

Identifying use-wear locations on bone sewing needles: Possible Later Stone Age sewing needle at Little Muck Shelter, South Africa

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Abstract

Sewing needles are often identified by their form rather than use-wear. As a result, some needles may be missed that do not conform to expected morphologies unless they are inspected more closely. Existing use-wear studies focus on what materials sewing needles were working, but little research presents the overall use-wear distributions that develop on the tool as a whole. These distributions can be used to help identify sewing needles for further investigation that deviate from the traditional tool form type, especially if only a portion of the tool remains. In this study experimental hollow sewing needles were created out of chicken ulnae and used for sewing a piece of hide to isolate the distributions of use-wear that develops on such a tool. These use-wear distributions in conjunction with other attributes were used to identify a potential Later Stone Age needle made from a tooth root at Little Muck Shelter, northern South Africa. The use-wear distributions correlate with those seen on the experimental needles and shaping on the inside rim of the needle's tip, as well as an impact fracture are strong indicators that this tool might have been used for sewing activities. Sewing technology is diverse and might take on forms that aren't necessarily viewed as such immediately, especially when a tool is used in an expedient manner.

Keywords: Bone needles; sewing; use-wear; hide-work; Later Stone Age; Little Muck Shelter; Shashe-Limpopo confluence area; experimental.

Introduction:

The earliest eyed bone needles date to between 49 - 44 ka and were found at Strashnaya Cave in Siberia (Shalagina *et al.* 2018). A bone needle found at Denisova Cave (Siberia, Russia) is attributed an age greater than 50ka (Reich *et al.* 2010; Derevianko *et al.* 2016), but this date is contested due to the limits of carbon dating, inconsistent dates obtained from the same layer, as well as other needles being found in layers dating between 25 - 15ka elsewhere in the Denisova Cave complex (d'Errico *et al.* 2018). Eyed bone needles are found throughout Europe (Legrand, 2008; Bignon-Lau and Lázničková-Galetová, 2016; d'Errico *et al.* 2018; Arampatzis, in press), Caucasus (Golovanova *et al.* 2010; Kandel *et al.* 2017), Asia (Pitulko *et al.* 2012; Derevianko *et al.* 2016; Song *et al.* 2016; Zhang *et al.* 2016; d'Errico *et al.* 2018; Shalagina *et al.* 2018; Zhang *et al.* 2018; Shunkov *et al.* 2020) as well as North America (Green *et al.* 1998; Goebel *et al.* 2011; Osborn, 2014; Lyman, 2015), but relatively few eyed needles have been found in Africa (Antonites *et al.* 2016). Sharpened bone implements that were used as awls for piercing soft material are present, with the earliest known examples in southern Africa from Blombos Cave and Sibudu in layers dated to 76 - 71 and 65 - 61 ka, respectively (Henshilwood *et al.* 2001; d'Errico *et al.* 2012). Earlier awls and bone points have been recovered from other Middle Stone Age sites in Africa (125 - 70 ka), but extensive use-wear analyses have not been performed to determine their use (d'Errico and Henshilwood, 2007). The earliest bone awls from Eurasia are found from the Initial Upper Palaeolithic level of the Denisova Cave in Russia and date to around 48 - 37 ka (Derevianko, 2010) and from Grotte du Renne, Arcy-sur-Cure in France dating to 45 - 42 ka, which were likely used to pierce hide based on use-wear studies done by d'Errico *et al.* (2003). Bone awls become more common in Eurasia after 42 ka (Camps-Fabrer *et al.* 1990; Yanevich, 2014) alongside sewing needles.

d'Errico *et al.* (2018) attempted to determine the origins and evolution of bone needles by collecting and analysing data for needles found throughout Eurasia and North America. They determined that eyed bone needles likely originated in Siberia around 45ka and then either spread into Europe and China or were independently invented, due to morphometric differences. Since earlier sewing needles have yet to be found, it is uncertain what strategies people employed to keep warm as clothing was likely essential in parts of the northern hemisphere. In addition, studies done on head lice indicate a split between head lice (*Pediculus humanus capitis*) and body lice (*Pediculus humanus humanus*) between 170 - 80 ka,

