bert Vandenhoff MD

A 34 year-old female with 17 per cent burns, including to the face, after a failed suicide attempt.

Treatment

On day 10 after injury, INTEGRA template was applied on the face and hands. 21 days later, the patient was grafted. The eyes healed spontaneously and INTEGRA template was not used. A new pressure mask technique was used where the inner layer is a separate silicone gel enabling the plastic of the mask to be heated and reformed to put pressure on desired areas as required.

Outcome

The patient has a particularly good result and her only complaint is the severity of a tracheotomy scar. Importantly, she has regained her will to live.

Patient on admission

After application of INTEGRA template

The graft used was perhaps a little thick, but this did not affect the final result. Unmeshed grafts with a 0.008 inch thickness were used. The eyes were not grafted as they were healing spontaneously by the time the INTEGRA template was applied at day 10.

Six months after treatment. The patient's only complaint is the tracheotomy scar
Summary of key points

- INTEGRA template can improve the surgical treatment of extensive burns and result in better cosmetic and functional outcomes.

- In facilitating early excision and coverage and reducing the inflammatory response, INTEGRA template has a role in reducing the post injury hypermetabolic rate that can affect patient progress well into rehabilitation.

- Excision must be down to viable tissue. While a uniform flat surface is preferable, if excision is performed to varying levels of fat, muscle or even periosteum, a uniform outcome can still be achieved using INTEGRA template.

- In burns, INTEGRA template can be used to cover any body surface area but should be used in functional areas at the very minimum and the face must be considered such an area.

- Used in the hands and feet, INTEGRA template covers tendons with no adherence and facilitates early physiotherapy and improved functional outcome.

- According to the level of experience of the team and the degree of injury, it is possible in some cases to allow patients to go home while the INTEGRA revascularises.

- Removal of the burned platysma muscle in neck injuries reduces the risk of deep contraction after healing.

- Comparing areas where the INTEGRA neodermis has formed well to areas using conventional grafting or unassisted healing in the same patient shows a markedly improved outcome with regards to scarring.

- Initial experience suggests that INTEGRA template can also be used on tangentially excised deep partial thickness burns to assist healing. These areas may epithelialise spontaneously under the silicone without need for second stage grafting.
The role of dermal regeneration in non-burn trauma

Contributors: Roger Huckfeldt MD, Juan-Carlos Lopez-Gutierrez MD, Stefanie Märzheuser MD, Naiem Moiemen FRCS

INTEGRA template has traditionally been used for burns, but experience is growing in other areas of use including extensive skin loss resulting from non-burn trauma. Speaking first, Dr Huckfeldt described the need for specialised coverage of a variety of surfaces in trauma patients and how not all patients are suitable for free- and pedicle flaps. Therefore INTEGRA template presents a valuable addition to the treatment armamentarium. He presented cases showing how INTEGRA template can be used to achieve neodermal growth over almost all structures, including synthetic mesh, vessel and nerve structures, bone and metal wires and in patients with high potential for infection.

Dr Lopez-Gutierrez highlighted how INTEGRA template improves outcomes in patients where previously there were extremely limited treatment options and discussed its use in outpatients, while Dr Märzheuser demonstrated successful outcomes in patients with non-burn trauma and extensive tissue loss. Finally, Mr Moiemen showed how INTEGRA template could be used effectively over a free fascia flap, where a flap would have provided a much bulkier outcome.

CASE 9a

Courtesy of Roger Huckfeldt MD

A 37-year-old woman presented to her primary care physician with localised trauma to the right axillae on a Friday and it was assumed to be a small strain. The following Tuesday she collapsed at home and after resuscitation was diagnosed with toxic shock syndrome, streptococcus at the site of the localised trauma, a vast necrotising fasciitis and myonecrosis.

Due to the fasciitis and myonecrosis, the patient was critically ill when treatment commenced in the intensive care unit on a ventilator at 100 per cent and receiving medication to control her blood pressure.

Treatment

The patient underwent multiple debridement daily until all non-viable tissue was excised and negative tissue cultures confirmed a clean wound bed. Skin, subcutaneous tissue, the right breast, significant chest wall musculature and the intercostal muscles to the right side of her chest were all removed, leaving an extensive area including exposed bone, vessels and nerve structures requiring coverage.

