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Which pen? A comparative study of surgical site markers

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Abstract

A preoperative requirement is the correct and clear marking of a specific surgical site. We aimed to compare the ability of marker pens to withstand surgical preparation. Five volunteers with different Fitzpatrick skin types were marked with ten pens. Marked skin sites were prepared with chlorhexidine followed by chlorhexidine, betadine followed by chlorhexidine, and betadine followed by betadine. Each site was photographed in theatre. Two volunteers ranked the top three most visible marker pens from each photograph. The results showed that Sharpie® W10 black, Dual Tip (Purple Surgical), and Easimark modern regular tip (Leonhard Lang) were the best performers across all skin types. Red pen should be avoided with betadine skin preparation. The study concludes that the above named three markers are the best at withstanding surgical skin preparation. Different skin types require different colour ink for maximal clarity in marking. Biro and drywipe markers should never be used for surgical marking.

Keywords

Safer surgery / Correct site surgery / Preoperative site marking/Site verification / Skin preparation / Skin markers / Marker pens

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Introduction, background and literature review

Numerous preoperative guidelines exist to ensure patient safety and allow planning of complex procedures. A recognised requirement within all surgical specialities is the correct and clear marking of a specific surgical site, prior to surgery (NPSA 2009, WHO 2009). The current guidance specifies that the mark should be visible to all persons of the operating team, at the time of incision (Robinson & Muir 2009a). In order to reduce the possibility of wrong site surgery, indelible marker pens are required to withstand surgical preparations and avoid the possibility of unintended erasure (Giles et al 2006, Neustein 2007, Robinson & Muir 2009a). This is also crucial for specialist preoperative localisation techniques, for example with stoma marking or oncoplastic breast surgery.

There is no clear guidance on the need for single use skin markers versus commercially available non-sterile or reusable pens. Studies have found disparities within the marking methods used by consultant surgeons (Mears et al 2009) including the type of pen used; some surgeons would use an indelible black marker, others their own personal pens, biros or dry wipe markers (Giles et al 2006).

As all skin is cleaned prior to incision in order to reduce the rates of surgical site infection (Young et al 2014), it is imperative that the pens used are able to withstand preparation of the surgical field. Topical solutions such as alcohol-based chlorhexidine or aqueous betadine are commonly used in the operating room to prepare surgical sites, alone or in combination. Evidence exists to suggest that alcohol based preparations are superior to povidone iodine solution at reducing surgical site infections rates (Sidhwa & Itani 2015). The primary aim of these preparations is to reduce the risk of infection, hence they are likely to be used increasingly (Young et al 2014).

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Most ineffaceable marker pens are alcohol-soluble and can therefore be partly or entirely removed during preparation of the skin (Tatla & Lafferty 2002, Mears et al 2009, Thakkar & Mears 2012). In addition to this, if the patient showers before surgery, and after they have been marked, this too could affect the clarity of the marked site. Another issue previously raised is the possible transfer of the mark onto another area of the body, which can lead to confusion regarding the correct surgical site (Robinson & Muir 2009b).

In the north-west region, various commercially available marker pens are in use for marking surgical sites, and often the surgeon's own pen is used. Single use indelible pens are at times not available on the wards preoperatively. The variability in the choice of marker pen and their resistance to skin preparation is a concern when marking a surgical site and ensuring patient safety. We therefore set out to compare the clarity of marks made using a variety of pens on different skins types, assessing their ability to withstand different surgical skin preparations. The study aimed to provide guidance on selection of a pen for marking skin, based on patient skin type and skin preparation planned.

Methods

The pens used in this study include, Biro (black) and Himark drywipe marker bullet tip (black), both of which are non-permanent; Himark permanent marker bullet tip (black), Easimark fine tip surgical skin marker (Leonhard Lang) (purple), Easimark modern regular tip surgical skin marker (Leonhard Lang) (purple), Dual Tip surgical marker (Purple Surgical) (purple), Viomedex® VX100 (purple), all of which are marketed as single use marker pens specifically designed for skin marking; and Sharpie® W10 black permanent marker, Sharpie® W10 red permanent marker, and Sharpie® W10 green permanent marker, which are commercially available as high-street marker pens not specifically designed or marketed for surgical use. The pens chosen are all used by a variety of surgeons in four separate Merseyside surgical units in which the authors (SB and EJN) have worked. The authors have no conflict of interest (pecuniary or otherwise) with the pen manufacturers.

The participants in our study were five healthy volunteers, one from each Fitzpatrick skin type grade 1-5 (Sachdeva 2009), who were not undergoing surgical procedure. Skin marking and skin preparation was carried out by a single individual in order to standardise the experiment. Subjects were marked with each pen variety in three separate anatomical locations. Each site was photographed in theatre under operating lights before skin preparation was applied (see Figure 1). The pens were allowed at least 15 minutes to dry before skin preparation was applied, reflecting practice of skin marking in advance of the patient going to theatre.

