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Flat and twisting chains: An analysis of the articulation systems of the bone pins from Chavín de Huántar (1200–500 BCE), Ancash (Peru)

Chaînes plates et ondulées : analyse des systèmes d'articulation des épingles en os de Chavín de Huántar (1200-500 avant notre ère), Ancash (Pérou)

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Abstract: The archaeological excavations conducted at the Formative Andean ceremonial centre of Chavín de Huántar (1200–500 BCE), Ancash, Peru, by the Chavín de Huántar Archaeological Research and Conservation Program, led to the discovery of a group of articulated and sculpted bone pins. This assemblage consists of approximately 87 pieces and, at the current stage of investigations, is unique for the Formative Period (1800–200 BCE) in the Central Andes. The pins display a superior technical ability, as each is made from a single piece of bone that has been cut to the desired form composed of three articulated sections: a long, thin needle articulated with a chain of one, two, or three links, itself hinged to its proximal termination in a carved motif. The singularity of these objects can be appreciated with their complex articulation system made with interlocking links, which represents a technical challenge. A thorough examination of the artefacts reveals two categories of links, which create technically distinct chains and divide the corpus into two primary subgroups: flat chains and twisting chains. This contribution presents analytical observations and preliminary experimental tests that studied the shaping processes and production of these chains.
Keywords: Central Andes; Formative Period; Bone industry; Bone pin; Articulated artefact.

Résumé : Dans les Andes centrales préhispaniques, la période du Formatif (1800-200 avant notre ère) correspond à l'aboutissement d'un long processus de complexification et de hiérarchisation sociale, identifiable par l'émergence de grands centres cérémoniels dans lesquels se développent des pôles d'artisanat de prestige pour produire des objets en lien avec les pratiques cultuelles. Les fouilles archéologiques conduites dans ces centres ont mis au jour des artefacts de natures diverses (céramique, malacologique, lithique, métallurgique) témoignant de connaissances techniques abouties. Parmi eux, les productions de l'industrie osseuse constituent un pan majeur de la culture matérielle et regroupent des pièces attestant une haute maîtrise technique. Ces artefacts en os nous invitent ainsi à repenser l'investissement mis en œuvre dans la fabrication des productions matérielles destinées aux centres cérémoniels, dont la valeur ne repose pas uniquement sur le choix de la matière première, mais dépend également de la sophistication des moyens techniques mis en œuvre.
La découverte d'un ensemble d'épingles en os articulées et sculptées à Chavín de Huántar (1200-500 avant notre ère, Ancash, Pérou), lors des fouilles menées dans le cadre du Programme de Recherche Archéologique et de Conservation Chavín de Huántar (dir. John W. Rick), souligne la volonté de sophistication et d'innovation technique deployée dans la production d'objets ornementaux en os. Cet ensemble comprenait approximativement 87 pièces (nombre minimum d'éléments) qui furent fracturées intentionnellement avant d'être déposées dans un canal souterrain hydraulique du site. Il s'agit d'une découverte exceptionnelle, à la fois par la quantité de pièces réunies et par leur qualité d'exécution, qui reste, en l'état actuel des recherches, unique pour le Formatif dans les Andes centrales. Ces épingles articulées ont été taillées dans une seule baguette d'os dans laquelle s'articulent trois sections : une longue et fine épingle, une chaîne composée d'un, deux ou trois maillons, et une partie avec un motif sculpté. Elles présentent une très haute technicité qui se mani-

feste dans la multiplication des techniques utilisées pour les façonner et les décorer. La singularité et la complexité de ces objets résident tout particulièrement dans leur système d'articulation par emboîtements successifs de maillons. L'examen des fragments, mené aux niveaux macroscopique et microscopique, révèle l'existence de deux catégories de maillons, créant ainsi des chaînes techniquement différentes et divisant donc le groupe en deux sous-groupes : celui des chaînes plates et celui des chaînes ondulées. Ces désignations font référence à la morphologie des maillons qui composent les chaînes et à leurs procédés techniques de façonnage. Une chaîne est dite « plate » lorsque les deux perforations de ses maillons ont la même orientation et ont été perforées sur l'axe longitudinal du support en os ; alors qu'une chaîne est dite « ondulée » lorsque les deux perforations de ses maillons n'ont pas la même orientation, l'une ayant été perforée sur l'axe longitudinal, et l'autre sur l'axe transversal du support, créant ainsi un maillon avec un volume beaucoup plus prononcé que celui d'un maillon plat.
Cet article propose une analyse approfondie des deux systèmes d'articulation du groupe des épingles articulées de Chavín de Huántar. Il détaille les observations morphométriques et techniques relatives aux procédés de façonnage employés lors de la production des deux types de chaînes, discute du recours [...] l'obtention d'une articulation, et présente les premiers tests expérimentaux réalisés.
Mots-clés : Andes centrales, Formatif andin, industrie osseuse, épingle en os, artefact articulé.