demonstrating that people likely started to wear clothes long before the appearance of eyed sewing needles (Toups *et al.* 2011). People could have employed a variety of techniques to ensure warmth that does not necessarily require garments to be sewn together (d'Errico *et al.* 2018). However, the absence of bone needles does not necessarily mean that needles were completely absent as they may simply have been made from other materials such as wood, as recorded for indigenous Australian communities by Bunbury (1930:84) and Hammond (1933:31). Among some Native American groups, for example, the agave plant (*Agave americana*) was used to produce needles to sew garments. The plant has a sturdy and hard tip on each of its leaves, which can easily puncture hides. The leaf fibres itself makes good thread, thus the leaf would have been soaked and or pounded to leave behind stringy fibres attached to the tip and left out to dry. This could then later be used as both the needle and thread for sewing. Additionally, reports from the 17-and-1800s indicate that Inuit groups would make use of a variety of materials to fashion needles including fish and bird bones as well as bone parts that already had a hole present (foramen for nerve or blood vessels) or creating a groove in the base of the needle to which a thread can be fastened and even quills to which thread was stuck to with resin (Hatt and Taylor, 1969; VanStone, 1989). A needle does not necessarily have to have an eye, or resemble modern-day technologies, as in the examples above as well as for needles used by indigenous Australian communities who snapped a kangaroo fibula and rounded and smoothed the snapped end into a point (Bird and Beeck, 1980). The awl was used to pierce the hide/skin while the two sides were overlapped and dry sinew was then threaded through the hole rather than the awl pulling it through. It is thus possible that even stone could have acted as “needles” as all that is required is something that can pierce holes into hide and then thread it manually. Calvo *et al.* (2019) proved this with experimental studies to determine the use of specialised Upper Palaeolithic burins (Noailles burins) found at Isturitz Cave, Western Pyrenees. They determined that most of the burins were likely used to perforate medium to soft materials such as hides and were shaped for this intent, some with a notch acting as a stop (stop notch). These burins acted like awls and drills to create a rounded perforation likely preceding the sewing of a garment. Osborn (2014) investigated similar stone drills made from flakes found in North America. One edge or a part of an edge was shaped to have a thin pointed part, thought to be tools used to engrave various items at first but might have been used to pierce hide. Osborn (2014) however, argued that they were likely used to help create the eye in the needle instead. Lithic drills, awls and borers found in archaeological contexts would thus have to be further investigated, preferably aided with use-wear and experimental studies, to help understand the origins and complexity of sewing.

Use-wear analyses are particularly valuable in identifying the usage of both lithic and bone implements that have a multipurpose shape, such as a bone point that can be used for drilling, piercing, digging, sewing or hunting. Use-wear can be detected on bone tools, but when used on similar materials (for example: various soft materials) the use-wear can appear very similar to one another (LeMoine, 1994). In addition, wear left behind from manufacture as well as post depositional factors can make identifying specific use on bone tools very complicated. However, using other sources along with use-wear investigations, such as ethnographic and historic accounts as well as tool morphology and archaeological contexts, has proven useful (LeMoine, 1994; Stone, 2011). Extensive experiments to determine specific macro-and-micro use-wear as well as raw material is also extremely useful (Legrand, 2008; Buc, 2011; Stone, 2011; Wells *et al.* 2014; Bradfield, 2015; Arrighi *et al.* 2016; Derevianko *et al.* 2016; Martín *et al.* 2018; Wojtczak and Kerdy, 2018; Hohenstein *et al.* 2020; Pal *et al.* 2020). Stone (2011) made use of tribology which is a discipline that deals with understanding the properties of different surfaces and predicting the outcome of contact between those surfaces. Factors involved in generating use-wear are, the hardness of both the material being worked and the tool, the initial shape of their surfaces, the amount of friction present, force exerted and the duration of use. Using this information, Stone (2011) was able to derive a model for wear produced on bone from plant and animal fibres. Animal fibres should thus produce rounded borders, attrition that deforms the original surface of the bone, extensive polish and striations that can vary in size and orientation (Stone, 2011). The author did not predict pitting on the surface, which was substantiated by other use wear studies (e.g. Wojtczak and Kerdy, 2018), who also determined that when a bone awl is used in a drilling manner to perforate hide multiple grooves surrounding the circumference of the needle tip develop. These studies focus on the use-wear that is produced (more often on the working edge/tip), but studies rarely look at the patterns of where use-wear develop on the entirety of the tool itself. Furthermore, not many examples are present in studies of hollow implements used as needles, for example, like small bird bones that can act like a tube where the thread is fed through the hollow bone. The thread could either be thread through the bone after the bone has pierced through the hide or with it fed into the tube right up to the tip. d'Errico and Henshilwood (2007) reported on an awl from Blombos Cave, possibly older than 125 ka, made from bird bone which was shaped by scraping the shaft as well as the distal epiphysis. Smoothing of manufacture traces were identified around the tip, which indicated use before discard. Use-wear was not extensively tested to determine the exact use of the tool, but it might be worth analysing such hollow pointed bone tools for traces of sewing wear in future.