There was insufficient tissue to cover the vascular and nerve structures with a flap and there was concern that a free flap was not a reasonable option due to the significant tissue injury in the axilla. It was decided to cover the entire wound with INTEGRA template. Lung tissue attempting to herniate through the ribs was retained within the chest wall using Vicryl mesh and the dermal regeneration template was stacked in this area and over the vessels and nerve structure to give added protection in the absence of a flap. The ribs were burred to give good vascular supply for the INTEGRA template.

There was concern that the natural build up of pleural fluid might cause the INTEGRA template to lift, but at postoperative day three there was good take. Within four days of complete coverage the patient was able to come off the medication controlling her blood pressure and was being weaned off the ventilator. Long-term intensive care complications were minimised and it is believed that this is in part due to early coverage made possible with INTEGRA template.

At postoperative day 24 a small area of failed INTEGRA template was observed on the arm. Removal of this infected section and use of a silver release dressing prevented the colonisation spreading to adjacent areas of the neodermis.

At stage two, a split thickness skin graft of 0.006 inch was applied to the neodermis and directly to the area where the INTEGRA template was lost to avoid any delay in grafting on the remaining, revascularised template.

Outcome

Six months later, the patient was able to move the arm above her head, although a small area of the axilla may be treated to improve on the range of motion. In the next stage her chest wall and breast will be reconstructed.

...continued overleaf
CASE 9a  ...continued from previous page

Final debridement and preparation for INTEGRA template. There is exposed bone at the iliac crest and ribs, with total excision of the intercostal muscles in that area and lung attempting to herniate through. The vessels to the right arm and an area of the brachial plexus are also exposed.

Application of INTEGRA template which was stacked over the Vicryl mesh, vessels and nerve structures to give added protection.

After removal of the silicone layer, there is good revascularisation of the wound bed and coverage has been achieved over the previously exposed vessels, nerve structures and ribs.

Split thickness skin graft postoperative day 21

Full coverage with good mobility. There is a clear difference between the area where INTEGRA template took well and where STSG was applied in absence of a neodermis on the upper arm.
The role of dermal regeneration in non-burn trauma
Contributors: Roger Huckfeldt MD, Juan-Carlos Lopez-Gutierrez MD, Stefanie Märzheuser MD, Naiem Moiemen FRCS

CASE 9b

Courtesy of Roger Huckfeldt MD

A 45-year-old woman sustained an open fracture of the sternum with exposed vessels and heart, traumatic mastectomy and amputation of the right arm when she was run over by a hay mower. Resuscitation started in the pre-hospital setting and she was transported to the trauma centre by helicopter.

Treatment

The mediastinal injuries were repaired immediately and there was primary closure of the sternum and debridement of the remaining injuries. Several sternal wires were required to reconstruct the sternum and provide coverage over the heart and mediastinal structures and there was concern that this might impede neodermal growth. INTEGRA template was applied one day post trauma, after the patient was medicated in the intensive care unit, to stabilise a coagulation disorder and for rewarming. At day eight there was good revascularisation including the area over the wires and she was grafted at around three weeks.

Outcome

The patient has returned to work. A prosthesis was fitted for her arm and there have been no problems with erosion through the tissue at the amputation site. She will return for reconstruction of her breast.
The role of dermal regeneration in non-burn trauma

Contributors: Roger Huckfeldt MD, Juan-Carlos Lopez-Gutierrez MD, Stefanie Märzheuser MD, Naiem Moiemen FRCS

CASE 9c

Courtesy of Stefanie Märzheuser MD

A seven-year-old girl presented with a haematoma and contusion of the skin after a lorry hit her. Another centre had attempted primary closure of the wound and necrosis was developing when she was admitted five days after the accident.

Treatment

An attempt was made to save the contusion tissue, but by post trauma day nine it was necessary to excise the necrotic and infected tissue, including large bags of fluid in the margins of the wound. Coverage was achieved using INTEGRA template.

Outcome

Smooth skin and free joint movement. The skin is pliable, although there is hypertrophic scarring and a tendency to hyperkeratosis at the margins of lesions.
The role of dermal regeneration in non-burn trauma

Contributors: Roger Huckfeldt MD, Juan-Carlos Lopez-Gutierrez MD, Stefanie Märzheuser MD, Naiem Moiemen FRCS

CASE 9d

Courtesy of Stefanie Märzheuser MD

A five-year-old boy with a full thickness soft tissue wound to the head exposing bone, which had become infected before he was admitted to hospital.

