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Tesis de Master:

Sex Determination, Morphological and Metrical parameters of adult human mandible from El Mirador Cave and Cova de la Guineu sites.

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ABSTRACT

The identification of human skeletal remains is fundamental in the forensic and anthropological field, as is crucial for further analysis, the mandible plays a valuable role in anthropological diagnosis as it resists post-mortem changes, and it is the most solid bone an attempt at studies applying morphological and metrical methods with the mandible on the determination of sex. The aim of our study is to determine the sex of unknown individuals and to show the reliability of the methods used (morphological and metrical). Morphological and metrical characteristics using with 21 different parameters were carried out to determine the sex in 64 fragmented adult human mandibles in poor state of conservation belonging in both caves. The first one is that of El Mirador (Atapuerca), and the second one is that of Guineu (Barcelona). Five morphological parameters showed that the female sex was the most frequent. While two morphological parameters showed the opposite, the shape of the chin showed that the male sex was more frequent with 11 males and 3 females for the populations of El mirador and, the parameter of posterior mandibular ramus than, the male sex was more frequent with 11 males and 4 females for the populations of El mirador and 5 males and 2 females for the populations of cove de la Guineu. As the metrical method although we could not to determine the sex, it was not reliable for our study, because there are no statistical values indicating the difference between males and females.

The morphological and metrical characteristics of the mandible are performance indicators to determine the sex but, it is still important to use other sources for sex identification, such as the pelvis or the DNA, especially when determining unknown individuals (prehistoric).

Keywords: Sex Determination, mandibles, morphological and metric parameters.

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1. Introduction:

Physical anthropology is a human biological study of evolution with an interest in the interplay between culture and biology to understand the human way of life and its nature. Physical anthropology and paleopathology are the two fundamentals to understanding the lifestyles and deaths of different ancient human groups. This study has allowed, with its based on proper methods, this study gave opportunity to specialist researchers to generate knowledge about human evolution over time. Physical anthropology is the part of anatomy that specializes in the study of human bones, deliver information about human anatomical features, which is fundamental answer about many questions related to the evolution of individuals. Thus, the skeleton becomes evidence of the previous existence of an individual, argues for obtaining more information regarding age, sex, size, disease, between these populations (White et al., 2011). So, the presence of relationships between Physical Anthropology and archaeology, pleads for characterizing different populations and helps to understand our origin and human evolution and to know the consequences of natural, ecological, and dietary influences that may play an important role.

Sexual dimorphism is the set of morphometrical differences between male and female individuals of the same species. This is expressed according to the species and individuals within the same species, and variable according to age and populations. Morphological traits can be found at both ends of either hyper-feminine or hyper-masculine traits, on the other hand, and between the two an area in which the differences are less marked, (Phillip &Walker., 2008).

As we know that the determination of sex, in anthropology as in forensic medicine, is a major element in the identification of an individual. Certain bones, in particular the hip bone, are particularly used and when a human skeleton is complete, the reliability of sexing can reach up to 99% (Chenghe, BenzhengJiao & Young., 2014).

The knowledge that fragmentation or lack of certain bones for this determination, led to extend the study of sexual dimorphism to the rest of the skeleton, with tested variabilities and even are numerous and imperfect, especially when the skeleton is not well preserved. These variables range from the mandible to the hand. the pelvis, now considered the most informative, is questionable depending on the age of the individuals: in young children, the pelvis does not distinguish morphologically different between the male and the female.

And among the most reliable bones for sex determination, the skull and pelvis have very high reliability, and in the case of absence or fragmentation, the mandible will be another source for determining sex, the latter being confirmed as a well preserved and even resistible bone comparing to other bones. Its morphological characteristics show changes depending on age and sex. (Vinay et al., 2013).

The identification of human skeletal remains is very important in the medico-legal field and in anthropology. The morphometric study of the mandible and its correlation with sex play a valuable role in anthropological diagnosis. The shape and size of the mandible reflect the characteristics of dimorphism. The small bones are generally conspicuous and show that the bones of the female sex are less robust compared to the male bones.

The size of the mandible, and its resistant, are generally sufficiently preserved and have been studied for the sexing of individuals. Thus, we have been able to observe some sexual dimorphism in the human mandibule, based on several morphological criteria. Example the mandibular angle is more closed in males, and the width and the height of the ramus are also more important in the males. (Phillip & Walker., 2008).

The pelvis is considered the best performing bone for the study of sex. Unfortunately, that in several some human remains, we do not find the pelvis or it only in fragmentary form, so that estimation of the sex remains will be unrecognized, in these cases, it is important to look for other skeletal remains to determine sex, such as mandibles (Ongkana, et al.,2009).

Several researchers have shown in their deferent experimental studies that the mandible is another source and an important bone to identify the sex, the determination is based on morphological traits, sex differences have been found with mandible, as the ramus flexure mandibular branch showed sex differences established with large percentages (Loth & Henneberg1996). And other researchers based in their studies on the part of the genius eversion to differentiate the sex, where they obtained results showing a remarkable sex difference by the gonial angle, finding 75.4% of males and 45.2% of females (Kemkes-Grottenthaler et al., 2002).

Also, we can concede that morphological parameters had a criterion for differentiate sex, like, the male mandibles had a rocker shape, the chin was bilobed and square, while the female mandibles had a pointed chin. The shapes of the coronoid process were hooked, rounded. The large dentition and the robust mandible also indicate male sex (Ongkana &Sudwan.,2010, Nagaraj et al., 2016, Najma et al., 2018).

Talking about the mandible, sex can be determined using morphometric criteria based on the development of the musculoskeletal system, especially the mastication muscle, which is attached to the mandible the. several studies have been conducted on this method and applied to populations with a tool, that allowed the comparison of linear distances and angles between points of different mandibles, the researchers observed presence sexual difference through these parameters, and the aim of the morphometrics method, is to find a parameter from the mandible that could be more reliable in determining sex (Babita, et al., 2017).

Recent studies on sex determination from the mandible using morphological and metrical methods, which include comparative studies with different populations have shown the existence of significant differences in either morphology or size.

Our study was carried out on 64 fragmented adult human mandibles in poor state of conservation, belonging from two caves, the first that of El Mirador Atapuerca and the second from Guineu cave in Barcelona. The measurements were carried out incompletely, a lack in the measurement for most of the mandibles.

To carry out our research we have structured our work into the following parts:

-Our study divided into chapters, including introduction. The first chapter contains the contextualization's of Cueva El Mirador and Cova Guineu the localisation of discovery the material of the study. In the second chapter, contains of the description of the materials and the working methodology. The third chapter presents results. The fourth chapter discusses the results obtained. The study ends with a conclusion and future proposals for this research.

Objective:

The aim of our study is first one, to determine the sex of the unknown mandibles belonging to the population of the Cueva de El Mirador and the Cova Guineu, and to apply both morphological and metrical methods for sex identification.

Also aim, to present the most important morphological and metrical parameters of the mandible, and to recognize the reliability of these both methods for sex determination.

2. Theoretical Framework for Sexual Dimorphism:

In archaeological records, it is possible to determine an individual's sex by analysing their skeletal remains and their gender by their material culture and context (White & Folkens, 2005). Knowing that it is difficult to determine the sex before adolescence we must wait until the bones are fused; meaning they have reached their adult morphology (Scheuer & Black., 2000).

If we talk about pelvis bone that are the most reliable for determining sex, there is an obvious functional difference between the female and male pelvis: childbirth. In general, the female sacrum and hip are smaller and less robust than the male, but the pelvic cavity and the sciatic notch are larger in the female hip bones; the female pelvis has a more elongated ischiopubic branch; the sub-pubic angle is greater in female individuals; the preauricular sulcus is most often present in the hip bones in female; the atrial surface is higher in the female ilium; and the acetabulum is generally relatively larger in males (Buikstra & Ubelaker., 1994; Mays & Cox., 2000; White & Folkens., 2005). Different authors have developed and deepened methods of sex determination of the specific parts of the haunch.

The morphological method of J. Bruzek (2002) applies to the observation for five parts on the hip bone: the pre-auricular region, the large ischial notch, the compound arch, the lower part of the hip bone and the relative length of the ischium and pubis.At least three of the five variables are required to estimate the sex of an individual (Bruzek., 2002). This method has been successfully applied to recent, highly diverse populations, with reliability of the results reaching a high percentage (Bruzek., 1991, 2002; Murail et al., 1999).