INTRODUCTION

In ancient Peru, the Formative Period (1800–200 BCE) is the result of a long process of social complexification and hierarchisation, which can be recognised by the emergence of large ceremonial centres, to which were attached prestigious craft centres for the production of objects associated with social representation and religious practices. Archaeological excavations of these ceremonial centres have revealed a wide range of material productions, among which there are complex and diverse bone artefacts that demonstrate a high level of technical sophistication. However, this category of artefacts has received little attention; research on the bone industry has been largely limited to hunter-gatherer-collector groups in South America (Lavallée, 1977 and 1995; Lavallée and Julien, 1980; Julien, 1981; Christensen, 2016), and remains surprisingly rare when dealing with Andean societies organised on a larger scale (Moore, 1999 and 2013; Sayre et al., 2015; Rosales Tham, 2016; Rosenfeld and Sayre, 2016; Rosales Tham and Vásquez, 2020; Ferras, 2023[1]; Rosenfeld, 2023).

Formative bone products are mainly straight and flat objects; they can be perforated and carved, and they can have anatomical or geometric volume, as per the spatulas, ceremonial spoons, pins, pipes, and snuffing tubes that are well-known artefacts registered during archaeological excavations in ceremonial centres. A notable category of artefacts stands out from this panorama: the articulated artefacts that materialise a remarkably sophisticated level of technical complexity and innovation. The most representative examples of these artefacts have been found at Chavín de Huántar.

The Peruvian archaeological site of Chavín de Huántar is located in the north-central highlands of the Ancash Department, on the eastern slope of the Cordillera Blanca peaks at an elevation of 3,180 m above sea level. Chavín is an important Andean monumental ceremonial centre, with its main development between 1200 and 500 BCE (Tello, 1943 and 1960; Lumbreras, 1972, 1989, 1993, 2007, and 2014; Burger, 1992, 1998, and 2019; Rick et al., 1998 and 2009; Rick, 2004, 2006, 2016, and 2017). The first archaeological interventions at Chavín occurred in 1919, and the site has been excavated since 1995 by the Chavín de Huántar Archaeological Research and Conservation Program, directed by J. W. Rick. The site is organised around major buildings (platform mounds) surrounding square and circular sunken plazas; Chavín architecture is notable for its extensive network of underground and enclosed structures called galleries and canals.

In 2016 and 2017, the excavation of an underground canal by the Chavín de Huántar Archaeological Research and Conservation Program led to the discovery of a group of articulated and sculpted bone pins displaying an exceptionally high degree of technical sophistication (Rick and Mesía, 2017 and 2018; Ferras, 2023[2]). Each was cut from a single piece of bone into three articulated sections: first, a long and thin needle, articulated with a chain comprising one, two, or three links, then a proximal end decorated with a carved motif. The singularity and complexity of these objects can be appreciated through their complex articulation system, made with interlocking, movable links. The purpose of this article is to provide a comprehensive examination of the articulation systems employed in these bone pins from Chavín de Huántar.

1. ARTICULATED BONE PINS ASSEMBLAGE

The Chavín de Huántar articulated bone pins assemblage was discovered during the excavation of an underground stone-built canal with hydraulic functions, so-called Canal de Explanada 7, situated beneath the Explanada sector (Rick and Bazan Perez, 2012, 2013 and 2014; Rick et al., 2016 and 2018; Arias Espinoza, 2021).. Sediments had filled up the canal, and four distinct stratigraphic levels were identified, each containing only diagnostic Chavín material, including the characteristic Janabarroide ceramic style (Rick et al., 2009, pp. 113–114, fig. 15), associated with the chronological and architectural phase known as the Black and White Stage, between 800 and 500 BCE. All the fragments which belong to the articulated bone pins assemblage were registered from the third level, along eleven consecutive metres.