Pointed bone implements are often present in assemblages, which are easy enough to identify by their form. However, having additional information to determine if a tool, or a part of a tool might have been used in specific activities (in this case sewing) can help a researcher quickly identify potential pieces to investigate more closely or to identify parts of such tools. The primary aim of this study is to provide use-wear locations or patterns on pointed implements that could be used to help identify potential sewing needles in assemblages for further study, which might otherwise be overlooked. Furthermore, this paper applies these use-wear locations (along with other attributes) to a hollow tooth root from Little Muck Shelter (LMS), a Later Stone Age (LSA) site in northern South Africa, to determine if it was used for sewing activities.

Study site: Little Muck Shelter:

LMS is a shelter depression in a sandstone ridge situated near the Kolope River in the Shashe-Limpopo confluence area (SLCA), South Africa (Figure 1). The shelter has an opening of approximately 12m and has a deep recess with a low ceiling that rises steeply towards the entrance. Multiple panels of rock art are present and include giraffe, kudu, elephant, feline forms, impala, and humans, as well as non-representational lines and comb-shapes. The site also has rich archaeological deposits from foragers, Iron Age farmers as well as some 19th century occupants. The shelter was predominantly occupied by foragers from approximately 200 BCE, followed by a contact period with early Iron Age farmers migrating to the area (350 - 900 CE). Between 900 – 1000 CE the most intensive occupation occurred before the sequence shows a decline in LSA artefacts. The site was possibly appropriated by farmer communities around 1000 – 1300 CE, interpreted from an increase in farmer items and the possible occurrence of boys' initiation at the shelter (Hall and Smith 2000). The front of the shelter is partly surrounded by bedrock that has multiple gaming boards, hollows and cupules carved into the bedrock. However, the renewed excavations done by the Hunter-gatherer Archaeological Research Project (HARP) are showing a continued presence of foragers at the site, producing LSA materials after 1000 CE and into the Mapungubwe phase (1220 – 1300 CE), albeit in lower frequencies (Forssman et al. 2023).

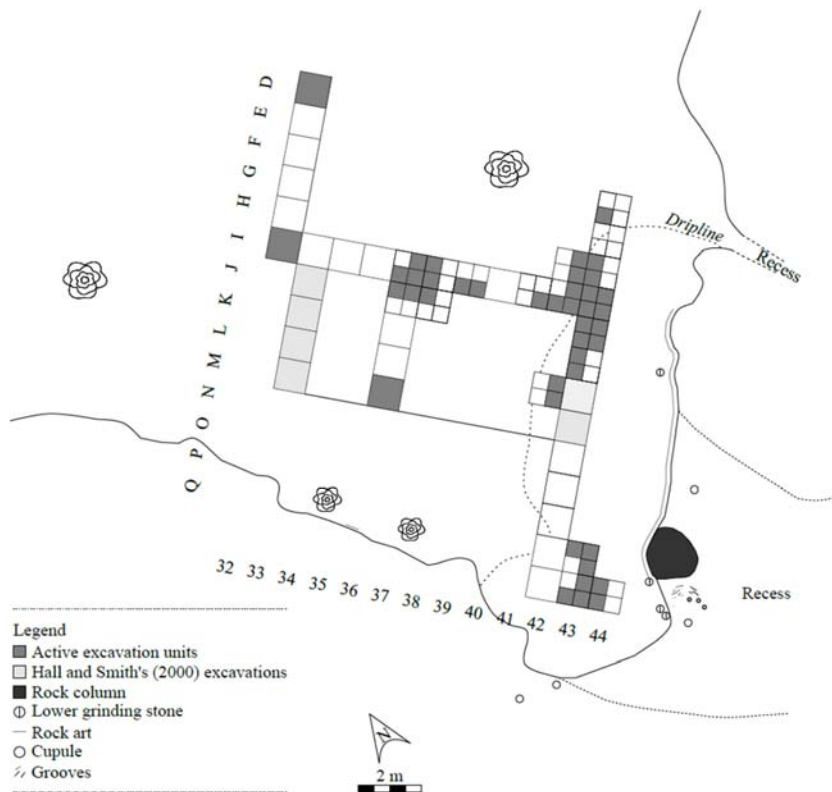
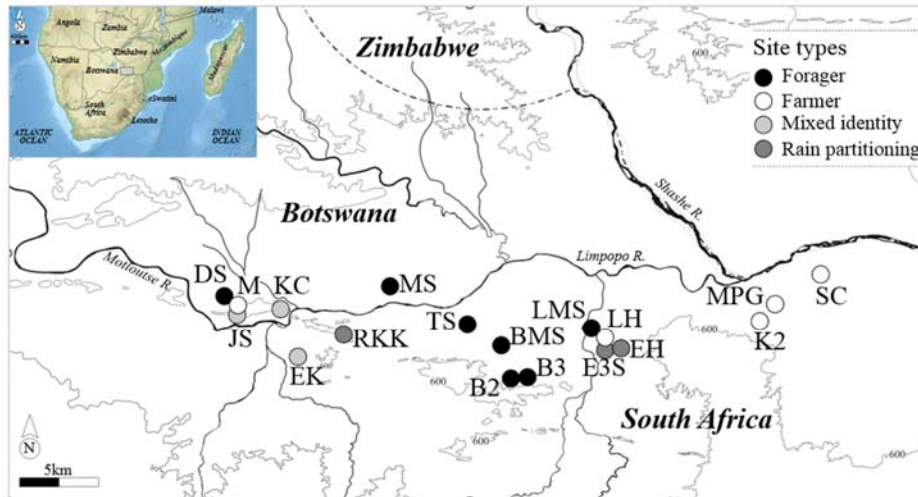