In probabilistic sex diagnosis (PSD), almost ten measurements are made on deferent parts of the hip treatment by a Bayesian process by software (Sexual Diagnosis), of course with a calculation of the probability of having the male or female sex (only the probabilities greater than 95%). To obtain a result, four the 10 variables, it is necessary to have four sufficient criteria out of ten, the application of this formula must be on the separate hip bones to have a result.

In all cases, where it is possible to perform a DNA test on the human remains to determine sex (method subject to conservation of the organic content of the sample and to economic availability), this is the most recommended option due to the high precision of the method, without the fragmentation level or ambiguous morphology being a problem (White & Folkens., 2005).

Following the methodology of Buikstra & Ubelaker (1994), the five aspects of cranial and mandibular morphology to be considered when classifying as male or female are: the profile and roughness of the nuchal crest, the size of the mastoid process, the thickness of the supraorbital margin, the prominence of the supraorbital arch and the projection of the mental eminence. Each of these characters is scored from 1 to 5, with 1 representing a "more female" morphology and 5 representing "more male morphology.

In general female skeletal elements are characterised by smaller size and density, although sexual dimorphism is not evident in female, and greater gracility than males. However, this size is highly variable, reaching a size difference of 20% in some cases, while in others there is no dimorphism. The morphological characteristics of a smaller and graceful male individual can overlap completely with those of a large and robust female individual (Mays & Cox., 2000; Garvin., 2012). In cases where very male individuals have strong and large bones, or females the smaller and more graceful bones, it is easier to differentiate sex, But, aside from the problem of estimating sex before puberty, not all skeletal bones adult individuals show differences between males and females. To determine sex, the elements that exhibit greater sexual dimorphism. This is particularly important in archaeological sites with a high degree of fragmentation. On the other hand, in physical and forensic anthropology, to estimate the sex of individuals, from traditional methods (Buikstra & Ubelaker, 1994), to methods using computerized techniques such as geometric morphometric analysis (Bytheway & Ross., 2010; Gonzalez et al., 2011).

According to the authors of the articles, this method has an accuracy of around 75-80% in classification, since there is a high degree of overlap between male and female individuals in these morphological characteristics, so that in many cases sex determination can only be considered feeble, but not certain. On the other hand, metric methods have been used, for the femur and tibia of which the authors defend an accuracy of 90% in the former case.

In recent years, a several studies have been conducted in the literature on the importance of mandibular morphology and metrical, to establish the mandibular branch to demonstrate the reliability of the mandibular branch in sex determining.

The results of Saini and colleagues (2011) were obtained after a metrical study for practical use in a forensic setting on the Indian population using the mandibular ramus literature review. They showed the efficacy of these parameters showed significant sexual dimorphism with an overall accuracy of 80.2%, and the height of the coronoid was the best parameter providing an accuracy of 74.1% .60. And females were found small compared to males. (Saini et al., 2011).

The study by Indira et al, (2012) digital radiographic on the mandibular limb indicated that the limb width measurement is the best parameter to evaluate for sex determination. For that he noted that the measurements of the mandibular branch were reliable for the determination of the sex. For this, they considered the mandibular branch as another tool to aid in sex determination in forensic analysis. after applied studies on different populations with reliability (Indira et al., 2012).

Vodanic and colleagues (2006), presented a metrical study on the mandibular branch angle (length of the mandibular body, mandibular angle, and minimum ramus breadth) mandibular and minimum, the width of the branches indicated that these parameters reliable to determine the sex as they reported the importance and reliability of the mandibular branch for sexual diagnosis in archaeological and forensic work (Vodanic et al., 2006).

Vinay and Gowri (2013) conducted an applied metrical study on the South Indian population to verify whether anthropometric measurements of the human mandible could be used to determine gender. They found that the minimum branch width and maximum branch width are highly predictive of the sex of the unknown mandible. except the mandibular angle, and their studies showed that the mandible is an important bone in determining sex with high precision (Vinay & Gowri., 2013).

The analysis of Raj and Ramesh (2013) in their study on analyse of sexual dimorphism in the mandible of South Indian origin, applied on 120 mandibles of 60 males and 60 adult females with six metrical parameters were taken into consideration. Their study found that one of the parameters analysed, the upper-lower height (right side) presented a significant difference between males and females. They obtained that the mandible can determinate the sex in this population after largest studies has been undertaken. (Raj & Ramesh., 2013).

The study was conducted by Pillai et al (2014) to demonstrate the role of mandible in determining sex. In a study 88 mandibles were analysed, measurements for 22 parameters were taken on each mandible. All variables were considered together and treated statistically; six factors were extracted that could explain 75.2% of the total variation in the data for all variables are: height of the ramus-right, body thickness, anthropometric arch width, inter incisor width, mandibular index, and mandibular angle. Their study reveals that mandibles of unknown sex can be sexed with 75% accuracy. they concluded that 6 dominant traits are parameters that bring efficiency that could be accurate up to 75.2% on 22 parameters (Pillai et al., 2014).

Singh et al (2015) showed in their study to evaluate the precision and the role of some metrical and morphological parameters in the determination of the sex applied on 50 mandibles of human adults of North Indian origin. Non-metric parameters observed are morphological features such as gonion flare, muscle markings, and the angle shape of the symphysis nervosa. They found that bigonial width and bicondylar width showed sexual dimorphism. They concluded that the metrical parameters (bigonial breadth and bicondylar breadth) and the morphological parameters (Gonion flaring, muscular markings and shape of angle of symphysis menti) show sexual dimorphism. Their study concluded that the mandible is a reliable tool in determining sex. It can even serve as a surrogate when other bones are missing (Singh et al., 2015).

Datta and co-authors (2015) presented a study to analyse the sexual dimorphism of mandibles in the southern Indian population. They submitted 50 adult human mandibles, they used in their study 12 different metrical parameters such as (Gonial angle, Bigonial width, Height of ramus, Bicondylar breadth, Mandibular, length, Length of lower jaw, Mandibular index, Body thickness, Coronoid height, Bimental breadth, Symphyseal height and Body height), in their study, they observed the presence of a statistically significant difference between the male and the female, with conclusion producing that the sex of the mandible can be accurately determined , using different metrical parameters (Datta et al., 2015).

Studies by Ongkana and Sudwan (2010), examined 80 Thai human mandibles, 64 males and 24 females to determine sex, using three morphological characteristics (the shape of the chin, the presence of a gonial notch and the appearance of the gonial angle) showed significant differences between the sex, they concluded that certain characteristics of human mandibles obtained sexual dimorphism and could be used to differentiate the sex of Thai mandibles. exhibited sexual dimorphism, with an accuracy of 75.0% and 70.3% in females and males (Ongkana et al., 2010).

Kawale and colleagues (2015) presented analyses of 100 (Male 50, Female 50) human mandibles of known sex for sexual dimorphism using 14 different metrical parameters (bigonial width, bicondylar breadth, maximum ramus height, mandibular angle and intermolar distance). The parameters showed statistically significant differences with 95% accuracy were observed on the two parameters (maximum ramus height and intermolar distance), they evaluated the mandible as another important bone for determining gender accurately like the pelvis and skull. (Kawale et al., 2015).

Panda and collaborators (2016) showed a study to find out the sex of an individual by examining the posterior branch of the mandible. The study resulted, that there was a notch on the posterior played a role in determining sex. The flexion of the posterior branch of the mandible is an important tool for accurate determination of sex (61%), in males had (68.57%) and in females had (43.33%). On this basis, they concluded that the posterior branch of the mandible could be considered for determining the sex of the mandible but will not be the only criteria and should be related with the other criteria. (Panda et al., 2016).

Nagaraj and colleagues (2016) presented a study to assess the morphological characteristics of the mandible in determining sex, they included 90 adult human mandibles of known sex, and used the morphological characteristics of the mandible such (shape of chin, inferior border of mandible, and shape of coronoid), they found that the morphological analysis of the mandible could be used for sex determination with than 90% accuracy. They found that the male mandibles had a rocker shape, the chin was bilobed and square, while the female mandibles had a pointed chin. The shapes of the coronoid process were hooked, rounded, and triangular with $P < 0.05$, indicating statistical significance. They concluded the importance of morphological analysis of mandible for sex determination (Nagaraj et al., 2016).