1.1. Quantification

The assemblage consists of approximately 87 pieces (MNE), which are subdivided into 405 fragments (NR). It is noteworthy that none of the 87 original artefacts were deposited intact, and all were intentionally fractured.[3] The group is categorised into six distinct fragment types (fig. 1): needle fragments with chain and with proximal part with a motif (a), needle fragments with chain (b), needle fragments (c), chain fragments with proximal part with a motif (d), chain fragments (e), proximal part with a motif (f).

1.2. Characteristics

During the Formative Period, the tools available for working bone material were lithic tools, made of flint or obsidian, such as scrapers, flakes, and points (Onuki, 2014, p. 112; Rosenfeld, 2023). The articulated bone pins indicate a specific technical ability in their working, as each was made from a single matrix of bone that has been meticulously shaped using lithic tools to achieve the intended form composed of three articulated sections: a long, thin needle articulated with a chain, itself hinged with a final motif-shaped segment. The articulated pins are characterised by their elongated form; they are perforated and engraved pieces. Despite their fractured condition, the longest fragments measure 15.5 and 15.6 cm; the thickest (at the level of the chain) is 0.50 cm, and the thinnest is 0.18 cm.

The technical specificities of these artefacts are detectable in their shaping and finishing processes (Ferras, 2023). The articulation system, which consists of the successive interlocking of links that create the chain, is one of the most noteworthy features of this group of artefacts. A thorough examination of the chains revealed the presence of two distinct technical and morphometric categories, respectively denominated "flat" and "twisting" chains. These two categories of chain are distinguished by the orientation of their perforations, which gives the links different shapes.. While the two perforations of flat links are both in the longitudinal section of the bone matrix, twisting links have one perforation in the longitudinal section and one in the transverse section. This central element will be detailed and discussed below. Chains can consist of one, two, or three links.

Another specific point is the effort invested in the finishing of these pins by using the heat treatment technique, identified through the characteristic dark and lustrous surface created. This technique requires a high degree of expertise to attain the desired finish without compromising the integrity of the object (Sidéra, 2000). A systematic analysis of the assemblage of all the 405 fragments revealed three distinct levels of heat treatment based on the regularity of the colouration: total (regular dark colouration), identified on 235 fragments (58.08% of the NR); intermediate (non-regular dark colouration), identified on 152 fragments (37.57% of the NR); and almost inexistent (without clear evidence of dark colouration), identified on 18 fragments (4.44% of the NR).

On the needle section, the heat treatment was combined with linear polishing and received different finishing processes, such as the addition of pigments to create a set of bichromatic stripes alternating dark (colouration via heat treatment) and light stripes (colouration via pigment application), which are regularly repeated on the needle and demarcated by a fine vertical groove. Alternatively, oblique abrasion is also employed to create a set of striations described as "bi-textural" for the alternation of linear