Figure 1: Map of the Shashe-Limpopo confluence area (above) and the excavation units at Little Muck Shelter (below).

Other sites are in proximity to LMS include a large Iron Age farmer settlement named Leokwe Hill (Calabrese 2005), approximately 1.5km south of Mbere Complex (Kuman *et al.* 2005) and Kaoxa Shelter, an impressive rock art site (Eastwood and Eastwood 2006). Due to the proximity of LMS to Leokwe Hill, Hall and Smith (2000) hoped to examine social relations

between resident foragers and nearby farmers and started the first excavations at LMS in 1998. They excavated two 1 x 1m squares next to one another on the inside of the shelter and a trench consisting of four 1 x 1m squares in the open-air portion of the site. The renewed excavations at Little Muck which began in 2020 under HARP were intended to obtain a secure chronology from the site and expand on the areas excavated inside and outside of the shelter (Figure 1).

Methodology:

Hollow bone needles were experimentally created and used to sew hide pieces to obtain use-wear locations and patterns which could be used to identify implements that were potentially involved in sewing activities at LMS. Chicken ulnae were selected because they are small but sturdy and most importantly because they are hollow. Sewing hide was tested as a suspected hollow tooth root was found in the LMS assemblage with distinct wear patterns and alterations. The bones were washed and cleaned thoroughly using warm soapy water to remove any marrow, tissue, and fats. The proximal end (back) was scraped down on a rock to be flat and perpendicular to the shaft of the bone, whereas the distal end (front) was scraped down at a 45° angle to create a pointed end (Figure 4). All of the bone needles were spraypainted with a layer of luminous orange paint and left to dry to assist with identifying wear regions on specimens. This design was chosen to replicate the shape and form of the suspected needle sample from LMS.

A 30 x 60cm square of scraped Kudu (*Tragelaphus strepsiceros*) hide was used for experimentation. Holes were pierced into the hide roughly 1cm apart with a sharpened bone point made from a cow (*Bos taurus*) tibia (Figure 2). The two edges were then sewn together with an overlap to ensure the holes met up. Each experimental needle was used to sew a pouch made from the hide (Figure 3). The thread (strips of semi-dried plant fibres, species unknown) was then removed, and the next experimental needle was used to do the same. Photos were taken at various stages of use after passing through 15 holes (strokes) to get an idea of use-wear progression.

Four experimental needles were used: two where the tip points slightly upwards, like the artefactual needle discovered at LMS; one with the tip pointing forward; and one where the tip points slightly downwards to determine if use-wear differs depending on the shape of the tip (Figure 4).



Figure 2: Pointed bone used to make perforations in hide.



Figure 3: Pouch made with experimental needles.