Lhot and Henneberg (1996) presented a morphological parameter for sexual dimorphism in the human mandible. They analysed 300 mandibles in adults with known sex. The morphological characteristics were based on the ramus flexure mandibular branch. In most females the ramus flexure of branch retained the straight juvenile shape, the overall accuracy of the prediction from the shape of the branch was 99% and 91.0% were correctly diagnosed in a different population (American and African). The utility of this trait is enhanced by the survivability of the mandible and the fact that preliminary investigations show that the trait is clear in fossil hominids. The presence or absence of ramus flexure would concede as a valuable tool for determining sex in complete and fragmented mandibles in historical archaeology, rare fossil hominids and modern forensics (Lhot & Henneberg., 1996).

Sikka and associates (2016) performed a study examining morphological and metrical parameters in the population of North India, applicated 126 mandibles to determine their sex. They found that the mean values of all metric parameters were higher in males than in females and statistically significant difference was observed in all parameters. They concluded that mandible has significant sexual dimorphism and combination of morphological and metrical parameters is important for determining the sex of mandible (Sikka & Jain., 2016).

Archaeological sites where the material of study come from:

The human mandibles we are analysed in this Master Thesis come from two sites: Cueva de El Mirador and Cova de la Guineu.

3. Cueva de El Mirador site:

The site is in the karstic system of the Sierra de Atapuerca, belonging to the municipality of Ibeas de Juarros (Burgos, Spain). With an altitude of 1033 meters above sea level, the cave is located on the southern slope of the valley of the Arlanzón river. The site takes on a shelter morphology due to the collapse of part of the vault [Fig 1]. This cavity has an entrance mouth 23 m wide by 4 m high and about 15 m deep, facing southwest, it consists of the geographical coordinates of 42º 20 '58 "N and 03º 30 ' 33 "W (Vergès et al., 2016). Its interior is formed by a complex system of galleries, the development and extension of which are still unknown. The possibility that the research team is considering is that the site will connect directly with the rest of the cavities that are part of the Atapuerca complex.

[Fig -1]: Location of El Mirador cave. (Vergès et al., 2016).

During the 1970s the first archaeological work was carried out by the Edelweiss Speleology Group. Later, fieldwork and research resumed in the El Mirador cave in 1999, and are still ongoing (Vergès et al., 2002). Three different sets of human remains have been recovered from these excavations.

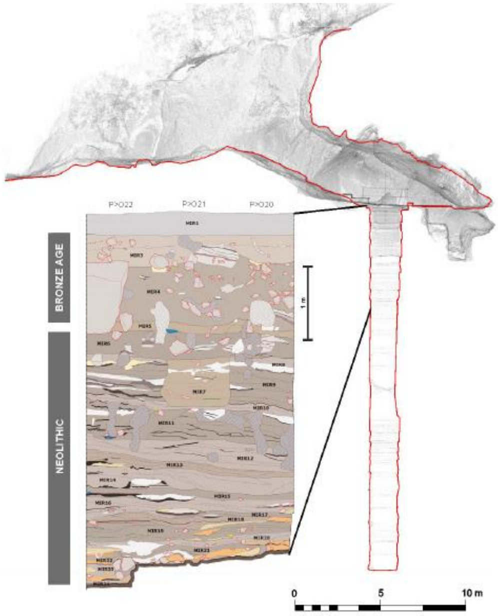
In the first, human remains were recovered from an investigation of just over 6 m2, and among these human remains, six individuals dating from the Early Bronze Age (4400-4100 cal BP) (Cáceres et al., 2007). After this first discovery, in 2009, fieldwork focused more specifically on a small cavity called El Laminador, which was located near the cave wall, it is here that new remains of a collective tomb were found individuals in a predominant anatomical position, but the most superficial remains are present with alteration and mixed by previous actions of previous excavators. The last human remains are found in the sector 100 and comprises an individual inhumation of young individual and disarticulated remains of other individuals.

3.1. Stratigraphy and chronology:

In this cave there is a central borehole, after research is carried out this test pit has reached a depth of 20 meters, with two groups of levels one Pleistocene and the other the Holocene.

The Pleistocene deposit is composed of limestone blocks, a sub-level with traces of human activity (MIR51 / 25) includes faunal and lithic remains. Charcoal samples taken from the hearth show a dating of 13,580 to 13,180 cal. AP (Vergès et al., 2016).

Regarding the Holocene levels, the first group of levels attributed to occupations from the Neolithic period (MIR24 to MIR6) and the second group with two other meters would belong to the Middle Bronze Age (MIR4 to MIR3). Regarding dating, the Neolithic levels have been dated between the end of the 6th millennium and the first half of the 4th millennium BC, while the Bronze Age deposit would belong to the 2nd millennium BC. [Fig 2]. These levels are the result of the cave's continued use as a sheepfold for cattle, showing accumulations of in situ combustion remains from animal and plant deposits (Martín., 2015).



[Fig - 2]: N-S section of the cave and stratigraphic profile from the Holocene units of the test pit. (Photography J. M. Vergès., 2016).

As already mentioned, to date, three well differentiated levels have been identified in the sector 200 (El Laminador cavity), although the latest interventions continue to widen the excavation surface and the stratigraphic levels. The human skeletal material recovered in this collective burial of sector 200 is the material analysed in this work.

- MIR201: corresponds to the level of surface interference, where a large quantity of archaeological archives has been recovered in a secondary position.

- MIR202: this level is characterized by the presentation of bioturbations under the action of animals which dig burrows, stirring and modifying the primary position of the deposited remains. At this level, there are usually remains with marks made by the animals themselves that remove bones or other material when excavating the tunnels.

- MIR203: this is the level which contains the remains in the primary position. Their conservation is exceptional, recovering in some cases anatomically connected remains. At the time of burial, the corpses were placed at the bottom of the cavity. When it was plugged, the bodies were pushed downwards, allowing new corpses to be deposited. Some of the bones, such as the skulls, show evidence of having been placed near the wall after the buried individuals were removed.

[Fig -3]: Chalcolithic collective burial (MIR203) (Photography J. M. Vergès., 2016).

In the collective burial of the site of El Mirador, [Fig 3] a minimum of 29 individuals were found deposited in a burial chamber dated to 4000 ± 30 AP (4550 and 4390 cal. AP) and 4120 ± 30 AP (4880 e 4480 cal. BP), these human remains are accompanied with other remains as the gatehouse dates to the Chalcolithic period. (Yustos et al.,2020).

3.2. Archaeological remains:

In addition to human remains, there are also faunal material, ceramics, malacofauna, or the lithic and bone industry, among others. Among the recovered fauna, the taxa corresponding to domestic species stand out, mainly Ovis and Capra. (Martín, 2015).

4. Cova de la Guineu Alt Penedés (Barcelona) site:

The Guineu Cave is a sepulchral cave located in the village of Font-Rubí (Alt Penedès, Barcelona) (X. 377972; Y. 4664374, UTM31N, WGS84) at 738 m above sea level at the top of the Plana Pineda Mountain (meadow -littoral Serralada) [Fig 4]. The cave was discovered in the 1970s by the Associació d'Estudis Cientifics i Culturals de Mediona (AECCM), and in the 1980s archaeological fieldwork was carried out by Josep Mestres, excavations that provided archaeological data very important that could later be studied by different specialists of the team. Today the cave continues to be excavated by Xavier Oms, Juan Ignacio Morales, and Artur Cebrià (Vanessa Villalba-Mouco et al., 2018).

[Fig -4]: Location of the Cova Guineu and humans remains on nivel Ic, image of the 2012 campaign (Oms et al., 2016).

