14 Observations on the quality of wound closure (A7)

Themes from the observations and interviews were grouped into three categories: i) making an incision, ii) wound closure and iii) extenuating factors that could influence wound healing. Findings from each category are summarised below.

1. **Making incisions**

Surgeons were clearly considerate of the impact of the initial incision on the ability to achieve good wound closure, and thus planned their approaches accordingly. They described several factors that they felt could affect wound healing: the choice of tool used to make the incision, the way in which the tool was used, and the length and width of the incision.

Choice and use of tools for wound closure

The observations demonstrated that most surgeons used a scalpel to make the initial skin incision followed by a cauterising tool (diathermy) to cut through the deeper layers. This was corroborated by interview data (13 of 17 interviewees). This contrasts with evidence from a systematic review of 14 RCTs, which found that incisions with diathermy were associated with reduced blood loss and pain. Justification for using a scalpel rather than diathermy included an opinion that cutting skin edges with diathermy may hinder skin healing by de-vascularising the area:

> ***S:*** *"...you need a clean vertical cut so that's why I think a knife is a good thing to use ... I personally have concerns about that (using diathermy) because if you burn the skin edges I don't think it will heal as well." (Consultant, Plastic Surgery)*

> ***S:*** *"Ideally an incision should be made with an appropriate blade. There's different sized blades depending on whether you're doing fine or a large laparotomy incision" (SpR, General Surgery)*

Many others felt that using diathermy to incise the skin might result in inadvertent damage by burning:

S: *"You want to go through just uh the first layer of the skin really with the knife and then I always swap straightaway after that to using the diathermy to use the Bovie which is the fine tipped monopolar and then use, use that to get through the other layers including the fat..." (SpR, General Surgery).*

All surgeons mentioned the importance of cutting the skin with the knife at 90 degrees, otherwise the size of dermis might differ either side of the incision, leading to de-vascularisation:

S: *" I think it's important to make sure your knife is at 90˚ to the skin so that you don't have an overhang of skin which isn't well vascularised on top." (SpR, General Surgery)*

Length and width of the wound

Cutting out (excising) or avoiding existing scars was deemed essential by some when making the initial incision, to improve the chances of having healthy-to-healthy skin edges at the point of wound closure, which in turn was thought to facilitate wound healing:

S: *"Previous scars, going across scars that have been previously made, excising tissue where you're not cutting through virgin skin - those are clearly factors that are gonna impact how nicely wounds heal" (SpR, General Surgery)*

By contrast, observations suggested that some surgeons incised directly through scar tissue. This may relate to the fact that some surgeons recognised that excision would present challenges at the point of wound closure. The excised skin edges were thought to subsequently require tighter pulling together, potentially resulting in a wound with tension:

S: *"it has to be tension free at the end of the procedure so if you're excising skin that's an issue" (Consultant, Plastic Surgery)*

Creating tension-free wounds at the point of closure was discussed in terms of planning the size or length of the incision:

S: *"I would rather make a longer incision and have relaxed wound edges when I'm retracting than have a smaller incision and put significant tension on the wound edges" (Consultant, Orthopaedics)*

2. Closing wounds

Aspects of wound closure that surgeons felt might impact upon wound healing were the choice of tools and materials and the techniques used for closing wounds.

Choice of tools and materials

Tools, such as forceps, were used to hold the skin edges while the surgeon sutured them together. Interviews and observations identified different preferences for 'toothed' and 'non-toothed' forceps amongst surgeons, based on the perceived degree of potential trauma to the skin (e.g. bruising):

S: *"using toothed forceps on the outside of the skin can cause it to be damaged and not heal particularly well." (SpR, General Surgery)*

S: *"I like to use tooth forceps...I know some people will think that you get less tissue damage with non-toothed forceps but I think you have to crush the skin to use this so I don't favour that." (Consultant, Plastic Surgery)*

