

Ultra-violet body painting: A new tool in the spectrum of anatomy education

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SUMMARY

This descriptive article explores the use of ultra-violet (UV) body painting within anatomy education. Whilst the use of body painting is not new, UV paint has not previously been used within medical education. It is well documented that body painting is a fun and engaging learning tool that, it is reported, uses multiple sensory pathways to promote retention of knowledge. That being said, it is not without its limitations, namely that it rubs off easily and cannot be layered to show superficial and deep views simultaneously – something that UV paint can achieve. This article compares the use of normal and ultra-violet body painting within the classroom environment. In addition to offering exemplars for best practice and maximum impact, the article offers practical guidance on the health and safety issues related to the use of the paint and associated UV lighting. UV paint provides a wet and therefore more visceral look to paintings. The fluorescent colour makes it extremely striking visually. One of the major advantages is that UV paint can be layered both on top of and beneath ordinary body paint. Thus when light is applied a hidden layer can be revealed. Use of an adhesive, such as liquid latex, underneath the paint ensures that the artwork lasts and withstands sweating and movement, as well as enabling an artefact to be produced if removed carefully from the body. UV paint therefore makes an excellent addition to the toolkit of any anatomy educator.

Key words: Anatomy – Medical education – Art – Surface anatomy – Ultra-violet – Body painting –

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INTRODUCTION

Over the past decade, literature has described the use of body painting within anatomy education (Op den Akker et al., 2002; McMEnamin, 2008; Finn, 2010; Finn and McLachlan, 2010; Finn et al., 2011; Nanjundaiah and Chowdapurkar, 2012; Finn, 2015; Aka et al., 2018; Cookson et al., 2018). This popular teaching and learning tool is one of many art-based approaches that are present in the teaching toolkits of anatomy educators. Body painting, in particular, is advocated as a fun and engaging manner in which students can learn gross anatomy (McMenamin, 2008; Finn, 2010; Finn and McLachlan, 2010; Finn et al., 2011; Nanjundaiah and Chowdapurkar, 2012; Bennett, 2014; Finn, 2015; Aka et al., 2018; Cookson et al., 2018). Furthermore, body painting is of particular use as a tool for students who struggle with cadaveric study of anatomy, as it provides a learning space outside of the dissecting room environment with peer-led learning at the core of the activity (Finn, 2010; Finn and McLachlan, 2010; Finn et al., 2011; Finn, 2015; Aka et al., 2018; Cookson et al., 2018).

Body painting is not only limited to use for anatomical study in medical education, but can also be beneficial as a mechanism for introducing and reinforcing clinical examination and associated communication skills. Many authors describe the professionalism developed when utilizing body painting with concurrent clinical examination (Finn, 2010; Finn and McLachlan, 2010; Finn et al., 2011; Finn, 2015; Aka et al., 2018; Cookson et al., 2018). In this vein, the use of body painting as a method

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by which the hidden curriculum can be exploited, so called 'teaching by stealth', has been reported (Aka et al., 2018). Bold and vibrant colour is central to the appeal of body painting and is frequently cited as a mechanism through which students effectively learn from this modality (Finn, 2010; Finn and McLachlan, 2010; Finn et al., 2011; Finn, 2015; Aka et al., 2018; Cookson et al., 2018). The use of body painting in anatomical education, and for the broader purposes of public engagement, health education, and outreach, draws on the demonstrated potential of Theatre, a broader notion that encompasses the academic use of body painting to engage the public and to foster their participation in health education (Ball, 1996; Nisker et al., 2006; Arveklev et al., 2015).

There are many advantages to body painting, including its relative cost-effectiveness, but it is, of course, not without its drawbacks. It requires some time investment as an activity. There are obvious cultural and religious barriers which also need consideration. There is the element of undress required for certain body areas, which can raise concerns over body image and vulnerability (Finn, 2010; Finn and McLachlan, 2010; Finn et al., 2011; Finn, 2015; Aka et al., 2018; Cookson et al., 2018). These cultural and body consciousness issues must be handled with care. Previous papers describe how to do this (Finn, 2010). However, there is an argument for promoting the expectation that students will participate actively, as these same issues will also be faced when doctors require patients to disrobe before examining them. Experiencing this in a safe, controlled, peer environment could assist students in developing the associated communication and professionalism skills. Op Den Akker et al. (2002) argue that the limitation of body painting is that it is not suitable for everything but it is well suited for large, superficial structures such as muscles. It is more limited for demarcating the relationship between structures (Op den Akker et al., 2002; Finn, 2015).