4.1. Stratigraphy and chronology:

The cave has a stratigraphy with a length of 4.5 m and the same complex includes three different zones [Fig 5]. The sequence consists of approximately 4 phases:

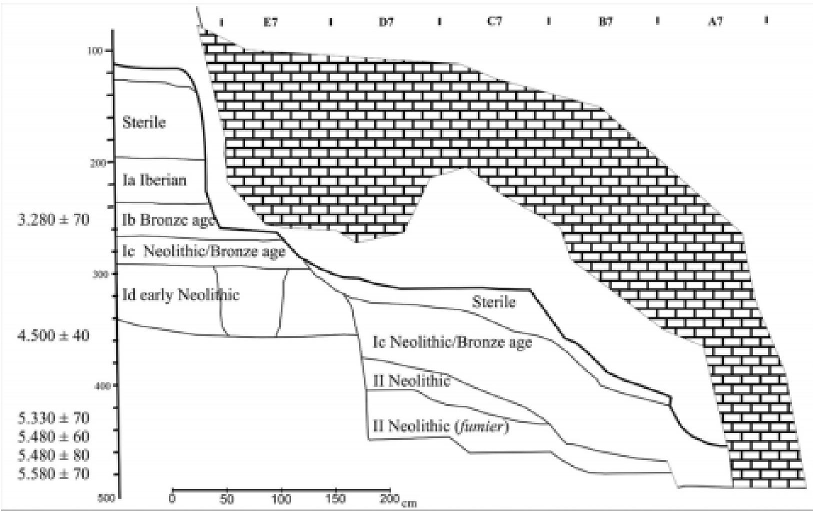
Phase 1 corresponds to the Early Neolithic and includes levels Ie, II, II (manure) and II-IIb.

Phase 2 includes levels Id and Ic / Id, which correspond to the two periods of the Upper Neolithic and the beginning of the Bronze Age.

Phase 3 includes levels Ic and Ib, which are layers of the Bronze Age.

Phase 4 corresponds to the Iberian period (level Ia).

The first and oldest occupation of hunter-gatherer groups, which contains level III (Epipaleolithic microlaminaria), as well as cardial levels (interior II, manure II and exterior Id) and exterior level Ie. At that time, the cave had extensive functionality, with approximately 70-80 m² of living space. Later, during the IV millennium, other occupations began which adapt to a new aspect of the cave.



[Fig -5]: Schematic drawing of Cova de la Guineu stratigraphy showing dating's and chrono-cultures. (Equip Guineu., 1995). (Allué et al., 2009).

The archaeological remains and the funerary objects recovered in the funerary levels plead to prove a continuity for a funerary occupation provided from the different phases, the oldest phase dating from the Late Neolithic, characterised by discoidal bone and seashell beads (Alday., 1995).

A second phase is characterized by the presence of pottery and a large set of lithic industry in flint blades and arrows, corresponding to the Chalcolithic period.

And a third phase contains the presence a rarity of pottery fragments, typically from the early Bronze Age with a metallic object found outside the cave (Oms et al., 2016a). In this phase, there was a long period of remarkable collective burials. In the third millennium, the Bronze Age, undergoes sporadic occupations throughout the period, the Complete Bronze (basic level Ia), the Final Bronze-First Iron Age (level Ia) and Iberian associations until the end of the Roman Empire. From post-medieval times until almost to this day this cave has served as a shepherd's hut. (Oms et al., 2016).

There is a wealth of more dominant material, namely Molinot-type ceramic weaves. There is also, without forgetting to point out a dispersion of some layers caused by modern movements. However, outside the cave (External Sector) it was possible to identify a level with a phase Ie, a very intact section with an ancient Neolithic layer. With a fraction as fine as a table with reddish clays and some engravings, it rests on a level of large blocks, with a power that does not exceed 20 cm today. The fact that it is located right in the only area not protected by any section of cave or refuge has caused the alteration of certain materials, in particular the fauna, which appears with the progress of the excavation of the External Sector, (Oms et al., 2016).

The dating obtained from this site is one of the most recent to date in the Alt Penedès. However, this dating fits perfectly into the general temporal framework, with the examples of the Fraile cave (Martin et al., 2015), the Cueva Bonica IV cave or the Draga (Bosch et al., 2011).

The dating is carried out with radiocarbon (14C) defines level III at approximately 9850 ± 80 BP (11,220-11,399 cal. BP), placing it in the micro laminar Epipaleolithic, a period including the beginning of the Holocene (García- Argüelles et al., 2005; Morales et al., 2013). It also belongs to a second phase of neolithization, which would correspond between 5300-4900 BC (Oms et al., 2016).

4.2. Archaeological remains of the cave:

The material record that we associate with the first Neolithic occupation of the cave is found in different areas of the cave. The interior level II (in the Sector of the cave) presents a lot of material although it was devastated by the post occupations of the Neolithic period.

After the study of the site material which demonstrated an occupation of the cavity, from the Epipaleolithic to the Bronze Age. Also, a funeral occupation has been reported by human remains that have been found. The first anthropological study was directed by S. Mendiela. A huge presence of these remains with the present human occupation of which, they have been interpreted as food offerings (Oms et al., 2016).

Regarding the archaeological remains of the site, the most important and remarkable was the cardial ceramics, of which ceramic fragments have been analysed and among these tissues presented with decorative motifs. There are also findings of bone and lithic assemblages with a raw material quartzite and quartz the most dominant, this assemblage carries a technology that can be microlithic characterized using the microlaminar technique although this is rare in some levels, objects and fragments that lack either technological or typological information. (Morales et al., 2013). The recovered wildlife remains are with variations in size such as mammals, reptiles, and birds, even malacofauna.

5. Material and methods:

5.1. Material:

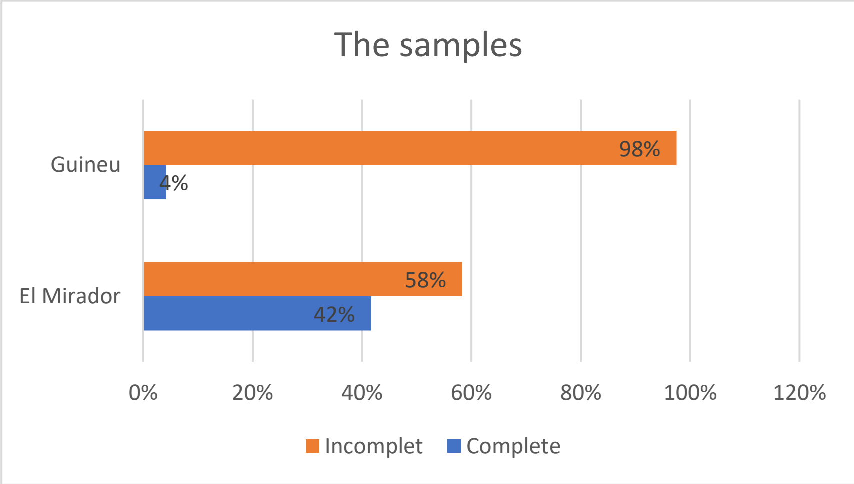
5.1.1. Selection of samples:

At the beginning, the material was classified in a data base, it was mixed with the loose teeth found in the sites. Therefore, the first step was to separate and sort out all that is mandible and create a fair basis for, identification and individualization of the remains. Then, the sample was ordered with count for each mandible, also to facilitate the localization of the remains according to the year of the campaign and by stratigraphic level of the material for each site. The El Mirador study material can be found in Sector 200 in three different levels MIR201,202 and 203. On the other hand, Guineu's material is classified by year 1982/1983/1989/1990/1991/1994/1995 and two mandibles without cords I have named them 2021.

5.1.2. Analysed material in the present work:

Our study sample in this work corresponds to the human mandibles recovered in two different archaeological sites, the first is the Cueva de El Mirador (Atapuerca), during several excavation campaigns from 2009 to 2016. including 10 complete mandibles and other hemi mandibles. The second in the Guineu cave (Barcelona), mandibles of such individuals recover in the Chalcolithic level. This material is not complete, just one complete mandible and others are only fragmenting not even hemimandibles. [Fig 6]

Almost all the mandibles are either left or right parts, or just fragments, a great obstacle to apply sex determination methods.



[Fig -6]: Percentage of mandibles analysed in the study for both caves.

5.2. Methods:

The determination of sex is another indispensable requirement in anthropological studies. Traditionally, researchers have used morphological and anthropometric methods to determine sex from different cranial or postcranial elements, with the pelvis and skull exhibiting the greatest sexual dimorphism. In our case, the bone elements analysed to determine the sex of individuals is with the mandible, two methods apply morphological and anthropometric. However, the review of the scientific literature for the determination of sex in human remains made it possible to select different methods presenting a more dominant method for its higher reliability in determining sex.