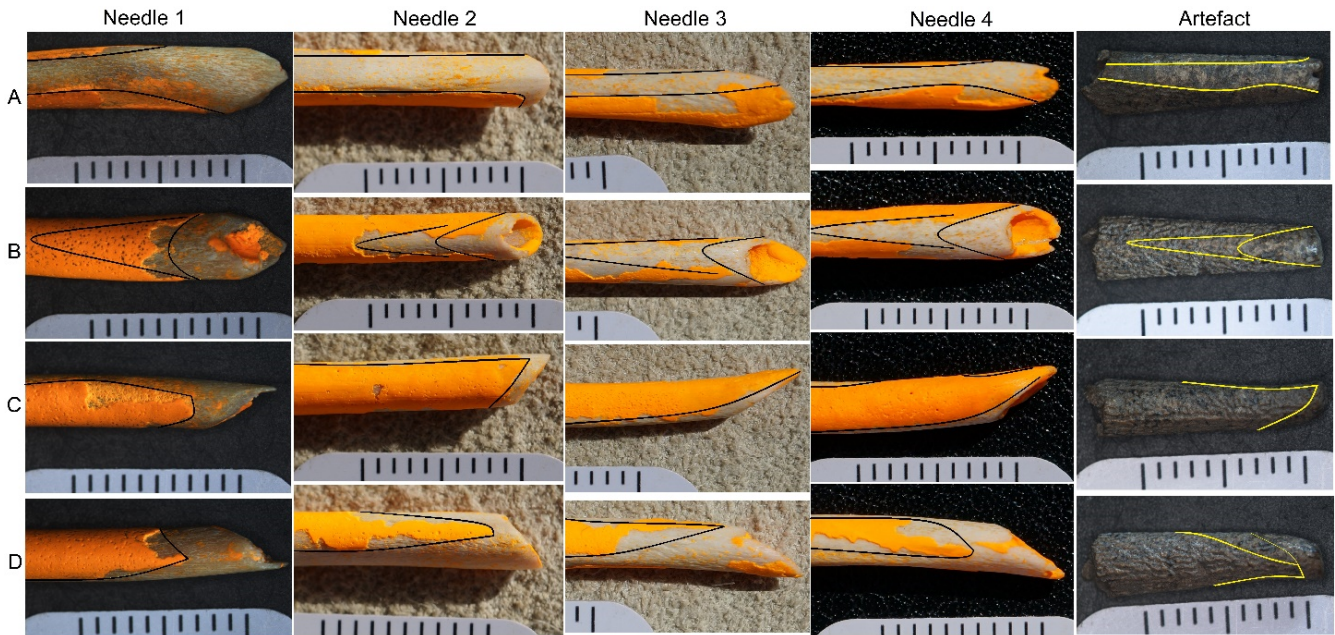


Figure 4: Use wear patterns of experimental needles (after 60 strokes) alongside the artefactual needle.

Results:

The general use-wear patterns on the experimental needles showed up after the first 15 strokes and became more prominent after another 15 strokes, resulting in more polishing in areas that made contact with the hide and fingers. Figure 4 shows the wear patterns for the experimental needles for the dorsal, ventral, and lateral sides. The dorsal side shows abrasion along the entire length of the needle from the proximal to distal tip. The movement of the needle when pulling it through the hide from the other side lets the dorsal side scrape up against the hide (Figure 5D). The grasp from the thumb pulling the needle through adds to the polish especially near the distal tip (Figure 5). The ventral side shows abrasion and polishing predominantly near the distal tip, due to the sliding motion when entering the perforation, but also due to the index finger grasping the base of the tip when pulling it through the hole. Often the grasp has to be tight as the needle can get stuck and needs to be pulled with some force, this sometimes results in the thumb and index fingers slipping off and is likely what results in the extensive polish on the ventral side of the tip (Figure 6B). The fingers can slip off more easily if the hands are sweaty, which can be prevented by lightly dusting the hands with sand. This fine sediment on the other hand can add to abrasion and polish on the areas where the fingers grasp the needle. The ventral side shows two areas of differing rates of abrasion and polishing as can be seen in Figures 4B and 6B. This is likely because the index finger grasps the very tip of the distal end

more often than further back, especially as the needle tip starts to come out of the other end it is grasped at the tip to start pulling it through the perforation. As it comes through the grasp is adjusted further towards the proximal end to get a stronger grip. Interestingly, the lateral sides can determine handedness as the left lateral (when viewed from the dorsal side from proximal to distal) will show more wear when a right-handed individual is using the needle, and the right lateral will likely show more wear when a left-handed individual is sewing. Left-handed wear was not tested but can be inferred. The experiments were done with a right-handed individual; thus, wear shows up predominantly on the left lateral (Figure 4D). This is also visible to some extent on the dorsal side, as the wear tends to curve towards the left lateral (Figure 4A). This is due to the person sewing pulling the needle up and towards themselves letting the needle contact the hide more often on the dorsal side and the lateral side facing them.