Wound closure techniques

Various suturing techniques were cited as important for subsequent wound healing: suturing and knotting techniques, techniques to achieve 'good apposition', and closure of deep skin layers. These techniques were felt to minimise infection, devascularisation of the epidermis, and tension across the wound.

i) Suturing and knotting techniques

Using too much suture material for wound closure was considered by some surgeons to be a potential source of infection:

S: "*it can take a long time to re-absorb or could be a source for infection" (SpR, General Surgery)*

Surgeons related the importance of neat suturing, without visible or excess suture material, to achieving good wound closure. As part of closing the wound, the suture material is held in place at either end to maintain the tension in the stitching, or suturing. Surgeons often referred to using knots to achieve this and were mindful of 'burying' the knot well so that it did not surface to become a nidus for infection. Other surgeons preferred to leave the suture material unknotted and instead used glue to hold it in place.

ii) Techniques for achieving 'good apposition'

Apposition was described as the wound edges 'matching up' without any gaps or visibly exposed subcuticular tissue, and was felt to be achieved by evenly placing and spacing each needle entry and exit point (referred to as 'bites'). Gaps or steps could occur if the skin was not well apposed, which surgeons related to potential problems with wound healing further down the line. A well apposed wound was also linked to being tension free and more likely to heal well:

> ***S:*** *With skin closure it's just achieving tension free skin apposition, in a way that will allow good healing...." (Consultant, SpR, etc.)*

> ***S:*** *"More likely if you get good apposition of the skin edges you will more likely get good healing of the skin by primary intention rather than by secondary intention and so you are more likely to get good skin healing which as a secondary thing will also give you good cosmesis." (Consultant, SpR, etc.)*

Eversion was a technique used by the surgeons to support good apposition of the skin edges. By slightly everting both skin edges, surgeons ensured that the epidermal tissue coming together was well vascularised, avoiding the creation of a "cavity or a sinus" and thus promoting wound healing.

iii) Closure of 'deep layers'

Some surgeons considered closure of the deep layers to be more important than the skin closure itself, in terms of favourable wound healing and cosmetic outcome:

S: *"the skin's quite fragile, quite gentle edge opposing really. With a dermal layer, you can get a bit more tension and make sure it's uh well held...I think the dermal layer is probably more important than the subcuticular cos subcuticular often we use glue and steri strips."*

3. Extenuating influences

Surgeons reported other factors (independent to wound closure quality) that could influence wound healing, including: the patient, the type and complexity of procedure, grade of surgeon and whether trainees were 'supervised', time taken to close the wound, and hygiene levels in theatre. Patient factors mentioned included age, diabetes, obesity, skin conditions, and drug intake, such as steroids. Surgeons associated many of these factors with poor blood supply and/or or higher infection risks. Procedures involving groin surgery or intra-abdominal perforations were considered high risk. These peri-operative factors are reported in the literature as having the potential to increase SSI and wound healing. Various preventative strategies were described as beneficial: for example, peri-operative antibiotics, antibiotic-impregnated sutures, and warming the patient during the procedure. Other interventions - incise drapes, pre-operative hair removal by shaving, and drain insertion – were evaluated in systematic reviews as ineffective. Most surgeons agreed that surgical experience impacted the quality of wound closure. One surgeon associated surgical experience with an ability to anticipate potential problems with wound healing (and adjust their technique accordingly). Conversely, other surgeons thought that experience was not important for wound healing but instead for cosmetic outcome. The time taken to close the wound was considered by some surgeons to impact wound healing, and to be inextricably linked to experience. One surgeon thought that the time taken was a balance between being slow enough to be careful and quick enough to decrease the length of time the wound was open and exposed to infection. Other surgeons did not think that the time taken for wound closure affected healing. This was corroborated by the literature, as no evidence was found to suggest a correlation between surgical experience and the quality of wound closure.

In summary, patient factors and hygienic conditions appeared to be most important to surgeons (which was mirrored in the literature findings) but there was less consensus around factors such as the grade of surgeon or time pressures.