Treatment

The infected and necrotic tissue was excised down to the skull leaving a large, temporal lesion measuring 11cm x 6cm and a smaller round lesion of 4cm in diameter at the occipital part of the head. INTEGRA template was applied and it was grafted after three weeks. There were problems achieving graft take and it was necessary to transplant twice.

Outcome

The margins of the lesions were hypertrophic and the skin had a tendency to ulceration, although this was more marked on the temporal wound. On the occipital part of the wound, the skin was smooth and pliable and there was no adherence to the skull. Over time healing and greater tissue strength was achieved.

Two infected lesions were excised to the bone before the application of INTEGRA template

Prior to the second epidermal graft

Closure is achieved, but there is hypertrophic scarring at the wound margins

In time, healing and greater tissue strength was achieved
The role of dermal regeneration in non-burn trauma
Contributors: Roger Huckfeldt MD, Juan-Carlos Lopez-Gutierrez MD
Stefanie Märzheuser MD, Naiem Moiemen FRCS

CASE 9e
Courtesy of Juan-Carlos Lopez-Gutierrez MD

A child with a Gustillo type III fracture with exposed, infected bone.

Treatment
Previously treatment for this type of injury would have entailed many surgical procedures, daily painful dressing changes and a long hospital stay. In this case aggressive debridement was performed and INTEGRA template applied directly onto the bone, which avoids additional risk to the patient associated with muscular flaps. Silver release dressings were used over the INTEGRA template and the patient was discharged home. The parents carried out daily dressing infusions to keep the dressing moist and weekly dressing changes took place at the hospital until revascularisation was achieved and the patient was readmitted for epidermal grafting.

Outcome
A good result was achieved after healing.
The role of dermal regeneration in non-burn trauma
Contributors: Roger Huckfeldt MD, Juan-Carlos Lopez-Gutierrez MD
Stefanie Märzheuser MD, Naiem Moiemen FRCS

CASE 9f
Courtesy of Juan-Carlos Lopez-Gutierrez MD

Patient with necrosis of the external aspect of the lower limb and exposed tibia and fibula.

Treatment
INTEGRA template was applied directly over bone and coverage was achieved.

Outcome
The patient is due to be grafted.

CASE 9g
Courtesy of Naiem Moiemen FRCS

A crush and friction burn of the ankle joint and lateral part of the foot with an open ankle joint.

Treatment
Reconstruction was achieved through a free fascia flap before INTEGRA template was applied.

Outcome
A good outcome was achieved with this combination, avoiding the bulky result of a conventional fascio-cutaneous flap.
Summary of key points

- INTEGRA template can be used in non-burn trauma cases and provides a method for rapid coverage that can support metabolic recovery and reduce long-term intensive care unit complications.

- There is a continuing role for free- and pedicle flaps, but these are not always suitable in trauma cases where there are many types of structures to be covered or a high risk of infection.

- Neodermal growth using INTEGRA template has been achieved over almost all structures, including Vicryl mesh, vessel and nerve structures, bowel, bone and metal wires.

- INTEGRA template does not appear to adhere to deeper planes, including bone, tendon or muscle resulting in smooth skin and free joint movement.

- Stacking INTEGRA template can provide additional protection where there is total loss of dermal tissue, over muscles, tendons, and vessel and nerve structures.

- INTEGRA template can be used effectively over a free fascial flap.

- INTEGRA template provides a durable surface, allowing for prosthesis to be used.

- Where the clinician is experienced, it is possible to discharge some patients after the application of INTEGRA template to await revascularisation. In these circumstances, an anti-infective layer and protective dressings have to be in place and patient and carer compliance are important. Weekly dressing changes take place at the hospital.
Many patients with persistent non-healing wounds are not suitable candidates for grafts and flaps or present with a history of free flap loss due to insufficient vasculature. Here INTEGRA template can have a role in the treatment armamentarium, as it seems to encourage closure to the point where a wound can be grafted with a thin split thickness skin graft. Importantly, there is nothing to lose by using INTEGRA template, avoiding flap or graft loss in the first stage when there is potential for a second non-healing wound at the donor site.

Dr Saxe described how the use of INTEGRA template in non-healing wounds convinces the body that there is a dermis and seems to convey benefits in the wound environment. He presented the results from a current study group treating 27 wounds in 25 patients. Wound types include necrotising fasciitis; trauma including exposed bone, infected wounds, venous stasis ulcers, pressure sores, chronic lower extremity wounds and excised tumours.