The three skin sites on each subject were prepared with chlorhexidine followed by chlorhexidine, betadine followed by chlorhexidine, or betadine followed by betadine respectively. This selection was based on regional practice observed within general surgery. Skin preparation was performed by one individual using a

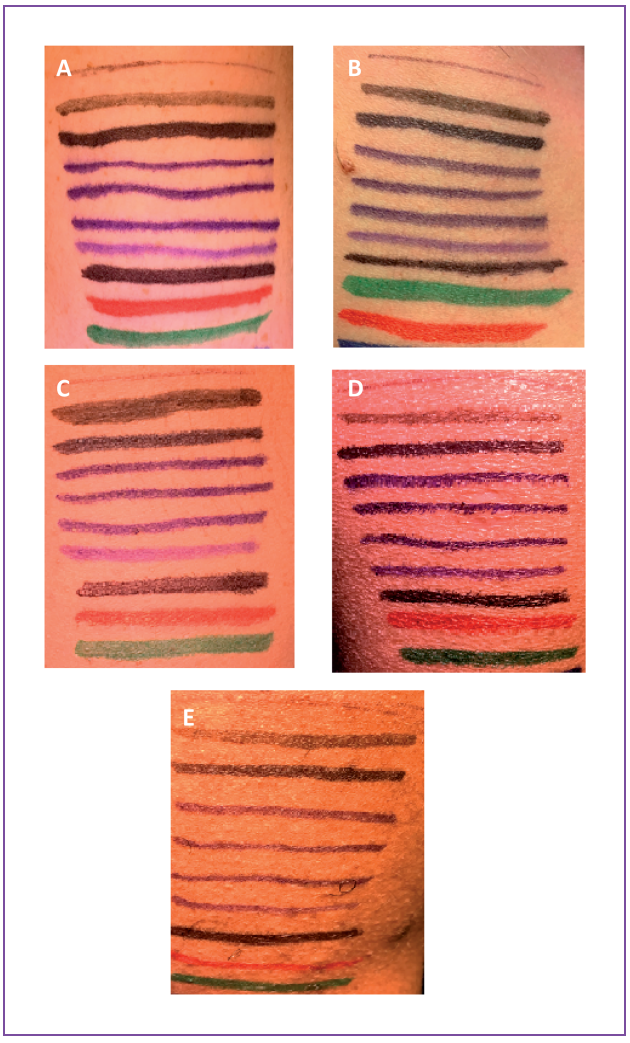

Figure 1 Pen markings on each of the five Fitzpatrick skin types prior to preparation Pens used from top to bottom were Biro, Himark Drywipe marker bullet tip, Himark permanent marker bullet tip, Easimark fine tip surgical skin marker (Leonhard Lang), Easimark modern regular tip surgical skin marker (Leonhard Lang), Dual Tip surgical marker (Purple Surgical), Viomedex® VX100, Sharpie® W10 black permanent marker, Sharpie® W10 red permanent marker, and Sharpie® W10 green permanent marker. (A) Fitzpatrick skin type 1 (B) Fitzpatrick skin type 2 (C) Fitzpatrick skin type 3 (D) Fitzpatrick skin type 4 (E) Fitzpatrick skin type 5

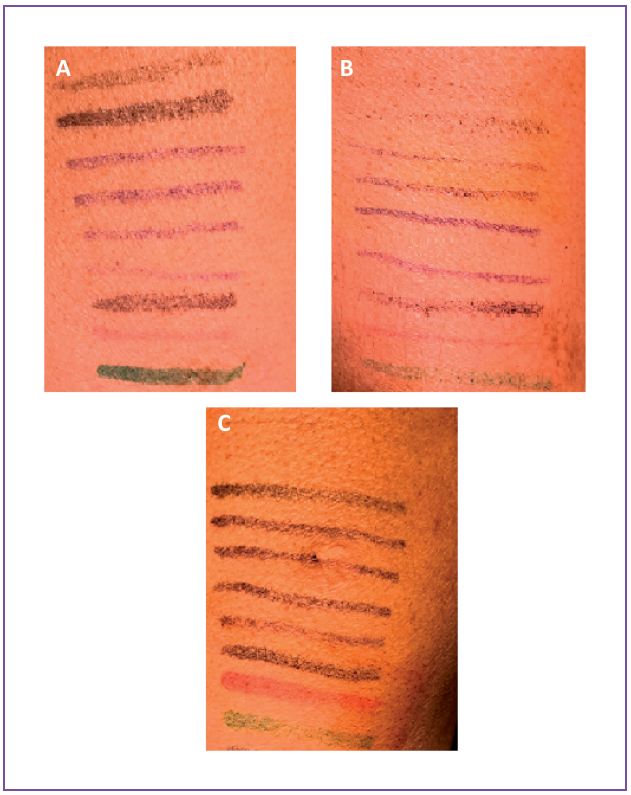

Figure 2 Fitzpatrick skin type 4 following each of the skin preparation regimens. (A) Chlorhexidine followed by betadine (B) Betadine followed by chlorhexidine (C) Betadine followed by betadine