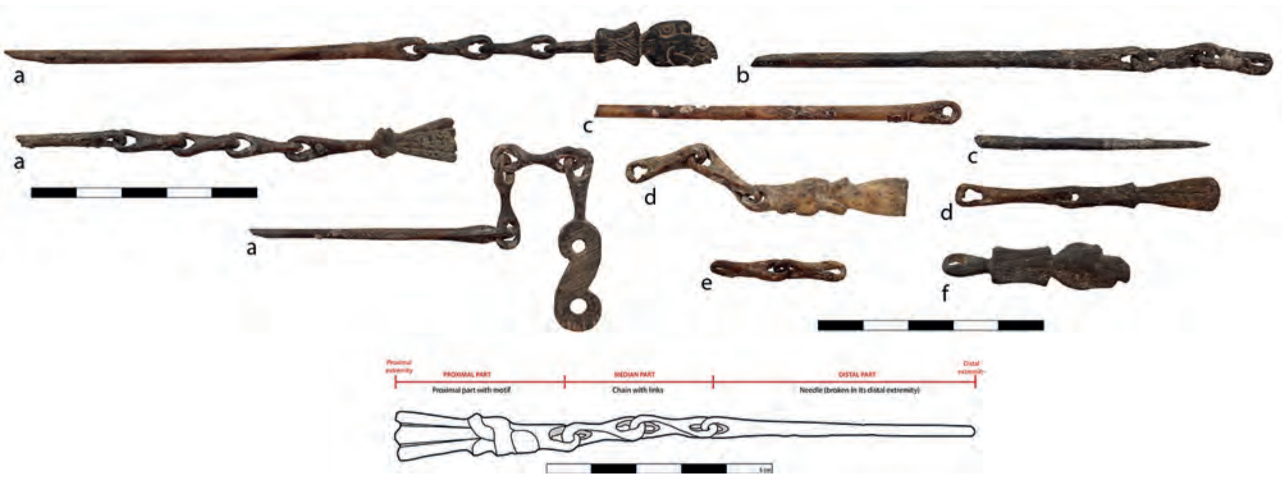

Fig. 1 – Diversity of fragments within the articulated bone pins assemblage: a. Needle fragments with chain and with proximal part with a motif; b. Needle fragments with chain; c. Needle fragments; d. Chain fragments with proximal part with a motif; e. Chain fragments; f. Proximal part with a motif (scale: 5 cm).

***Fig. 1** – Diversité des fragments dans l'ensemble des épingles en os articulées : a. fragments d'épingles avec chaîne et partie proximale avec motif ; b. fragments d'épingles avec chaîne ; c. fragments d'épingles ; d. fragments de chaîne avec partie proximale avec motif ; e. fragments de chaîne ; f. partie proximale avec motif (échelle : 5 cm).*

polishing and oblique striations. They also display regularity, and each is demarcated by a fine vertical groove.

Moreover, the articulated pins are distinguished by the motif adorning their proximal extremity; there are a total of fifteen distinct motifs. Some are simply the result of cutting the bone to create a general silhouette, whereas others combine the general shape with incisions to create details, and a few present pigments remains identified as cinnabar.

Despite the apparent homogeneity of the assemblage, heterogeneity is evident in several aspects, including the articulation system with two distinct chain types, the surface finishing processes, and the extensive range of motive shaping on the proximal section.

1.3. Technical and formal subgroups

The preliminary analysis highlights the variables present within the general assemblage of articulated pins. Through the analysis of these variables, two technical and formal subgroups can be identified (fig. 2).

Needle fragments with bi-textural treatment are invariably articulated to a flat chain composed of two links, and the proximal part always receives the same motif: an S-shape, which may present some cinnabar pigment remains. These fragments constitute the first subgroup, and are distinguished from the other fragments in every aspect: by the bi-textural finishing and the remarkable thinness of the needle, whose diameter never exceeds 2 mm; by the flat two-links chain; and by the repetition of the same motif (fig. 2a).

Such a consistent association of features is not observed among other pieces in the group, and the identification of other subgroups is therefore not as straightforward: either there are insufficient elements to assess the repetition of common patterns, or the elements are subject to change. Consequently, it is only possible to discern one general subgroup composed of artefacts featuring a pin, which may be monochrome or bichrome, a twisting chain with one, two or three links; terminating in a proximal part carved into a variety of motifs (fig. 2b).

Therefore, among the articulated pins assemblage, there is only one restrictive and homogeneous subgroup with a single type of needle, a single type of chain (flat with two links), and a single motif that is repeated from one piece to another. All the other elements constitute a

Fig. 2 – Fragments from the two technical and formal subgroups: a. Flat chain subgroup; b. Twisting chain subgroup.

***Fig. 2** – Fragments des deux sous-groupes formels et techniques : a. sous-groupe des chaînes plates, b. sous-groupe des chaînes ondulées.*

heterogeneous subgroup with distinct types of needles, a twisting chain comprising one, two or three links, and a large range of motifs.

2. FLAT AND TWISTING CHAINS: ANALYTICAL DISTINCTIONS

2.1. Formal and technical distinctions

A bone matrix, extracted from a bone to be turned into an artefact, constitutes a three-dimensional element with a longitudinal axis and a transverse section. The longitudinal section is defined as the axis between the matrix's distal and proximal extremities, and the transverse section represents the shape and thickness of the matrix. In the case of the articulated bone pins, the longitudinal section refers to the shape and measurements of the upper and lower faces of the matrix, and the transverse section refers to the shape and measurements of the two sides of the matrix.

Flat chains (fig. 3) are always composed of two links. They present a flat morphology because the link perforations have the same orientation, since they have been perforated in the longitudinal section of the bone matrix. Each perforation has a slight indentation, which serves to ensure better connection and interlocking with the subsequent link. The flat chain links have been cut to a very pronounced degree, removing a significant portion of the bone and thus increasing the proportion of voids in the articulation zone between two links. This importance of voids gives the flat chains a slender shape and ensures optimal articulation.