The main objective of this work (master thesis) is to be able to determine the sex of deceased individuals with the anatomical and metric indicators of the mandible and to apply different metric and anatomical methods. Then a comparison about the accuracy and availability of the different tested methods will be done. So, one of the main objectives is find out the reliability of two methods morphological and metrical applied on our materials for sexual dimorphism on the mandibles of a documented series of adult individuals from two populations of the same Chalcolithic period.

5.2.1. Bibliographic consultation:

After selecting the sample and creating a database of known general characteristics, an in-depth literature search on different existing analytical methods was carried out to know and select the methods and apply them to the samples.

Several more specific works related to new techniques and methodologies applied to determine sex have been consulted. The most accurate method of sex determination in biological anthropology is with postcranial bones, the most practicable pelvis for reliability of its results, after coming the skull and mandible, in recent times, researchers have been used the method of determination with the mandible with few changes between them, with different characters.

5.2.2. Analytical techniques:

In this study there were 64 human mandibles presented the two populations, coming from two different caves of indeterminate sex, 24 mandibles from the cave of El Mirador the calcolithic period, the remainder of which were found in a small cavity near the cave wall (Sector 200), 40 mandibles warning of Guineu cave, most of these mandibles are fragments and in poor state of conservation.

This work is presented and structured following two main methods; morphological and metrical, name is applied on the two samples taken in two sites of the same chronology El Mirador and Guineu, after a bibliographic search which shows different methods to determine the sex. Different methodologies that can be applied to anthropological remains proposed by different researchers in exhaustive bibliographic reviews.

In this study a total of twenty-one (21) parameters, seven (7) morphological and fourteen (14) metrical, these parameters were observed on each hemimandible, following the morphologically method of Naira and colleagues (2017).

5.2.3. The morphological method:

Naira and colleagues (2017) used 128 adult mandibles of blacks and whites including 56 females and 72 males, concerning the determination of the sex of these mandibles, they selected 7 morphological characters, the first six characters have been proposed by Hu et all (2006) and seventh summer parameter proposed by Loth and Henneberg (1996), and for our study we followed the same procedure in the analysis as those of Naira et al (2017). We used the 7 morphological parameters on the 64 mandibles to determine the sex. The morphological indicators observed in our study:

1. The shape of the chin.

2. The divergence of the gonial angle.

3. The profile of the chin.

4. The contour of the base of mandible.

5. The shape of the ramus of mandible.

6. The profile of the ramus of mandible.

7. Posterior mandibular ramus flexure.

5.2.4. Metrical parameters:

In the study by Villanueva et al, (2017) two samples of determine sex mandibles were analysed metrically, the first from Mexico City (XIG), and the other from Santa María Xigui. The MEX sample was composed of 108 mandibles, and the second XIG sample with 56 mandibles, it showed in its results, significant differences in the degree of sexual dimorphism observed between the MEX and the XIG samples, for these results we just took the population of small size and used for our study.

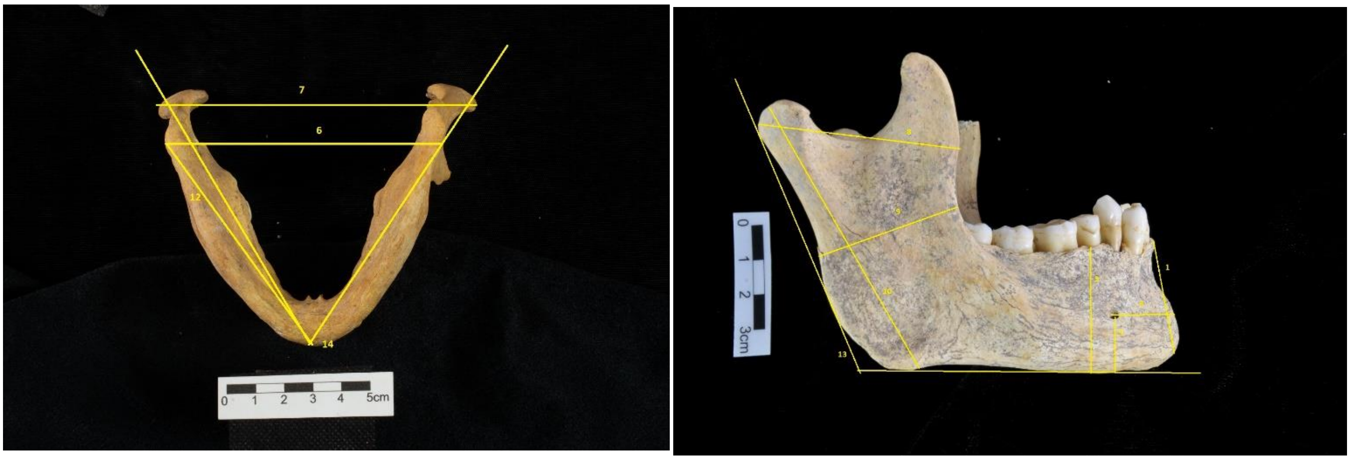
We took the fourteen measurements of each hemimandible in mm, were recorded using the following instruments a calliper and to measure the angle of the mandibles, we used the software Image J, to measure the angles of the mandibles. These were the same measurements as the Villanueva et al (2017) method accompanied by the criteria studies Ubelaker et al., (1994) and other measurements as proposed by Vodanovi et al., (2006).

we took the average of each metric measurement to separate the female sex and the male, [table -1] presented the average of each parameter for both sexes. The metrical parameters were observed in our study:

1.Height of symphysis, 2. Breadth of mandibular body, 3. Height of mandibular body,4. Foramen height, 5. Foramen-to-chin distance, 6. Bigonial breadth, 7. Bicondylar breadth ,8. Maximum ramus breadth, 9. Minimum ramus breadth, 10. Maximum ramus height, 11. Mandibular length, 12. Length of the body, 13. Mandibular angle and

14. Mental angle.

All 21 parameters are recorded on bases to determine sex.



[Fig -7]: The metrical parameters taking with calliper in our study. (Mandible, Mirador Mir 202, num 17.

In the second metrical method, a minimum and maximum of 14 diameter of all the parameters in each population was taken for each characteristic. The [table- 2] was produced to determine the sex for our population.

Mandibular measurement	Female (mean) (mm)	Male (mean) (mm)
GNI	(29.90)	(31.97)
TML	(10.94)	(11.13)
HML	(28.42)	(29.43)
FBB	(13.79)	(14.41)
MFA	(27.03)	(27.57)
GOG	(84.80)	(90.06)
CDL	(111.33)	(116.85)
MRL	(41.46)	(43.44)
WRK	(30.87)	(32.19)
vXRL	(64.08)	(68.91)
MLT	(78.27)	(79.87
GGN	(72.97)	(76.07)
MAN	(124.82)	(123.28)
GMG	(71.06)	(73.04)

[Table -1]: The mean of each parameter in the mandible of Mexico population (Villanueva et al., 2017).

Mandibular measurement	Measurement Min(mm)	Measurement Max(mm)
GNI	(24.79)	(33.72)
TML	(8.16) - (8.30)	(11.86) - (11.86)
HML	(25.22) - (26.16)	(31.72) - (31.95)
FBB	(9.21)	(16.17)
MFA	(22.84) - (23.46)	(29.35) – (29.67)
GOG	(85.35)	(101.27)
CDL	(109.20)	(121.42)
MRL	(35.44) - (35.61)	(47.37) - (47.30)
WRK	(26.13- (27.13)	(36.76) - (36.53)
XRL	(46.72- (43.91)	(67.74) - (75.12)
MLT	(61.74)	(75.44)
GGN	(72.77- (79.39)	(84.45) - (88.35)
MAN	(113.39)	(136.04)
GMG	(67.91)	(80.67)

[Table -2]: Measurement Max and Min of different parameters in the mandible (Material study El Mirador & Guineu sites.)

In the analysis, the maximum and minimum mean of each measurement was produced to be able to separate the sex. [Table-2].

Talking about the mean and statistically significant values (P value) of each parameter are unknown. So, our analysis was just based on percentages for metrical and morphological parameters.