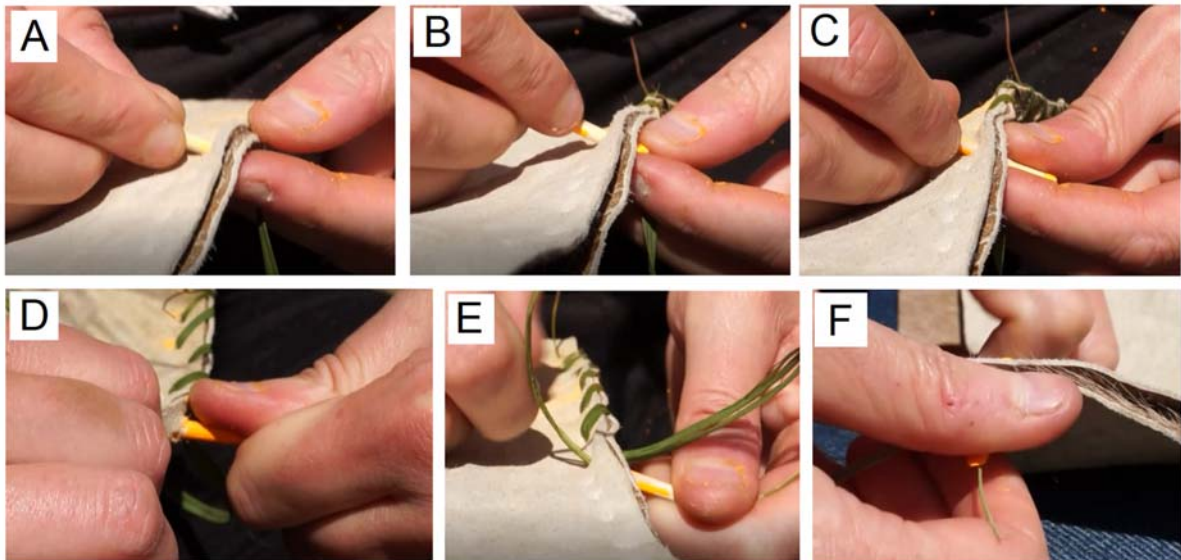


Figure 5: Prehension while sewing. A: Needle is pushed through perforation with tips of thumb and index figure on the right hand. B: Tip of needle is grasped with the thumb and index finger of left hand and needle is pulled while pushing it with right hand. C: Left hand thumb and index figure's position adjusted to further up the shaft to get a better grip. D: Needle is pulled through by left hand while the right hand holds back the hide. E, F: Different angles showing the left-hand grasp.