single gauze swab on a Rampley's sponge holder, dipped into a galley pot of preparation and scraped so that no free dripping was apparent from the swab. The skin was cleaned with a swab as would be expected in routine surgery, but not scrubbed. Following skin preparation each anatomical site was photographed in theatre under operating lights (see Figure 2).

Two volunteers were asked to rank the top three most visible marker pens from each photograph. The observers were blinded to each other's answers; they were also blinded to pen type at time of review. Where discrepancy arose a third volunteer was asked to analyse the picture.

Results

Prior to skin preparation, all of the pens tested, except the biro, were easily visible on each skin type. The Biro pen was particularly poorly visible on Fitzpatrick skin type 5. Himark Drywipe marker bullet tip was almost completely erased by all three preparation regimes. Figure 1 demonstrates each of the markings on each of the five Fitzpatrick skin types.

During the skin preparation, the authors noted that chlorhexidine solution smudges all the pens on first application, but following the second application the smudged marks are no longer visible.

The two reviewers were asked to rank the pen marks and identify the clearest three pens in each photo. As the Biro and dry wipe marker were not clearly visible at this stage they were excluded. The reviewers were in agreement with the majority of analysis. Discordant opinions on the post preparation images occurred in only 3 of the 45 ranking decisions. These discordant images were analysed by a third reviewer who agreed with one of the two initial reviewers on each occasion.

Table 1 shows the reviewers' assessment of which pens were the most visible following the three regimens of skin preparation. The results are separated into Fitzpatrick skin types. Consistently, the Sharpie W10 black permanent marker, the Dual Tip surgical marker (Purple Surgical) (purple) and the Easimark modern regular tip surgical skin marker (Leonhard Lang) (purple) were the best performers across all skin types. There was much more variation between the best pens in the lighter skin types, whereas in Fitzpatrick skin type 5, three of the pens were consistently better. The Biro, Himark Drywipe and Sharpie® W10 red permanent marker were never deemed the clearest on any skin type. The Viomedex® VX100 (purple) was deemed among the three clearest pens on only one occasion.

Table 2 demonstrates the number of times each pen was in the top three choices following each of the individual skin preparation regimes. Again, the best performing pens were Sharpie® W10 black permanent marker, Easimark modern regular tip surgical skin marker (Leonhard Lang) (purple), and Dual Tip surgical marker (Purple Surgical) (purple). The Sharpie® W10 red permanent marker was never identified in the top three pens in any analysis and the Viomedex® VX100 (purple) was identified only once.

The authors noted that the red ink of the Sharpie® W10 red permanent marker was particularly difficult to see following either of the betadine skin preparation regimes.

Discussion

Preoperative marking of a patient is recommended for all patients undergoing surgery, particularly in cases of laterality, in order to help reduce the incidence of wrong site surgery. Protocols are being created to give

Table 1 Table demonstrating the number of times that each pen was deemed to be the top three most clear pens for each of the five Fitzpatrick skin types

Fitzpatrick skin type	Himark permanent marker bullet tip (black)	Easimark fine tip surgical skin marker (Leonhard Lang) (purple)	Easimark modern regular tip surgical skin marker (Leonhard Lang) (purple)	Dual Tip surgical marker (Purple Surgical) (purple)	Viomedex® VX100 (purple)	Sharpie® W10 black permanent marker	Sharpie® W10 red permanent marker	Sharpie® W10 green permanent marker
1	2	1	2	1		2		1
2	1	1	2	3		2		
3	2	1	1	1		2		2
4	1	1	1	2	1	2		1
5			3	3		3		1
Total	6	4	9	10	1	11	0	4

Table 2 Table demonstrating the number of times that each pen was deemed to be the top three most clear pens for each of three different skin preparation regimens

Fitzpatrick skin type	Himark permanent marker bullet tip (black)	Easimark fine tip surgical skin marker (Leonhard Lang) (purple)	Easimark modern regular tip surgical skin marker (Leonhard Lang) (purple)	Dual Tip surgical marker (Purple Surgical) (purple)	Viomedex® VX100 (purple)	Sharpie® W10 black permanent marker	Sharpie® W10 red permanent marker	Sharpie® W10 green permanent marker
Chlorhexidine, chlorhexidine	4	1		2		4		4
Betadine, chlorhexidine		1	5	5	1	3		
Betadine, betadine	2	2	3	3		4		1

guidance on how patients should be marked. The World Health Organisation explains that surgical markings should be unambiguous, be drawn with a permanent pen to avoid removal of the mark during surgical skin preparation and be visible when draped (WHO 2009). The protocol also states that skin markings should be made before patients are taken to theatre and that it is important for patients to be involved in the placement of the mark. These recommendations therefore make it an essential need for durable, ineradicable single use surgical marker pens. However, there is no guidance on which markers are most effective in this setting (NPSA 2009). Nor is there clear guidance on whether single use markers are better or necessary.