5.2.5. Data treatment:

All the data collected is in the database created with Excel to be able to carry out descriptive statistics. It is important to get the most out of all scanned fields and therefore statistical treatment of these is necessary.

Through data processing, it is possible to obtain comparative graphs and tables that allow and help to understand the results obtained from the study. The results corresponding to the statistical analysis are detailed in the analysis section of the chapter (not yet completed this task).

6. Results:

6.1. Morphological results of both sites (Cueva de El Mirador and Cova de la Guineu):

According to the statistical analysis for the shape of the chin indicator, for El Mirador on 24 mandibles, the most frequent shape was the square shape with a percentage of 33%, followed by 13% bilobate of shape and the pointed shape is 13%. In the population of Cova de la Guineu, there is the same percentage of 3% for the bilobate and square shape and 5% for the pointed shape, for a total of 40 mandibles. And according to the method used by Deana and collaborators in 2017, the pointed chin of the mandible is characteristic of females, while the square and bilobate shapes are male indicators. In a group of 24 mandibles, for El Mirador the determination of sex for 14 mandibles, 11 are males (46%) and 3 are females (13%), as well as 42% of undetermined sex. [Table-3]. For the population in Cueva de la Guineu, the determination was very low 3% for the both bilobate and square shape and 5% for the pointed for shape [Table-6].

The divergence of the gonial angle for the Cueva de El Mirador population shows an everted shape, 25% for the males on the right side and on the left side 21%. For the inverted shape the same data are found on both sides. For the straight shape it was a 12% on both sides, so a percentage of 42% for the indetermined mandibles [Fig-8]. For Cova de la Guineu, the reverse shape is 2% on both sides and the everted shape is 3% on the right side and 0% on the left side, and the straight shape is 3% on the right side and 0% on the left side [Fig-11].

For the profile of the chin, there were two morphologies: prominent and vertical, the most dominant shape in the Cueva de El Mirador population is the vertical shape with 54% and the less prominent shape with 8%, and 38% are undetermined [Table-4]**.** For Cova de la Guineu the vertical shape at 8% and 2% showed the prominent shape [Table-7].

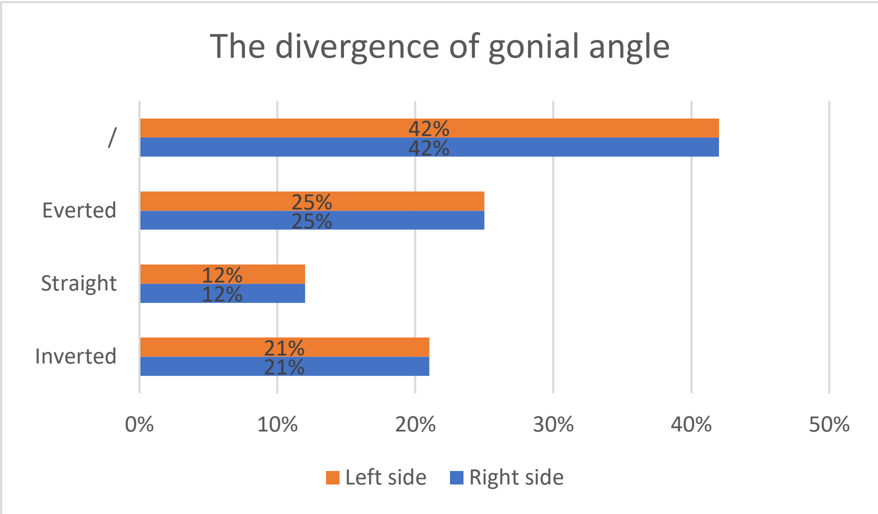
6.1.1. The shape of the chin (Cueva de El Mirador):

Bilobate/Square are Male, Pointed is Female

Shape of the chin	Num	percentage
Bilobate	3	13%
Square	8	33%
Pointed	3	13%
/	10	42%
Total	24	100%

[Table -3]: Statistical analysis of male and female chin in the la Cueva El Mirador.

6.1.2. The divergence of the gonial angle (Cueva de El Mirador):



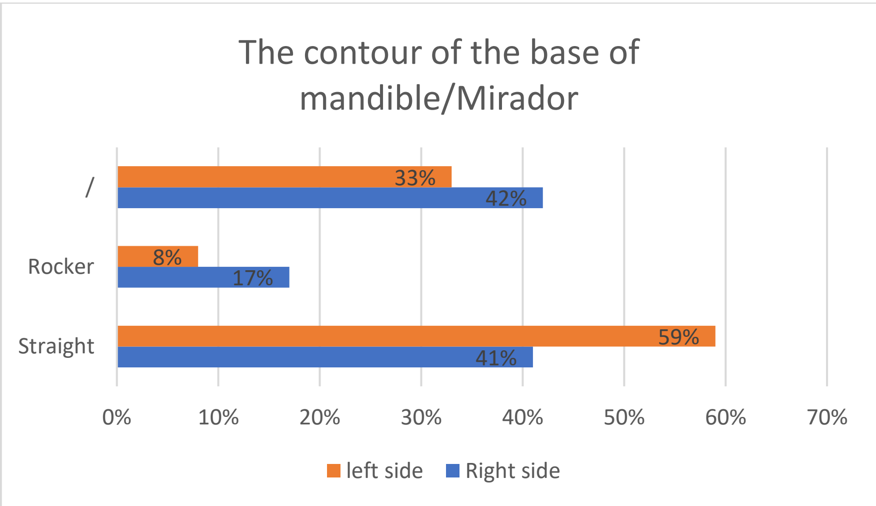
[Fig-8]: Statistical analysis of divergence of gonial angle of male and female mandibles in both sides.

6.1.3. The profile of the Chin (Cueva de El Mirador):

profile of the Chin	Num	Percentage
Male	2	8%
Female	13	54%
/	9	38%
Total	24	100%

[Table -4]: Statistical analysis of profile chin of male and female mandibles

6.1.4. The contour of the base of mandible (Cueva de El Mirador):



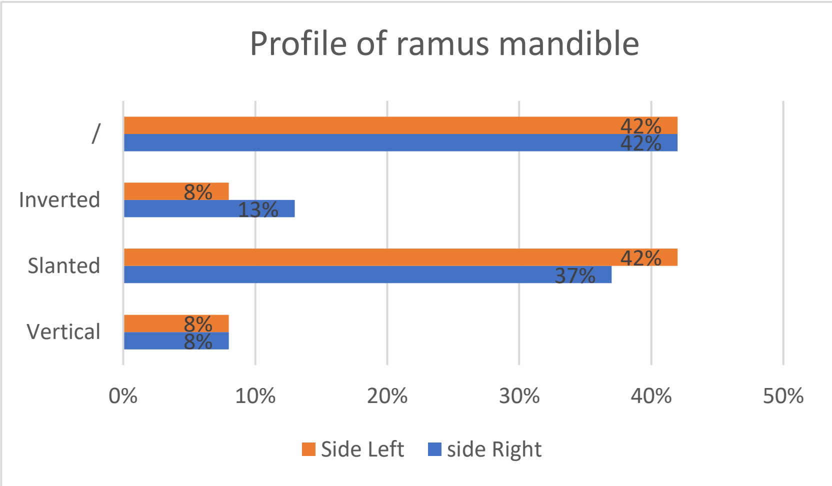
[Fig-9]: Statistical analysis of contour of the base of mandible of male and female mandibles in both sides.

6.1.5. The shape of the ramus of mandible (Cueva de El Mirador):

Shape of ramus	Num	Percentage
Pinched	11	46%
Wide	3	12%
/	10	42%
TOTAL	24	100%

[Table-5]: Statistical analysis of shape ramus of male and female mandibles.

6.1.6. The profile of the ramus of mandible (Cueva de El Mirador):



[Fig-10]: Statistical analysis of profile ramus of male and female mandibles in both sides in the la Cueva El Mirador.