In 23 (85%) of the wounds, INTEGRA template take was greater than 80 per cent and failure only occurred in four. Some of the wounds could then be closed primarily by approximating the wound edges. 21 had thin split thickness skin grafts and of these 16 (76%) had a greater than 80 per cent take.

Mr Moiemen presented cases where INTEGRA template was used to achieve successful closure of a chronic leg ulcer of 15 years’ duration and a large non-healing wound after cancer surgery.

Dr Haas discussed work undertaken at Fachklinik für Amputationsmedizin Osterhofen, Germany, a specialist hospital for amputees, treating wound and trauma patients prior to and after amputation and into rehabilitation.

He described how many of the patients have compromised healing due to underlying aetiology such as diabetes and he confirmed that using INTEGRA template in certain patients has helped to bring wounds to full healing.

In particular, he highlighted the benefits of the added protection provided where dermal regeneration is achieved using INTEGRA template at an amputation site and that it is far more durable than skin grafts, which often break down in patients who are regularly using prosthesis.

**CASE 10a**

**Courtesy of Jonathan M Saxe MD**

Leg wound in a female patient with severe rheumatoid arthritis – autoimmune in origin – and impaired wound healing capability due to steroid treatment. She had already lost one leg due to an infected wound and a failed split thickness skin graft, suggesting that this would not be a good treatment option.

**Treatment**

In the first instance, there was nothing to lose by trying INTEGRA template and avoiding the creation of a second wound. The INTEGRA template took and a meshed graft was used at the second stage.

**Outcome**

Excellent healing was achieved and the lady was able to walk.

Reporting on cases of specific interest, Dr Haas described a male diabetic amputee with a persistent wound at the amputation site at the forefoot.

The wound was debrided and meshed INTEGRA template was applied and fixed with Dermabond. Bulky dressings and splints were used to off-load the foot and a meshed graft was applied subsequently. The outcome was full healing and the patient is ambulatory.
Dermal Regeneration Template in non-healing wounds – a new approach to wound treatment

Contributors: Fritz Haas MD, Naim Moiemen MD, Jonathan M Saxe MD

CASE 10b

Courtesy of Jonathan M Saxe MD

A male insulin-dependent diabetic presented with a suspected infected knee. It proved to be necrotising fasciitis affecting the whole leg and he suffered renal and respiratory failure, requiring ventilation for three weeks.

Treatment

The leg required full excision from the groin to the ankle. INTEGRA template was used to avoid creating a large donor site in a patient in a critical condition, and was applied two weeks after primary excision following debridement and cleaning of the wound. Three days after the INTEGRA template was applied the patient’s metabolic response decreased and he was able to come off ventilation.

Outcome

After healing, the leg is completely functional.

The acute wound after full thickness excision to the muscle from the groin to the ankle

INTEGRA template was applied to the entire wound two weeks later

After grafting with a mesh graft

The healed leg is fully functional. The knee was the only part of the leg where the skin was not lost and although the INTEGRA template was not stacked there is no step at the junction
CASE 10c

Courtesy of Naiem Moiemen FRCS

Chronic leg ulcer on the tibia of 15 years’ duration, with no infection.

Treatment
No changes to the bone were observed with X-ray and it was agreed to fully excise the ulcer and use INTEGRA template for resurfacing.

Outcome
Closure of the wound was achieved.

Chronic leg ulcer  Excision and resurfacing with INTEGRA template  Closure of the wound was achieved
CASE 10d

Courtesy of Naiem Moiemen FRCS

A male patient after an abdominal wall section for cancer of the colon that could not be fully resected and could not be closed. Primary closure was attempted twice but failed and the wound was open for six weeks. He could not be moved from the intensive care unit.

Treatment
The wound was washed and dressings changed daily until it was clean then INTEGRA template was applied directly over the bowel.

Outcome
Closure and healing was achieved and the patient was discharged and enjoyed good quality of life at home for the last few months of his life.

Abdominal section in a patient with cancer of the colon that could not be closed and was not healing
INTEGRA template was applied directly over the bowel
Despite the proximity to the colostomy site there were no complications and revascularisation was achieved within three weeks

The patient achieved full healing and enjoyed good quality of life at home for the last few months of his life
Summary of key points

- INTEGRA template is an addition to the treatment armamentarium for chronic wounds, especially for patients where conventional flaps or grafts are not an option.