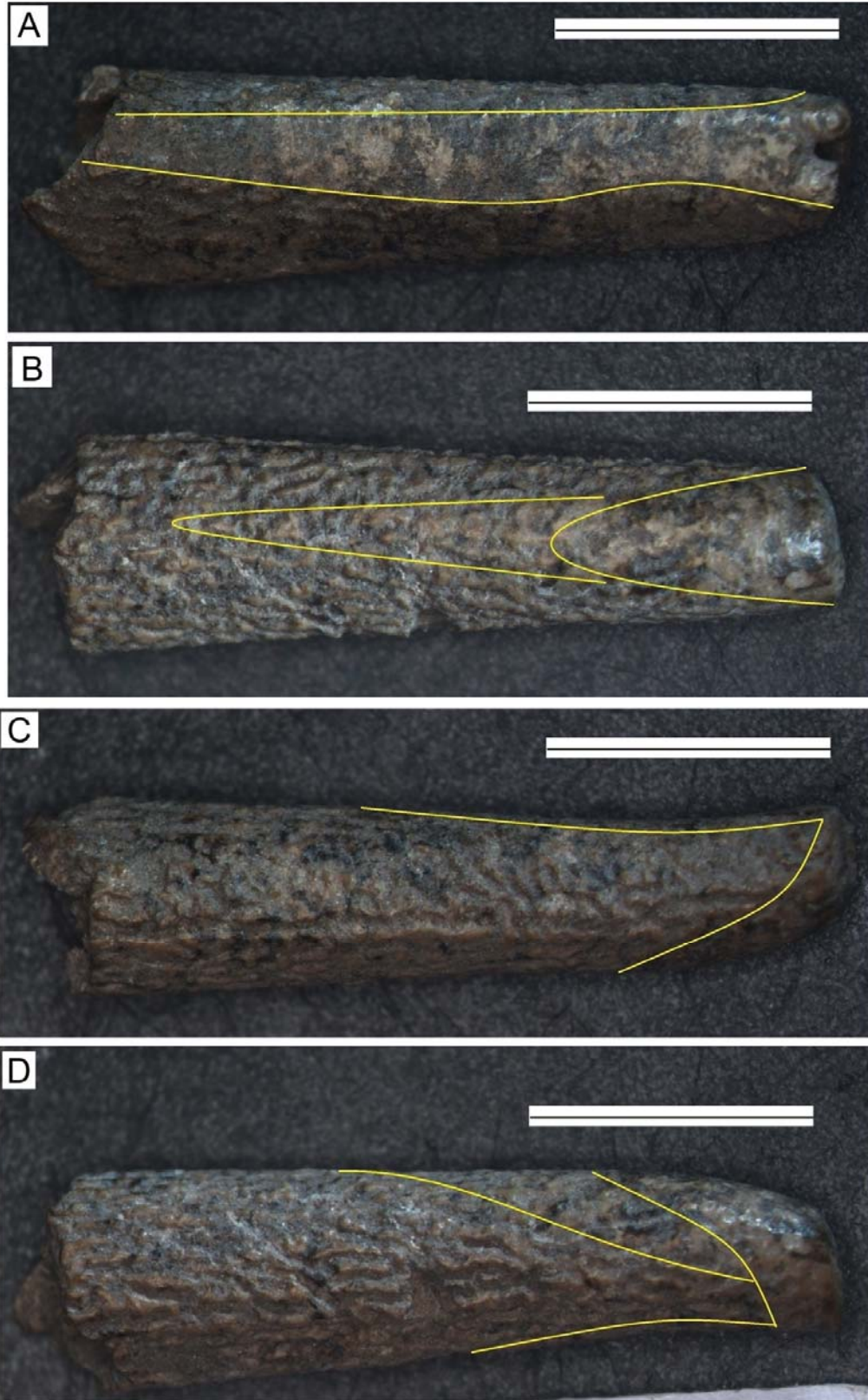


Figure 6: Artefactual needle from LMS showing use wear areas. A: dorsal side; B: ventral side; C: right lateral; D: left lateral. Bar is equal to 1cm.

The artefact from LMS is a hollow tooth root from a bovid (species unknown) and was possibly used for sewing as the use-wear is consistent with the experimental needles. The distal tip shows signs of being prepared before use where the hole has been scraped on the inside rim to expand the hole (Figure 8 and 10). In addition, the artefactual needle would have been used by a right-handed individual due to the wear patterns on the left lateral side being more extensive than the right (Figure 6D). The artefact from LMS also has a step fracture on its tip (Figure 7) as does the experimental needle 4 (Figure 4) which developed a small fracture during the sewing experiments, but it was uncertain if that was due to a weakness created during the initial shaping of the tool. Therefore, to test if these types of fractures can occur during the sewing process one of the experimental needles was used for further experiments by threading existing perforations in the hide for another 100 strokes. A fracture did not occur, however, when used to try and puncture/perforate the hide material, as in Figure 9, a step fracture did occur. It is thus possible for step fractures to occur on the tip of the needle if it is used to puncture the hole in the hide or if the holes are small, and the tip of the needle is used to push through and expand it further for the needle to fit. This can also occur if the tip of the needle catches the hide while trying to thread it through if the person sewing misses the hole. Further use was not employed on the needle to determine wear of the damaged area, but would likely smooth, round and polish angular or rough edges, as seen on the artefact in Figure 7.



Figure 7: Distal tip of artefact and experimental needle showing step fracture.

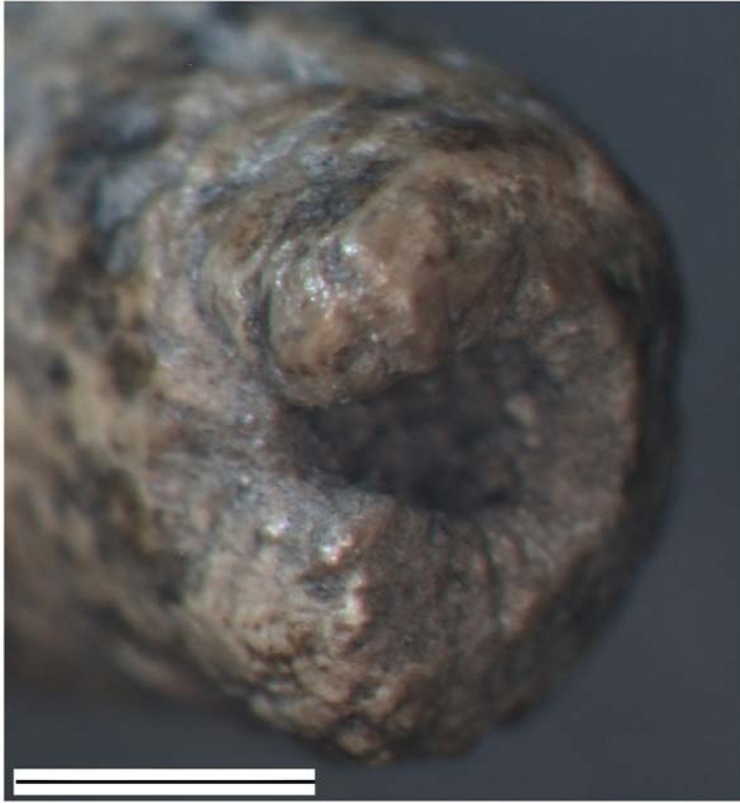


Figure 8: Distal tip showing the widening of the hole around the inside rim before use. Use-wear present as polish and rounding of angular or high lying areas. Scale is equal to a millimetre.