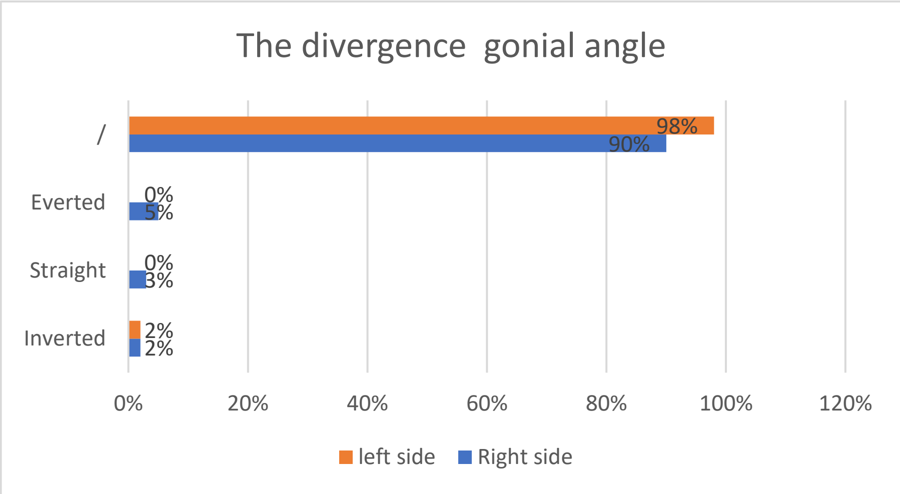
6.2. Morphological results of Cova de la Guineu:

6.2.1. The shape of the chin (Cova de la Guineu):

Shape of the chin	Num	Percentage
Bilobate	1	3%
Square	1	3%
Pointed	2	5%
/	36	90%
Total	40	100%

[Table-6]: Statistical analysis of male and female chin.

6.2.2. The divergence of the gonial angle (Cova de la Guineu):



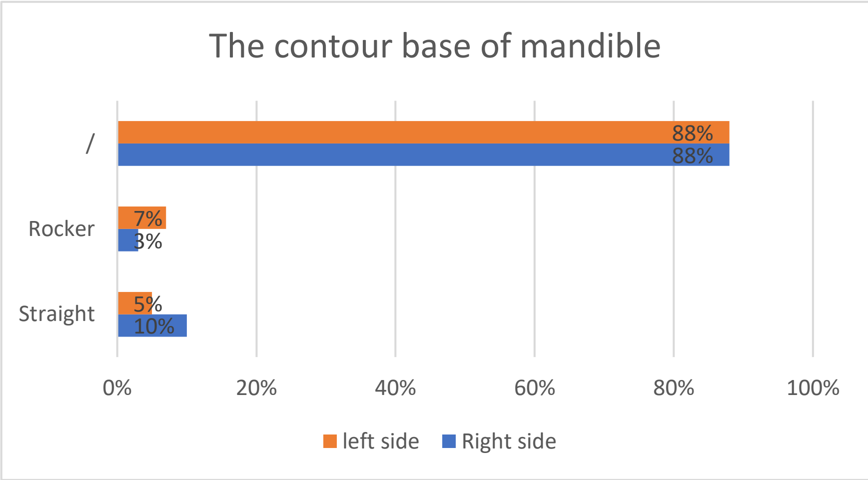
[Fig-11]: Statistical analysis of divergence of gonial angle of male and female mandibles in both sides.

6.2.3. The profile of the chin (Cova de la Guineu):

profile of the Chin	Num	Percentage
Male	1	2%
Female	3	8%
/	36	90%
Total	40	100%

[Table-7]: Statistical analysis of profile chin of male and female mandibles.

6.2.4. The contour of the base of mandible (Cova de la Guineu):



[Fig-12]: Statistical analysis of base of male and female mandibles in both sides.

The contour of the base of the mandible: The most frequent shape in the Cueva de El Mirador population for the contour is the straight shape presented the females with 41% on the right side and 59% on the left side and the second, rocker shape are less presented males with 17 % on the right side and 8% on the left side. For indeterminate individuals the contour of the base of the mandible was 42% on the right side and 33% on the left side [Fig-9]. For Cova de la Guineu results, there was 10% straight shape on the right side and 5% on the left side, the rocker shape is 3% on the right side and 7% on the left side [Fig-12].

The shape of the ramus of mandible: This parameter was presented with two morphologies: pinched and the wide shape. The results in the Cueva de El Mirador, the most frequent shape was pinched with 46% and 12% was with the wide shape, whereas the 42% are undefined. The right side like the left side show the same results [Table-5]. For the Cova de la Guineu, the pinched shape presented with 2% on both sides, and the wide shape was at 0% on the right side and 2% on the left side [Table-10].

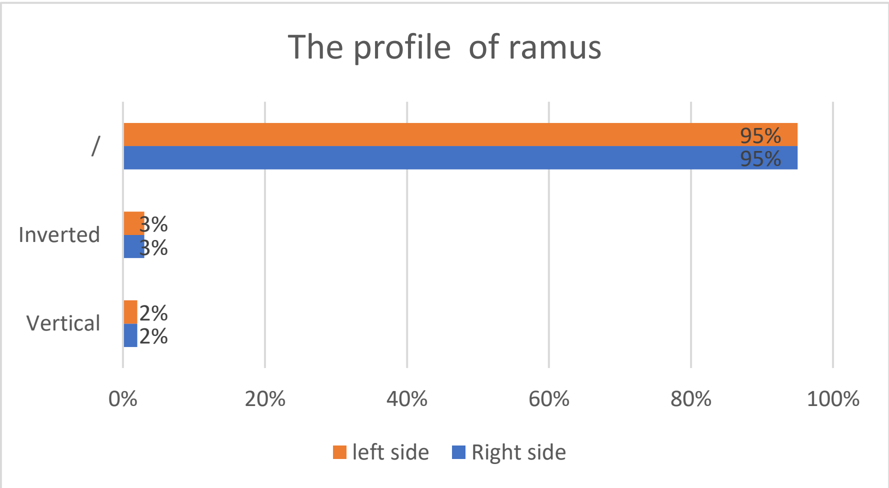
In this parameter (the profile of the ramus of mandible), the most frequent type in the Cueva El Mirador, the slanted type with 37% on the right side and 42% on the left side showed on both male and female, for the vertical ramus just 8% on both sides, and the inverted ramus showed with 13% on the right side and 8% on the left side. Thus 42% on both sides are indetermined mandibles [Fig-10]. For the Cova de la Guineu, the vertical ramus showed 8% on both sides, the slanted type showed 0% on both sides and the inverted ramus showed 3% on both sides [Fig-13].

6.2.5. The shape of the ramus of the mandible (Cova de la Guineu):

Shape of ramus	Num/ Right side	Percentage	Num/ left side	Percentage
Female	1	2%	1	3%
Male	0	0%	1	2%
/	39	98%	38	95%
TOTAL	40	100%	40	100%

[Table-8]: Statistical analysis of ramus shape of male and female mandibles in both sides.

6.2.6. The profile of the ramus of mandible (Cova de la Guineu):

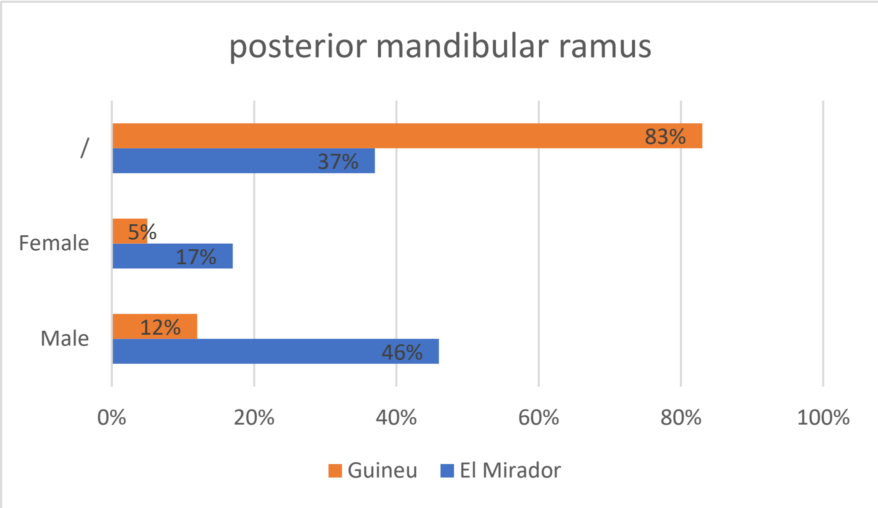


[Fig-13]: Statistical analysis of profile ramus of male and female mandibles in both sides.