- Use of INTEGRA template avoids the risk of creating a donor site wound in a patient at risk of impaired healing, the loss of the autologous transplant material and the resultant creation of another wound.

- Physiology in non-healing wounds is different to acute wounds. INTEGRA template seems to convince the body that there is a dermis, allowing healing to commence.

- Compared to skin grafts at amputation sites where prosthesis are used regularly, dermal regeneration provides greater protection and improved durability.
Discussion points

During the meeting there was the opportunity to question the presenters and for discussion around techniques and observations in the use of INTEGRA template. This section reports on some of the points raised and the arising discussion and answers.

Mechanism of INTEGRA template and histology

What is the role of the silicone layer?

In animal experiments using only the scaffold, there is regeneration within the INTEGRA template, but granulation occurs at the surface forming a scar.

If the mature neodermis is not grafted when the silicone is peeled after three or four weeks there will be granulation in the same way as with a naked wound – it is very important that it is kept covered to prevent scar tissue developing.

Why were rete ridges not seen at the dermal epidermal junction in early INTEGRA template work when they are now?

In the early days it was standard practice to graft with a very thin layer of epidermal cells. Now it is usual practice to take a thin graft that includes basal membrane and this may be an explanation.

Uses for INTEGRA Dermal Regeneration Template

Is scarring for a deep partial thickness burn frequently worse than with grafting for a full thickness burn and is this an indication for INTEGRA template?

Deep partial thickness burns heal spontaneously, but slowly and with scarring. If they are very deep, tangential excision and grafting may be advisable, particularly in functional or cosmetic areas. Dr Huckfeldt has used INTEGRA template at his centre over deep partial thickness burns and reports that after seven to 10 days the silicone peels back with an epidermal layer formed underneath and there seems to be a much better, rapid healing rate and functional recovery.

What is the theory behind using INTEGRA template in patients with non-healing wounds or underlying aetiology?

The main advantage is that most of these patients have a history of failed blooded skin transfers – flaps or grafts – that also leave the patient with a second wound. These patients often do not have the vasculature to support a flap, but INTEGRA template may take with microvasculature and provide a bed for a meshed graft. With INTEGRA template there is nothing to lose by trying.

In amputations why do you use INTEGRA template, is it that the skin is more durable for the prosthesis and has less blistering?

The skin does seem to be more durable with prosthesis after INTEGRA template is used as the regenerated dermis provides an additional protective layer.

Is it possible to define whether a wound is indicated for free flaps or INTEGRA template?

It is important to avoid generalisations, as treatment must be decided according to the patient circumstances. However, there was agreement that INTEGRA template may provide a treatment alternative for several indications where free flaps are done historically.

Is there any experience of treating patients of African origin with a tendency for hypertrophic or keloid scars where the results have been observed for more than one or two years?

Experience is varied, but it was highlighted that where cases are successful, staples used for fixation of the INTEGRA template must not be placed in the healthy skin surrounding the defect. It was suggested that this could be achieved by applying the staples in parallel in the inside of the wound margin or by overlapping the INTEGRA template around the edge of the wound by one or two millimetres.
How does INTEGRA template take over non-vascularised wound beds such as bone?

INTEGRA template is effective over bone or tendon and it is thought that fibroblasts are migrating from the edges of the wound where INTEGRA template is placed on viable structures, ‘bridging’ the avascular area. It takes longer to revascularise in these cases.

How do tendons take INTEGRA template and does it first adhere and later separate?

Functionally, the INTEGRA template glides very well when placed over tendons and all organs and it has also been used over the bowel with no adherence. It is not known how – histological studies would be required to show if there is a reorganisation of the cells around the tendon.

Excision

Should the burn be left intact on the posterior surfaces where INTEGRA template is not being used in this area?

The whole wound, including posterior surfaces should be excised as soon as possible to reduce the risk of infection. The most difficult areas – the buttocks and top of the thigh just below the buttock crease may be covered with allograft, autograft or a combination of the two if the surgeon decides not to use INTEGRA template in these areas.

If you delay application of INTEGRA template after excision in order to stabilise haemostasis and oedema, what is used to dress the wound?

This varies from centre to centre, but allograft or a temporary skin substitute such as Biobrane may be used.