This communication describes the novel use of UV-reactive fluorescent body painting, as an adjunct to the use of regular non-fluorescent body painting, to overcome the limitations described by Op Den Akker et al. (2002) and Finn (2015), and to facilitate the demonstration of key anatomical relationships using the medium of body paint. It further describes how UV body paint can be utilised to reinforce learning and to foster the construction of "learning landmarks" in anatomy education.

DESCRIPTION

Practicalities and application

UV light (10-40 nm) is invisible to the human eye. However, the fact that UV light causes particular substances to glow is utilised in the production of special UV paints. Such paints are marketed as offering colour saturation that maintains maximum fluorescent brightness, without white-light-to-black-light colour shift. UV body paints are readily available and frequently used outside the academic envi-

ronment, for example on the rave scene, in nightclubs, and at festivals.

Using UV light and fluorescent body paints has health risks and, as such, use within the classroom or public domain must be well considered and limited. This is not to say that the activity is high risk or should be avoided, but it would be irresponsible not to describe the drawbacks of using the UV paints. Models or participants who are being painted should be asked to provide appropriate informed consent. This precaution may also be extended to all those individuals present, but we feel that this may border on being overly cautious. It is however necessary to perform a comprehensive risk-assessment on the use of both the UV lighting and the body paints. Exposure to the UV lighting should be kept to a minimum. The advantage of the UV body paints is that they can be clearly seen in daylight, meaning that the painting process can be conducted without the need for continuous exposure to UV light – its use being limited to the demonstration of the finished painting.

UV lights come in many forms, from highly fluorescent bulbs to LED cells and clusters, the latter being commonly used within the beauty industry for the application of gel nail varnish. Therefore, the exposure required during a short painting session and the associated demonstration or display should be considered within context. UV lights can be readily purchased from popular online retailers, as well as specialist shops and sites. Large industrial filming rigs are available, but these are costly and not of benefit unless doing large scale displays or high definition filming. The small handheld UV torches which are made up of around 12 LED cells are adequate and inexpensive for classroom teaching sessions. Larger versions with 50 plus LEDs are a good enough quality for demonstrations and high-resolution photography.

UV paint is easily applied, can be thinned, and is available in both liquid and solid applicator (e.g. pencil/crayon) form. The paints are marketed as being safe, water-based, and non-toxic in formula. However, a small test application could be conducted in advance of using the paints on large areas on participants or models to ensure that any sensitivities or allergies to the ingredients are clearly identified and/or excluded. Since the publication of our original body painting research (4), we have not to date observed any reactions to the paint but caution should always be exercised.

As with 'normal', non-UV body paints, the UV paints are readily and commercially available. They are advantageous in that they possess colours that can be seen in normal light (Fig. 1B daylight, typical indoor lighting conditions), are visually striking (Fig. 1C-D), and relatively cheap. The price is comparable to that of normal body paint. The UV paints can be applied in isolation, underneath, or on top of normal body paint. When combined with the normal paint, they are still visible although a little fluorescence can be lost. The advantage of a combined approach is that layering is possible. An example being the areas of cutaneous innervation