Twisting chains (fig. 4) can be composed of one, two or three links. They present a twisting morphology because the perforations on the same link and the two perforations that create an articulation do not have the same orientation: one has been perforated in the longitudinal section of the bone matrix, while the other has been perforated in the transverse section. To achieve this shaping, it was necessary to work on a thicker and wider paraxial bone matrix than for flat chains. Indeed, the three-dimensional morphology of the twisting chain necessitates that the width and thickness of the paraxial matrix to be of equal dimensions, whereas in the case of the flat chain, which presents a flatter aspect, the thickness does not need to be equal to the width.

The assemblage demonstrates a preponderance of twisting chains, with a minimum of 81 fragments, in contrast to the 15 fragments assigned to flat chains. Consequently, the corpus exhibits an overwhelming dominance of twisting chains, accounting for 84.4% of the total fragments, while flat chains comprise a mere 15.6%.

2.2. Morphometrical analysis

From a morphometric perspective, flat chains tend to be longer than twisting chains, and flat links frequently exceed twisting links in length (fig. 3 and fig. 4) On average, a flat link measures 2.05 cm in length, while a twisting link measures 1.77 cm. On each pin, three measurements were taken for link widths (fig. 3a and fig. 4a): the central width, which is always the narrowest, and the widths at the two perforations. The average central width for flat links is 2 mm, while it is 3.2 mm for twisting links; and the average width at the perforations is 6.1 mm for flat links and 5.4 mm for twisting links. Additionally, the thickness at the perforation level is bigger for twisting links, averaging 2.25 mm, as compared to 1.6 mm for flat links.

This morphometric data tends to underscore the fact that the processing techniques for bone material differ between flat and twisting chains. The two types of links and the articulation they produce are not the result of the same technical process.

2.3. Technical traces

Distinct technical traces were identified on the fragments through a combination of macroscopic and microscopic observations, using both an optical and a scanning electron microscope. On the needle section surface,

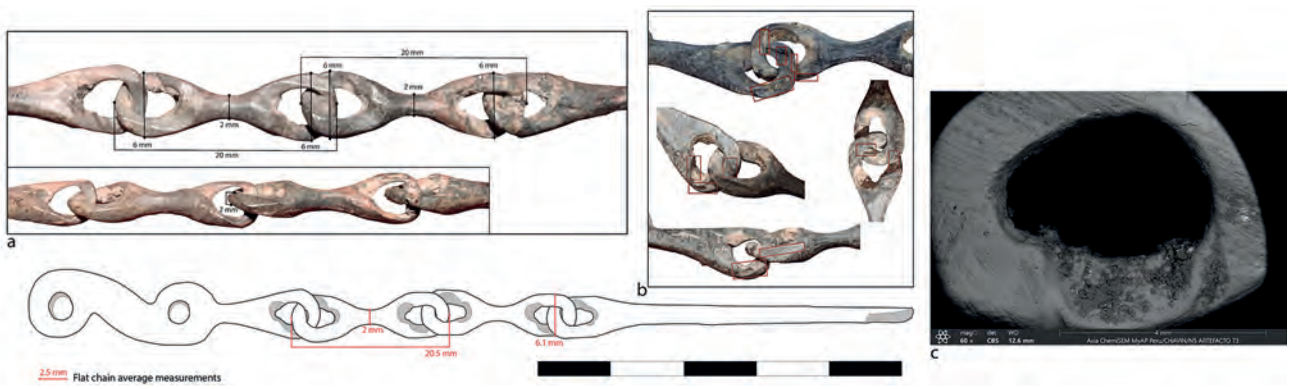

Fig. 3 – Flat chain analysis: a. Morphometric details; b. Technical traces; c. Magnification of a flat perforation (SEM view, ×60, MyAP Peru).