How should burn tissue be debrided and how aggressive is it necessary to be if you have deep dermal and mixed partial burns in an area such as the face?

There is consensus that it is useful to aim to achieve the same plane on the same aesthetic area, but it is frequently difficult unless it is down to fat to determine if there is remaining dermis. There is less of an issue with different levels of excision because INTEGRA template covers both deep and partial burn areas.

I tend to use coagulation and diathermy devices to dissect tissue – is there any problem with this?

There was consensus that the tools used for excision do not affect the outcome. Care should be taken not to create necrosis in the wound bed by broad area cauterisation.

What should be incised/ excised in reconstruction cases?

For a contracture, it is important to fully release the scar including deep contractures.

Application of INTEGRA Dermal Regeneration Template

Why and how is INTEGRA template stacked?

INTEGRA template is being stacked to provide even surfaces or to confer added protection, for example over bone vessels or nerves. Dr Huckfeldt reported that in his centre up to five sheets are stacked, peeling off the silicone in lower areas and allowing longer – maybe four or five weeks – for revascularisation. Another centre awaits revascularisation of the single layer before removing the silicone and adding the next.

Patient Protocols

Can reconstruction patients be cared for under an outpatient protocol?

Yes, where the team has sufficient experience working with INTEGRA template, the patient can be allowed home between the first and second stages. Patient and carer compliance and use of appropriate dressings are critical in this case. After the initial few days, where there are no complications, they can come back for dressing changes as appropriate.
Discussion points

Vascularisation and epidermal grafting

Revascularisation with a standard graft will be seen by around day four, yet INTEGRA template does not start to vascularise until around day 12 – why is this?

There is consensus that a standard graft has the architecture to support early vascularisation, where INTEGRA template is a matrix and vessel structures have to regenerate from the wound bed.

There seems to be great variation in the times that people are grafting the revascularised neodermis - how is this?

The time to revascularisation depends on the type of wound, the patient and their circumstances. INTEGRA template is ready for epidermal grafting when the colour changes from deep red to a pink-peach tone that blanches when pressure is applied. However, there are cases where the silicone has been left for three months or more where there is insufficient epidermal graft available.

Why are results mixed using meshed epidermal graft over INTEGRA template – it seems it is possible to achieve good cosmetic results in some cases but not others?

Meshing the epidermal graft can be a good option, particularly for the resurfacing of large areas where there are insufficient donor sites. If the mesh pattern returns it is due to the dermal portion contained in the graft – it is a function of the dermis not the epidermis. With a thick skin graft the mesh is more visible, but with a thin skin graft even where it is meshed the differential with the dermis is not significant and tends to be less noticeable. Where donor sites are available and in cosmetic and functional areas INTEGRA neodermis can be covered with thin sheet grafts for best cosmetic results.

Postoperative care and dressings

Why use antiseptic dressings?

The use of antimicrobials avoids contamination from surrounding areas. It is important to monitor the INTEGRA template from day one after application, because it may still be possible to control any small area of infection by washing the area with an antimicrobial if necessary. If it is left too long the infection will spread and the INTEGRA template may be lost.

Should prophylactic antibiotics be given to patients undergoing reconstruction?

Practice varies according to the centre – some do, others believe that it is not necessary where good bacteriological protocols are followed.

What should be done if the silicone layer is lost due to infection or fluid?

The silicone may be reattached after the template is meticulously cleaned, but if it is lost, it is important to keep the matrix covered until it is ready for epidermal grafting to avoid granulation at the surface.

Should face masks and pressure garments be used in rehabilitation? Is physiotherapy necessary?

Yes, all the standard measures as for any skin graft should be used after the epidermal graft has healed.

Is there a problem with colour match after resurfacing?

There will be redness, but this should fade after between six to eight months and by one year.

How early should physiotherapy commence?

This depends on patient circumstances. INTEGRA template sites should be immobilised for several days post application. Some centres initiate careful range of motion therapy with the INTEGRA template in place, after day seven-to. Mechanical dislodgment must be avoided. Some centres immobilise for longer periods of time. There was consensus that even where physiotherapy is delayed and there is no mobilisation of the joints for three to four weeks, the pliability of the reconstructed skin with INTEGRA template shortens the duration of rehabilitation compared to conventional therapy.
Dermal Regeneration Improving Function and Cosmesis in Skin Grafting Experience and Best Practice

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