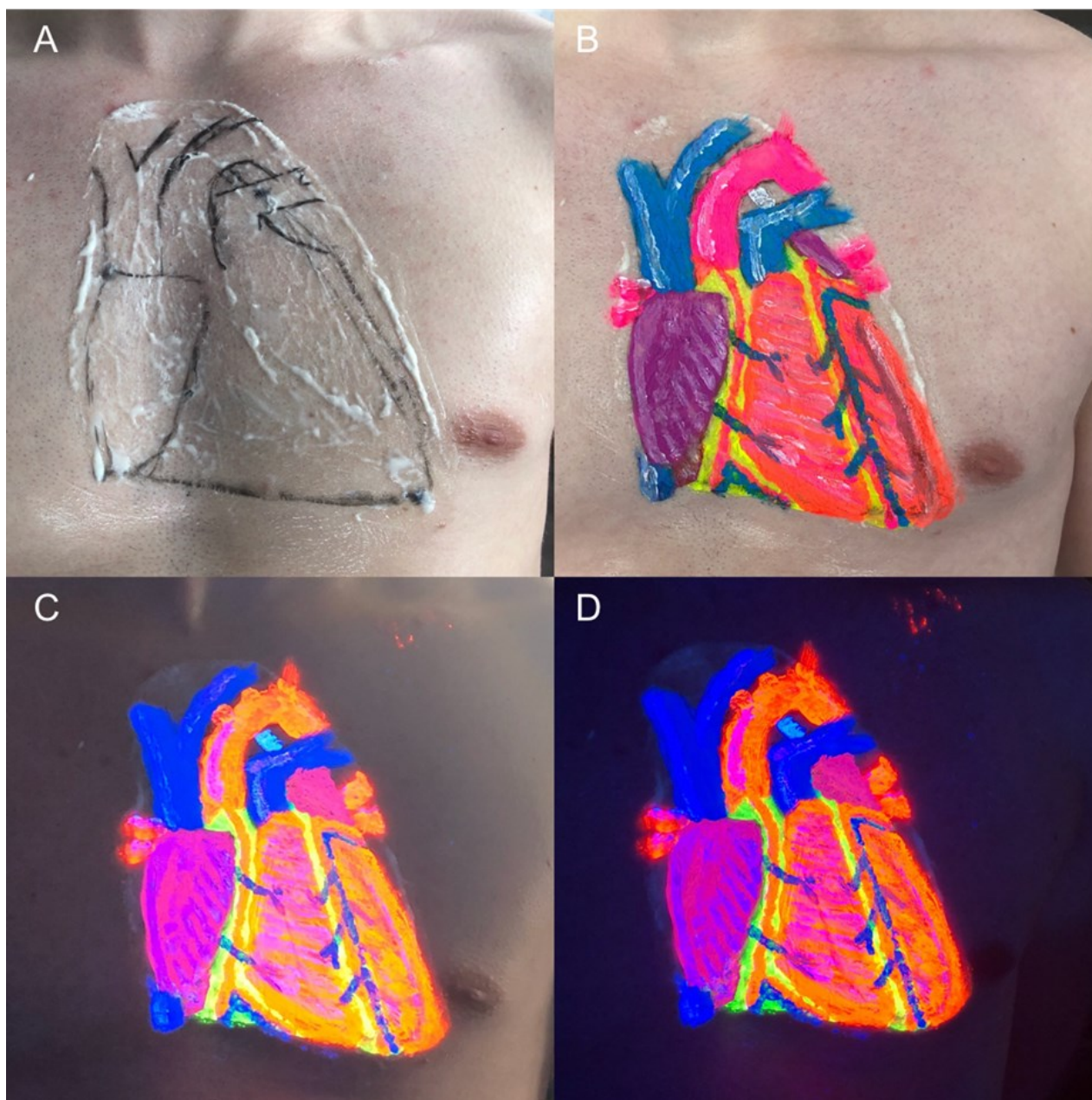


Fig 1. Stages of UV body painting and visualisation. **(A)** Application of latex base and rough outlining of structures to be painted. Surface anatomy landmarks should be used to correctly position the structures on the model. **(B)** Normal lighting conditions. **(C)** Illumination with UV light and normal light. The vibrancy of the paint stands out while maintaining clear visualisation of non-painted regions. **(D)** UV light in a blackout room. Only the painted structures can be seen.

in the hand which can be painted in normal body paint, with the cutaneous nerve branches painted in UV underneath (Fig. 2). When the UV light is applied, the branches are highlighted, and the anatomical relationship between the areas of cutaneous innervation and the underlying cutaneous nerves can be clearly demonstrated. The ability to layer the paint is of particular advantage to institutions who do not have readily available cadaveric material, as multiple viewpoints can be achieved in one painting. This layering approach means that, for example with the hand, two anatomical concepts can be interfaced. In this example, the abstract view of dermatomes and discrete areas of

cutaneous innervation can be interfaced with the more delineated gross anatomy of the nerves and associated branches. A further example is that superficial and deep layers of musculature (Fig. 3) can be painted on one side of the body and viewed both independently and simultaneously. This is something not readily achieved using normal paint, where typically a different side of the body is utilised to present each view. When painting musculature, maximal visual impact can be achieved by combining UV painted muscle striations (in a variety of tones—orange, white, pink, red, etc.) over a solid, colour-block base layer of normal paint. When the model moves, the fluorescent reflection