***Fig. 3** – Analyse de chaînes plates : a. détails morphométriques ; b. traces techniques ; c. vue augmentée d'une perforation plate (MEB, ×60, MyAP Peru).*

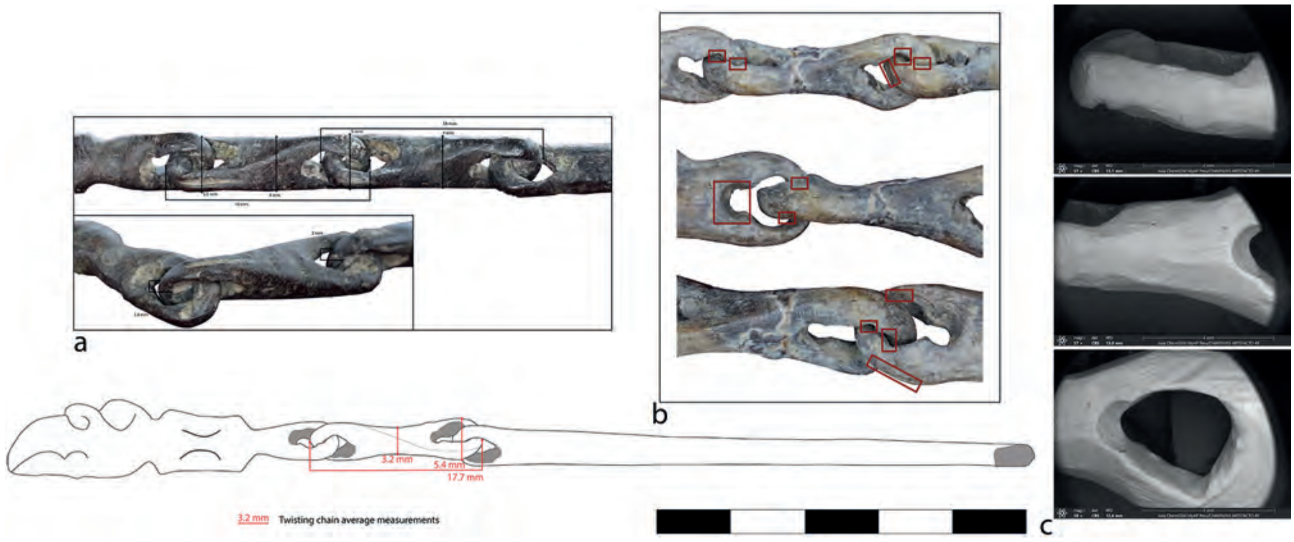

Fig. 4 – Twisting chain analysis: a. Morphometric details; b. Technical traces; c. Magnification of a twisting link (SEM view, ×57, ×57, ×58, MyAP Peru).

***Fig. 4** – Analyse de chaînes ondulées : a. détails morphométriques ; b. traces techniques ; c. vues augmentées d'un maillon ondulé (MEB, ×57,×57,×58, MyAP Peru).*

scraping and polishing traces were clearly discernible when examined under a stereoscopic microscope, with rectangular longitudinal shape with transversal traces inside for the scraping technique, and longitudinal parallel and unidirectional traces for the polishing technique. To identify technical traces related to the production of the chain and its articulations, macroscopic observations were complemented by scanning electron microscopy (Provenzano, 2004; Sidéra and Legrand-Pineau, 2006; Legrand and Sidéra, 2007). For both flat and twisting chains, the techniques used are circular scraping to drill, incising, and scraping, realised with lithic tools of flint and/or obsidian, such as scrapers, flakes, and points.

In the case of flat chains, the articulation of two links results from a cut in the thickness of the bone matrix, which is then split into a lower part and an upper part to obtain the lower part of link 1 on one side and upper part of link 2 on the other side. Producing an articulation between two links requires four main steps: 1) Drilling of the contiguous perforations of the two links; 2) Combining incising and edge scraping on the bone to split the ends of the two links; 3) Incising the articulation space on the upper and lower sides of the matrix, at the junction of the external contours of each perforation, to separate it into two links; 4) Once the articulation is produced, scraping and abrasion to adjust the external shape of the perforation and the general shape of the links.

In the case of twisting chains, instead of splitting the bone matrix down the middle, the longitudinal and transverse axes are cut to produce a three-dimensional chain. There are five main steps in the production of the twisting articulation: 1) Drilling the contiguous perforations of two links, the first perforated in the longitudinal axis of the bone, the second in the transverse axis; 2) Incising the internal contours of each perforation to increase the space created by the perforation; 3) Drilling two fine perforations in the internal part of the contour of each perforation, at the junctions between the two future links; 4) From these two fine perforations per link, incising in the longitudinal axis between the two perforations of the longitudinal perforation and in the transverse axis between the two perforations of the transverse perforation to produce the separation of the two links. 5) Once the articulation is produced, the external shape of the perforation and the general shape of the links are adjusted by scraping and abrasion.