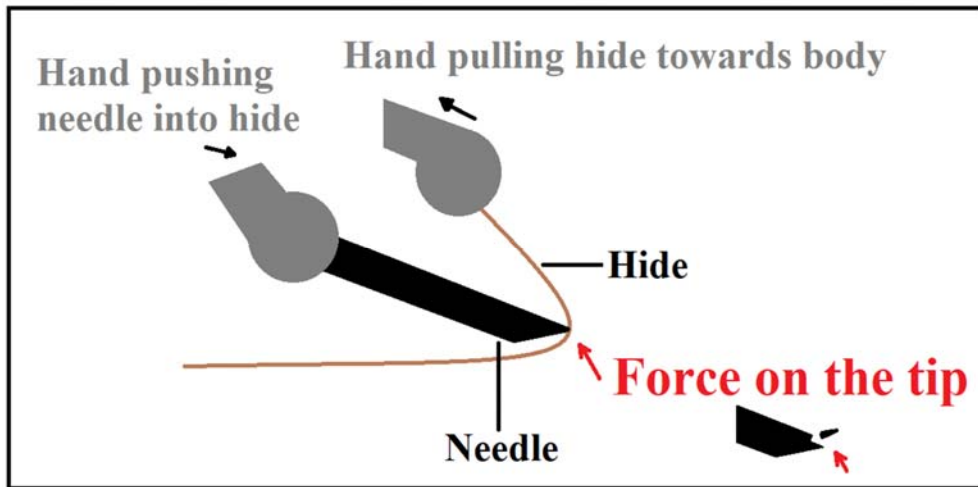


Figure 9: Diagram showing the method of puncturing a hole into the hide and how forces are directed at the tip.

Discussion and conclusions:

It is possible to determine general use-wear patterns on specific tools that can be used to determine the function of artefactual tools, such as needles made from bone. Studies often look at use-wear on working edges of a tool to determine specific damage patterns created from working certain materials, but rarely look at finding the overall patterns of where use-wear develops on the entirety of the tool. This study focused on determining the pattern of use-wear formation on hollow bone needles rather than testing if use-wear was material specific. Micro use-wear was not analysed for the artefact; nevertheless, it is something that could be undertaken in the future to confirm what materials were being worked (hide, plant or other). This type of study is however largely dependent on inferring similar techniques for varying individuals. Sewing movements, for example, may not be consistent between people and were based on what felt natural in this study. The author was recorded while performing the tasks and footage was reviewed afterwards. The experimental needles only show the areas that would be most affected by constant abrasion and were not subjected to intensive use to fully develop wear on the bone surface itself. Some polish was observed on the bone surface, but it would likely take many hours for the wear to show up more prominently on the bone, such as on the artefact. [Legrand \(2008\)](#) and [Stone \(2011\)](#) indicates that prolonged use does indeed wear the bone surface down and generates extensive polish. In addition, use-wear on the artefact is more easily noted due to the natural ridges on the tooth root, which are the first to be polished and worn down from repetitive contact. Wear inside the needle was also not analysed as more specialised equipment was needed to get a decent resolution of any potential wear caused (if present) by thread. This is something that can be analysed in future, especially if more such artefacts are discovered.



Figure 10: Other tooth roots found at LMS alongside the suspected needle (top right) as well as two distal tips (A & B) alongside the suspected needle's distal tip (C).

It is also paramount to consider natural wear that can occur on bone elements after deposition or from other processes. The artefact is likely the root of a bovid tooth (species unknown), and while similar root pieces were found in the assemblage they lacked the specific wear such as on the artefact in this study. However, wear is present in certain parts and can be due to how tooth roots naturally wear in the animal's mouth over time (see Figure 10). It is thus possible that use-wear patterns might simply resemble specific use patterns by co-incidence, however the deliberate shaping of the inside rim of the hole, as is clear in Figure 10 bottom right, is not observed on the natural pieces and could thus be a good indicator of intent to be used for sewing. Expanding research to look more closely at hollow bone remains and others, especially for Middle Stone Age sites, could help discover the origins of sewing and early sewing implements. Additionally, making use of both micro-wear as well as overall use-wear patterns

on tools might prove to be beneficial in determining use of bone tools, in future, alongside other sources such as ethnographic and archaeological contexts (LeMoine, 1994; Stone, 2011). These and future methods could help shed light on the origins of sewing as the earliest eyed sewing needles are found in Eurasia and date to approximately 50Ka (Shalagina *et al.* 2018). However, studies done on body lice (*Pediculus humanus humanus*), which are associated with clothes, indicate that people were already wearing clothes between 80-170 ka (Toups *et al.* 2011) and that sewing possibly originated on the African continent. Therefore, expanding research to look more closely at hollow bone remains and others, especially for Middle Stone Age sites could help discover the origins of sewing and early sewing implements.

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