We aimed to demonstrate which pens are able to withstand three recognised and acceptable skin preparation regimes prior to surgical incision. Our study has highlighted that the various pens used regularly to mark patients for surgery vary within their ability to withstand surgical preparation, with regards to their overall clarity. From the pens tested in our study, the Sharpie® W10 black permanent marker, the Dual Tip surgical marker (Purple Surgical) (purple) and the Easimark modern regular tip surgical skin marker (Leonhard Lang) (purple) were able to withstand the surgical preparation adequately and consistently. Marks made using dry wipe marker pens completely disappeared following skin preparation and therefore should not be used. Biros should never be used due to their poor visibility, even before preparation of the skin. Our study highlighted that when using betadine to prepare the skin, pens containing brown or red ink should be avoided due to the similarity in colour with skin preparation agents. We advocate that the pen colour should be different from the colour of the dye used in the skin preparation of choice.

Skin type should be considered when marking patients. Our study suggests that, whilst there were more skin markers that were easily visible after skin preparation on Fitzpatrick types 1-4, patients with Fitzpatrick skin type 5 are more likely to have poor visibility with a many of the commercially available pens. We therefore recommend the use of one of the top three rated pens for this group.

The best preforming pen was the Sharpie® W10 black permanent marker. However, this is not a single use pen. The Dual Tip surgical marker (Purple Surgical) (purple), and the Easimark modern regular tip surgical skin marker (Leonhard Lang) (purple) are both single use pens, and they were the second and third best performing pens respectively. Cross-contamination of patients by using multiple use pens could potentially be increasing infection risk, especially with regards to patients colonised with MRSA (Tadiparthi et al 2007). We believe that single use pens should therefore be used where there is a known infection risk, or implants are being used. Evidence for other patients and operations is limited. Patient allergy is another consideration that should be taken into account when considering which pen to use. Patients can have adverse reactions to ingredients used in ink. Fortunately, we did not experience any adverse reactions to ink during this study.

The importance of clarity for surgical skin marking is not only to ensure patient safety by avoiding wrong site surgery but also further extends to meticulously planning particular procedures. In plastic and reconstructive surgery marking the patient is an essential part of surgical preparation, necessary for producing optimum cosmetic results (Sarifakioglu et al 2003, Tatla et al 2001). The mark up of accurate reference points and lines minimises the margin for surgical mistakes. However, if the pens used are not durable enough to withstand vigorous skin preparation this could potentially lead to distortions in the markings and affect the completed surgical appearance (Ayhan et al 2005). It could also encourage inadequate skin preparation for fear of removing these markings.

Study limitations

This study has a number of inherent limitations. We were unable to fully standardise the marking and preparation with each skin type. However as this was performed by a single individual variation has been kept to a minimum and arguably, this is a reflection of true clinical practice, where marking and skin preparation is performed by different individuals in a non-standardisable way and therefore is unlikely to be uniform. Another inherent limitation is the number of pens compared in this study. There are numerous single use sterile pens and commercially available non-sterile pens available and in use nationally. The pens were however selected to represent regional (Merseyside) NHS practices and the results should highlight that commercially available permeant marker pens are not necessarily inferior to single use sterile packed skin markers.

Conclusion

Overall the best pen for surgical marking would require be ineffaceable to surgical preparation. it would also be an entirely different colour from both the patient's skin colour and the colour of the preparation used; where possible it should be single use.

We conclude that multiple use commercially available or high-street marker pens can be more visible than single use surgical skin markers. Specifically, this study has found that the Sharpie® W10 black permanent marker, the Easimark modern regular tip surgical skin marker (Leonhard Lang) (purple), and the Dual Tip surgical marker (Purple Surgical) (purple) are the best at withstanding surgical preparation amongst the markers used in the current study, although we acknowledge that all markers used throughout the NHS were not tested in the present study. The Biro should be avoided as it not clear even prior to preparation. Dry wipe markers should also be avoided due to fading post skin preparation.

Different skin types require different colour ink for maximal clarity in marking. Further studies are required to ascertain optimum duration and repetition of use of the reusable pens, cost of purchasing indelible reusable markers and also the risk of infection associated with marker reuse.

No competing interests declared

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