The multiplication of these sequences underlines the high level of technique required in the production of these two articulation systems, and thus underscores the choice to produce very complex and sophisticated artefacts.

Preliminary experimental tests and results on the articulation systems

This article presents below a brief overview of the initial experimental tests conducted to comprehend the technical processes involved in the articulation production.

In the context of Central Andes archaeological investigation, where technological approaches remain underdeveloped, the utilisation of experiments is not a prevalent process for deepening research, and experimental archaeology is mostly developed as a pedagogical resource for students or tourists (Quijano-Araníbar, 2018).

The technical complexity of Chavín's articulated bone pins assemblage underlines the necessity to formulate an experimental approach (Beyries, 2020; Christensen, 2020). The initial preliminary tests on the articulated systems are part of a larger experimental protocol that aims to elucidate the technical stages implicated in the fabrication of these highly specialised artefacts (technical experiments), and their functions and utilisation (functional experiments).

The experimental tests first focused on the articulation systems, as they represent the most salient and technically distinctive feature of the assemblage. First, observations of the traces visible on the surface of the chains and links were conducted to deduce the technical stages employed to make the articulation systems, and preliminary experimental tests were carried out to verify their probability. These preliminary tests were conducted with the objective of ascertaining the sequence of techniques and their localisation on the bone matrix. Indeed, for flat and twisting articulation, a critical aspect is the necessity to work on both faces and sides of the bone. With this in mind, a series of experiments were conducted to ascertain the optimal positions for each drilling, incision, and scraping, and to understand the succession of each distinct stage to create the articulation without causing any fractures.

These preliminary tests were carried out on two different materials, steatite and deer bone, worked exclusively with flint tools. The tools consisted of points, scrapers, and flakes, and were used to execute direct manual drilling, incising, and scraping. The bone blank was obtained by longitudinal grooving.

For initial experiments, we used a blank of steatite, a soft stone primarily composed of talc, which provided us with a general understanding of the technical sequences employed to produce an articulation. This process encompasses the sequence of techniques and gestures, the localisation of each action on the blank, and the interactions between these actions. Because steatite is a much softer material than bone, it was possible to experiment with different cutting lines prior to identifying the optimal method for cutting the blank, separating the two links, and thereby generating an articulation.

Subsequently, the next tests were conducted on terrestrial mammal bone, specifically deer metatarsal (fig. 5), which was soaked in cold water for a night prior to being worked. Deer bone was selected due to its comparable dimensions to the articulated pins, and because Cervidae bones were a component of the raw bone material used at Chavín, although not as much as Camelidae bones (Rosenfeld and Sayre, 2016; Rosenfeld, 2023).[4] The techniques apprehended from experiments on steatite and from studying the artefacts were applied to this deer bone blank to successfully obtain the articulation between two perforations. While the general shape of the experimental articulations is not as round than those of the archaeological artefacts, the dimensions are similar, providing an encouraging result towards understanding the complex technical processes involved in the production of the articulated bone pins.

CONCLUSION

The two categories of bone pin articulation systems developed at Chavín de Huántar represent a technical achievement that can be fully appreciated through a detailed examination in which analytical and experimental approaches complement each other to understand the high technicity employed in the production.

The exceptionality of Chavín's articulated bone pins is further accentuated by a scant comparative frame of reference of contemporary pieces.At the current stage of research, only four other examples have been identified: two fragments of needles with a link at Kotosh (Izumi