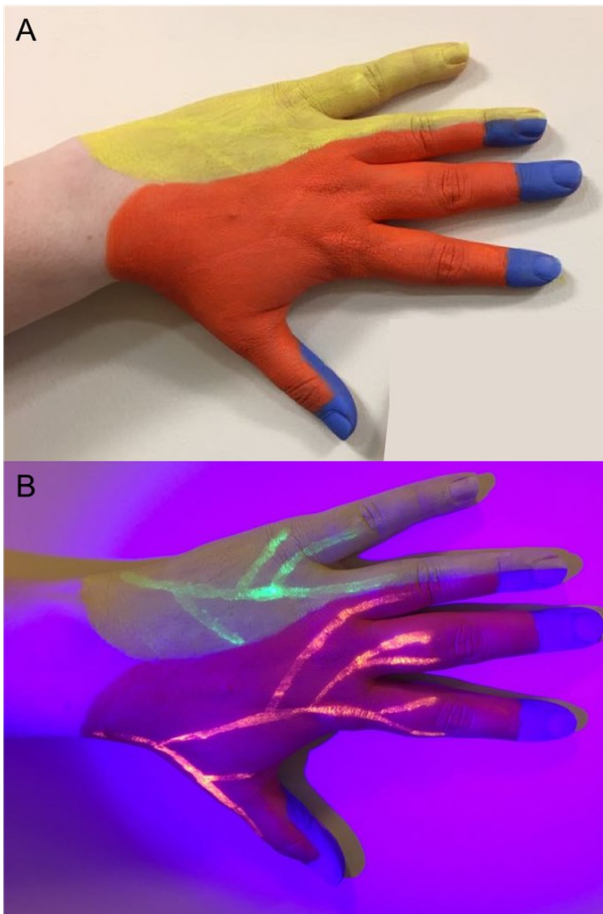


Fig 2. Cutaneous innervation of the hand painted with normal, non-UV paints over the cutaneous nerves painted with UV paints visualised under **(A)** normal light where only the innervation regions can be easily seen, and **(B)** UV light bringing the cutaneous nerves courses into view.

of light and striations present an illusion of muscle tension and movement. This is especially visible at points of origin and insertion. Similarly, a darker (blue, black, purple) outline can be painted around the borders of muscles to provide depth and definition. Due to the nature of the paint, it can't be easily block painted, adding individual striations is more time-consuming than using a normal body paint. However, this time commitment is countered by the more striking visual impact presented. UV painting can be a more time-intensive process. One reason for this is that it may require the application of a base of normal paint if fine detail is required, as this provides a surface on which to layer and a background for the detail work. UV paint is also a thinner paint, so sometimes requires the application of additional coats to ensure good coverage. When considering multiple viewpoints, the more layers painted, the more time required. Speedy application is a possibility if UV crayons are utilised. The crayons are instant and are applied directly on the skin without the need for a brush. They are ideal for neurovascular structures and quick outlines. The colour from the crayons is not as intense but they still fluoresce well.

One issue encountered with body painting is that

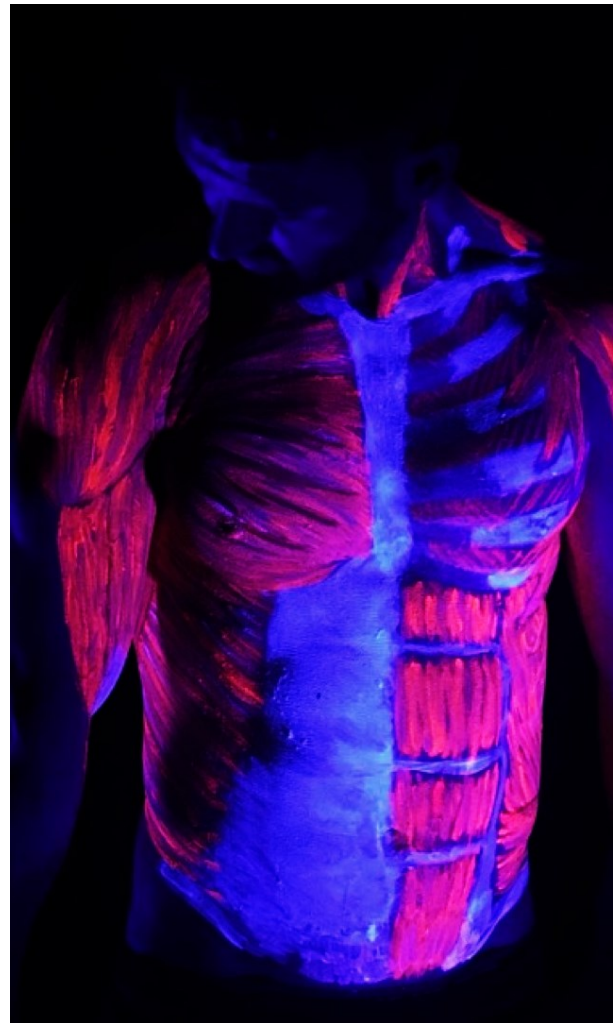


Fig 3. Anterior trunk painting with UV paints to show the superficial muscles on the right and deep muscles on the left.

the water-based nature of the paints results in paint easily rubbing off both during the painting process and during any demonstrations. Using a liquid latex as a base on the skin (Fig. 1A) enables the paint to be held in place for longer durations. As with the UV paints, liquid latex is readily available, but is a commonly reported allergen. Using latex as a base is ideal when body paintings are required for prolonged periods, for example multiple demonstrations, dynamic exhibits where the painted model needs to move, or photoshoots, but it should be used with extreme caution. The principles of risk assessment, patch-testing, and consent described above apply equally to the use of liquid latex. When using liquid latex as a base layer, a protective oil-based substance such as petroleum jelly or coconut oil should be applied to the skin in advance. Extra caution should be taken when applying latex to hairy areas of the body as hair will adhere to the latex. This can be prevented by removing hair from these areas or applying extra amounts of the oil-based protective layer. To ensure a good painting surface, at least two layers of liquid latex should be applied with each layer having dried before application of the next. This



Fig 4. Demonstration of UV body painting being used in the classroom using one model to demonstrate the anatomy and positioning of the heart to a group of students.

solid foundation will enable clean and easy removal of the latex and paint layers when complete. We have found that latex is best applied using a dense makeup applicator sponge in a dabbing fashion rather than spreading it with a brush or spatula.

In terms of application, apart from the potential use of a latex base-layer, the principles and tips described in previous papers (Finn, 2010; 2015) are relevant for use of UV-body painting.

In terms of suitability for body regions, UV paint can be applied in the same manner as normal body paint. It works well for all systems, regions, and structures. Examples provided in this paper demonstrate a range of applications from the heart to dermatomes and musculature. Caution may need to be taken if painting the face and then applying UV light, but the paint will still be visible using oblique lighting to avoid shining it directly into a model's eyes. Body painting, whether UV or normal, makes an excellent adjunct to any anatomy curriculum. It is a tool which can help promote curricula integration of basic science knowledge and clinical skills. It is suitable for use with any cohort studying anatomy.

DISCUSSION

Educational uses

UV body painting can be utilised within any teaching or learning session which would ordinarily lend itself to body painting. However, impact can

quickly be lost if this tool is over-utilised. UV painting is best used as an adjunct, for example, as single model demonstration within a teaching session, rather than as a whole-class painting activity (Fig. 4). There is little to be gained by all students using UV paint to learn gross anatomy that can be achieved over and above students using normal paints. The real impact is achieved when 'extra' structures or function is demonstrated on a UV model, especially when UV paint has been applied unbeknown to the cohort. The unveiling of the UV painted structures is literally and metaphorically a 'light-bulb' moment. The audible wow can be heard within the classroom and a striking learning moment, previously referred to as a "learning landmark" (Finn and McLachlan, 2010), is created.

An example of the use of UV to reveal hidden structures is the painting of the contents of the antecubital fossa. The biceps tendon, bicipital aponeurosis and vasculature can be painted in normal paint, whilst the median nerve can be painted in UV. Coupling this painting with a phlebotomy demonstration on either an artificial limb or live model means that the UV paint can be utilised to highlight 'hidden' neurovascular structures that are at risk of damage when performing venepuncture. This 'what lies beneath' style demonstration of gross anatomy and clinical application is beneficial for students as an explicit link is formed between the two.

As described previously, UV painting is particu-



Fig 5. The heart painting from Fig.1 removed in a single piece that can be preserved.

larly impactful when used to demarcate the musculoskeletal system. The advantages of such paintings are that the UV paint shows natural points of tension around muscle's origins and insertions, as well as tension within the muscle belly when contracted in a functioning state. During a live UV demonstration, if the striations are correctly painted the effect is truly that of vivisection where the observers really feel that they are seeing beneath the skin. The fluorescent shine also presents a 'wet' look, which mimics the natural living state of visceral structures within the body, adding to the realism for observers.