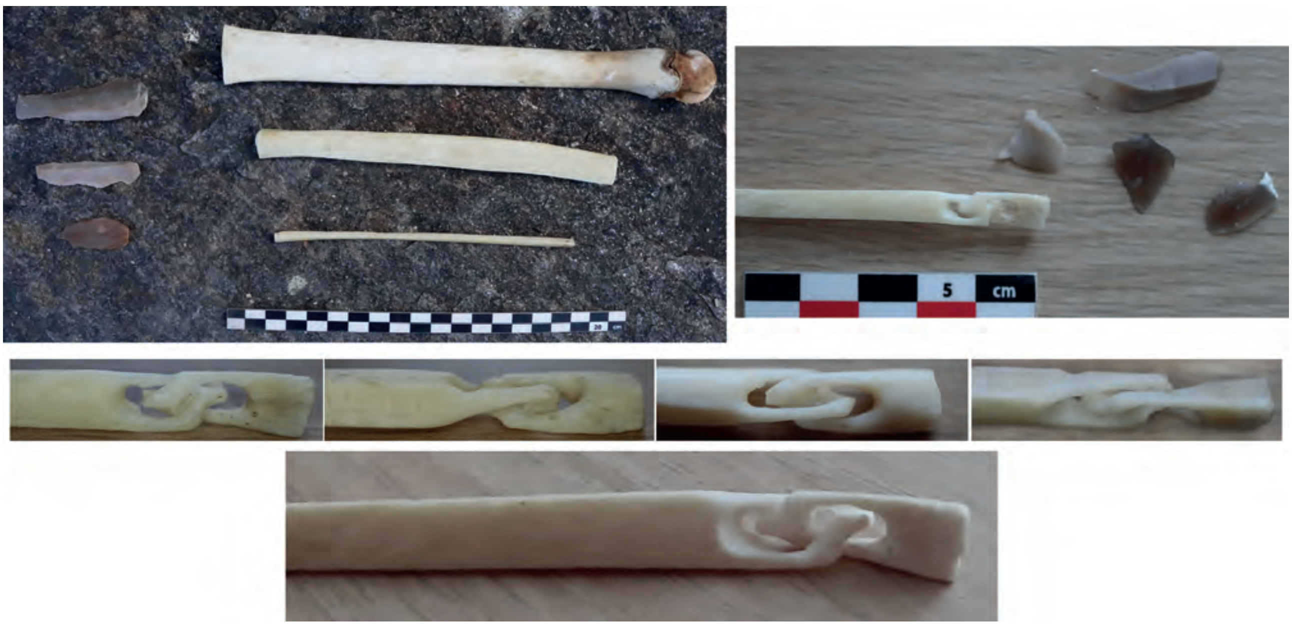

Fig. 5 – First experimental test on a deer metatarsal, worked with flint tools (scrapers, points, flakes). Distinct steps from the cut of the bone matrix on a metatarsal to the production of a flat articulation.

***Fig. 5** – Premier test expérimental sur un métatarse de cerf, travaillé avec des outils en silex (racloirs, pointes, éclats). Différentes étapes depuis la découpe de la baguette dans le métatarse jusqu'à l'obtention d'une articulation plate.*

and Sono, 1963, p. 127), a needle with a link and a shaped motif at Puémape (Arevalo Elera, 1998, p. 646), and a needle with articulation at Kuntur Wasi.[5] These four specimens display a flat articulation system, underscoring the distinctiveness of the twisting system within Chavín's assemblage.

Artefacts with a complex articulated system indicate a pursuit of innovation and technical creativity to produce complex pieces and new shapes. The probable uses of the articulated pins in Chavín de Huántar appear to be associated with ornamentation, particularly with clothing ornamentation, such as the ornamental so-called *tupu* in the Central Andes (Vetter Parodi and Guerra, 2017). However, the majority of these objects were straight pieces (for Chavín *tupus*, see Lumbreras, 2007, pp. 294–295), and the very sophisticated articulation systems of the articulated bone pins do not seem to respond to a practical necessity. In this sense, I suggest that, for the Central Andean Formative Period, these articulated bone pins represent a response to social and technical factors, rather than a specific practical necessity.

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NOTES

1. See also: FERRAS M., "Artefactos óseos articulados en Chavín de Huántar. Estudio preliminar y definición del grupo", poster, Berkeley, Institute of Andean Studies, 63rd Annual Meeting, 2023.
2. See note 1.
3. The hypothesis of intentional fracturing of the articulated pins was first formulated based on a macroscopic analysis of the needle fractures, which have the same angular shape likely resulting from exerted pressure on the needle section to induce the break. An examination of these fractures using a scanning electron microscope supports the hypothesis, revealing the fracture patterns that consist of two groups of parallel traces: the fracturing traces themselves with material removal, and the traces of the pressure exerted on the needle to cause the fracturing.
4. Characterisation and identification of the raw material will be realised by using biogeochemical analysis (stable isotope analysis) and proteomic analysis (Zooarcheology by Mass Spectroscopy).
5. Some similar artefacts produced by the Thule culture (Alaska, Arctic and High Arctic regions, ca. 1000–1500 C.E) are inventoried by L. Prieur. She mentions eight fragments of ivory articulated artefacts that, despite their chronological and geographical gaps, show formal similarities with the Formative Andean articulated pins (Prieur, 2024).

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