As with all paintings, the use does not need to be limited to the classroom environment. As previously described (Finn and McLachlan, 2010; Finn, 2015), body painting can be readily used for public engagement and outreach events. Examples include, UV dancing and exercise demonstrations with pre-painted models to highlight functional anatomy.

One major advantage of the UV paint when applied over a liquid latex base layer is that, with careful removal, a keepsake artefact can be created, whereby the painting is preserved as a single piece of latex (Fig. 5). This is difficult to achieve, although not impossible.

The literature has previously described the professional development that can be achieved by engaging with the painting process (Finn, 2010; Finn and McLachlan, 2010; Finn et al., 2011; Finn, 2015; Aka et al., 2018; Cookson et al., 2018). Increased awareness of surface anatomy and bony landmarks, confidence in palpation and clinical examination, and opportunities to rehearse a professional script when dealing with models or peers as though future patients are a few well-documented examples of this (Finn, 2015). If used within the classroom environment, rather than for demonstration purposes only, UV painting pro-



Fig 6. UV body paint on dark skin. The vibrancy is maintained and structures can be clearly identified.

vides an equivalent learning opportunity for the development of such skills while incorporating increased visual impact.

Another observation is that UV paints are more inclusive as the colour spectrum and bold emission means that they can be seen more readily on a range of skin colours (Fig. 6). A black model remarked that, *"I was initially a bit disappointed that the paint seemed rather dull against my skin tone. But once the UV light hit it, I was taken aback by how brilliant it all looked. Amazing!"*

Previous research has elicited the views of faculty and students on the use of body painting as a teaching tool (Finn and McLachlan, 2010; Aka et al., 2018; Cookson et al., 2018). The findings of such studies are, in our experience, equally as valid with the use of UV body painting. Participants in events using UV paint have made a number of significant observations which merit consideration for anyone wishing to implement UV painting into their anatomical teaching toolkit:

"Using UV paints can create a semblance of three-dimensionality within the body painting. It gives an extra dimension with which to illustrate the structures under the skin."

"When wanting to illustrate overlapping systems or structures, using the UV paints allows them to be simplified and separated, but still visible together, so the interaction between them can be explored more easily."

"The vibrancy that UV paints add creates highly memorable images which stick in the mind, aiding both engagement and retention of learning."

"It [UV paint] was a valuable experience in terms of visualising the anatomy of the human heart in relation to the body wall. It helped with forming a mental picture of its size, shape and surface features proving a novel and engaging way of applying surface anatomy knowledge."

"Whilst the UV aspect of this body painting exer-

cise was of little educational significance, it certainly improved student engagement and interest due to its novelty. This is something which whilst in itself is not directly contributing to learning, is certainly creating an atmosphere more conducive to it.”

“I can see that such a technique of UV body painting could be of significant value in justifying the anatomical reasoning behind the use of different physical examinations, both in terms of understanding the underlying anatomy, as well as with regards to justifying sites of auscultation in relation to different structures such as heart valves. This is due to the fact that the anatomy is visible on the model in question whilst the body wall is also accessible for interaction with in a clinical manner.”

Concluding remarks

UV paint immediately engages the intended audience, as it is clearly more visually striking than normal body paint. In order not to lose this impact, its use should be limited to demonstrations that require a multilayer (superficial/ deep) or functional approach, or for anatomy that may be conceptually difficult for students to master.

The cost-to-benefit ratio needs to balance in terms of utilisation of UV painting over normal body painting. As with all painting activities, it cannot replace cadaveric or other detailed study of gross anatomy (actually going under the skin) but it aids in the formation of learning landmarks, promoting recall, engagement, and the creative, positive learning environment. It is time-intensive, but the benefits in visual appeal and impact are worthy of such an investment. Due diligence must be taken when utilizing the UV lighting and liquid latex as there are health and safety implications which must not be trivialised. Awareness and adherence to safe practice mean that these implications are not prohibitive to the use of UV body painting as a teaching tool.

In summary, UV painting presents a unique view of human anatomy that is visually striking for both subject specialists, students, and lay audiences. Its unique selling points are: the visceral appearance of the anatomy painted and the inclusivity gained from its bold pigmentation and fluorescence, which makes it suitable for all skin tones.

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