6.2.7. The posterior mandibular ramus flexure Cueva de El Mirador and Cova de la Guineu:

IND	SCORE 1	SCORE 2	TOTAL SCORE	SEX	IND	SCORE 1	SCORE 2	TOTAL SCORE	SEX
MIR202-4	-1	+1	0	M	GUIN-60	/	/	/	/
MIR202-6	+1	-1	0	M	GUIN-64	/	/	/	/
MIR202-21	+1	+1	+2	M	GUIN-57	-2	/	-2	F
MIR201-17	+1	+1	+2	M	GUIN-63	-1	/	-1	F
MIR203-7	0	+1	+1	M	GUIN-66	/	+1	+1	M
MIR203-1	-1	0	-1	F	GUIN-67	/	/	/	/
MIR201-24	/	/	/	/	GUIN-8	/	/	/	/
MIR201-16	/	/	/	/	GUIN-153	/	/	/	/
MIR201-9	/	/	/	/	GUIN-518	/	/	/	/
MIR201-13	/	+1	+1	*M*	GUIN-*1/nci*	/	/	/	/
MIR203-5	-1	-1	-2	F	GUIN-2/naci	/	/	/	/
MIR201-8	0	+1	+1	M	GUIN-685	/	/	/	/
MIR203-19	/	+1	+1	M	GUIN-566	/	/	/	/
MIR201-12	/	/	/	/	GUIN-1820	/	/	/	/
MIR202-14	/	/	/	/	GUIN-195	/	/	/	/
MIR201-15	-1	/	-1	F	GUIN-815	/	/	/	/
MIR201-18	+1	+1	+2	M	GUIN-7022	/	+1	+1	M
MIR203-2	+1	0	+1	M	GUIN-7000	/	/	/	/
MIR202-10	/	/	/	/	GUIN-7006	/	/	/	/
MIR202-20	+1	+1	+2	M	GUIN-7024	/	/	/	/
MIR203-3	-1	/	-1	F	GUIN-7112	/	/	/	/
MIR202-22	/	/	/	/	GUIN-1319	/	/	/	/
MIR201-11	/	/	/	/	GUIN-3 naci	/	/	/	/
MIR201-23	/	/	/	/	GUIN-4 naci	+1	/	/	M
					GUIN-56	+1	/	/	M
					GUIN-211	/	/	/	
					GUIN-424	/	/	/	
					GUIN-1546	/	/	/	
					GUIN-683	/	/	/	
					GUIN-10	/	/	/	
					GUIN-123	/	/	/	
					GUIN-3353	+2	/	/	M
					GUIN-6	/	/	/	/
					GUIN-3302	/	/	/	/
					GUIN-3304	/	/	/	/
					GUIN-3	/	/	/	/
					GUIN-3300	/	/	/	/
					GUIN-1836	/	/	/	/
					GUIN-434	/	/	/	/
					GUIN-3352	/	/	/	/

[Table-9]: Predictive accuracy of mandibular ramus flexure as a singular morphologic indicator of sex among males and females. Data from Cueva de El Mirador and Cova de la Guineu.



[Fig-14]: Statistical analysis of posterior ramus flexure of male and female mandibles Data from Cueva de El Mirador and Cova de la Guineu.

The posterior mandibular ramus flexure showed angulation in males, in females this border is straight with scores for both left and right sides (Loth & Henneberg. 1996). In our study posterior flexion of the mandibular ramus, for the Cueva El Mirador we were able to determine 46% of males with scores 0, + 1 and +2 and 17% are females with scores 1- and -2.

37% are undetermined mandibles [Fig-14]. For the results obtained in the Cueva de la Guineu cave, 12% are males, 5% are females and 83% mandibles of the totality are undetermined [Fig-14].

The scores are **(+1), (+2)** and **(0)** are male. **(-1)** and **(-2)** are female.

Classification of nonmetric items	Types	Mirador (males)		Guineu (males)		Mirador (females)		Guineu (females)	
		R		L		R		L	
1. The shape of the chin	1.Bilobite	13%	3			3%	1		
	2.Square	33%	8			3%	1		
	3.Pointed	13%	3			5%	2		
2. The divergence of the gonial angle	1.Inverted	21%	5	21%	5	2%	1	2%	1
	2.Straight	12%	3	12%	3	3%	1	0%	0
	3.Everted	25%	6	25%	6	2%	2	0%	0
3. The profile of the chin	1.Prominent	8%	2			2%	1		
	2.Vertival	54%	13			8%	3		
4. The contour of the base of mandible	1.Straight	41%	10	59%	14	10%	4	5%	2
	2.Rocker	17%	4	8%	2	3%	1	7%	3
5. The shape of the ramus of mandible.	1.Pinched	46%	11	46%	11	2%	1	3%	1
	2.Wide	12%	3	12%	3	0%	0	2%	1
6. The profile of the ramus of mandible	1.Vertical	8%	2	8%	2	2%	1	2%	1
	2.Slanted	37%	9	42%	10	0%	0	0%	0
	3.Inverted	13%	3	8%	2	3%	1	3%	1
7.The posterior mandibular ramus flexure	1.(0) (+1) (+2)	46%	11			12%	5		
	2. (-1) (-2)	17%	4			5%	2		

[Table -10]: The result with percentage of the nonmetric characteristics of the mandibles of both sites Cueva de El Mirador and Cova de la Guineu.

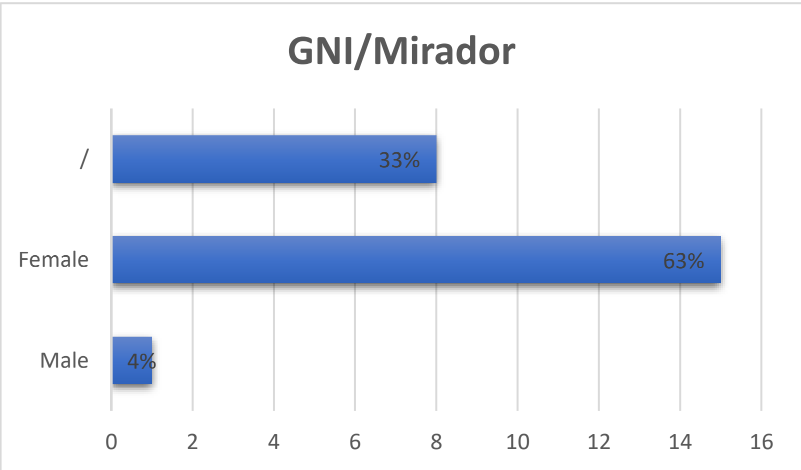
6.3. Metrical results of both sites (Cueva de El Mirador and Cova de la Guineu):

Height of symphysis (GNI): The height of the symphysis of the mandibles of our population, the maximum is 33.72 mm, and the minimum is 24.79mm. This height GNI measurement has determined 63% females, 4% are male and 33% are indetermined mandibles in the population of El Mirador [Fig-15]. However, the population of Cueva de la Guineu, presented 20% females, 7% male and 73% are indeterminate [Table-11].

Breadth of mandibular body (TML): In the population of El Mirador, this parameter, the length, range between 8.16 / 8.80mm for the small dimension, the large between 11.04 / 11.86mm. We observed 50% determinate on both sides are female. While males had 21% on the right side and 8% on the left side, and 29% are undefined on the right side and 42% on the left side [Fig-16]. On the other hand, in Cueva de la Guineu population, the sex percentages are lower, 15% of females on the right side and 7% on the left side and 80% presented indeterminate mandibles in the right side, 88% in the left side [Table-12].

Height of mandibular body (HML): The height of the body in the male mandibles range between 31.95 to 25.22 mm for the two populations. HML sex determination for 38% of males on the right side and 25% on the left side, 29% of females on the right side and 46% are found on the left side and 33% are undefined [Fig-17].About Cueva de la Guineu population, the sex estimation is very low, 5% of males on both sides, 15% presented females on the right side and 7% on the left side and 80% presented indeterminate mandibles in the right side, 88% in the left side [Table-13].

6.3.1. Height of symphysis (GNI):

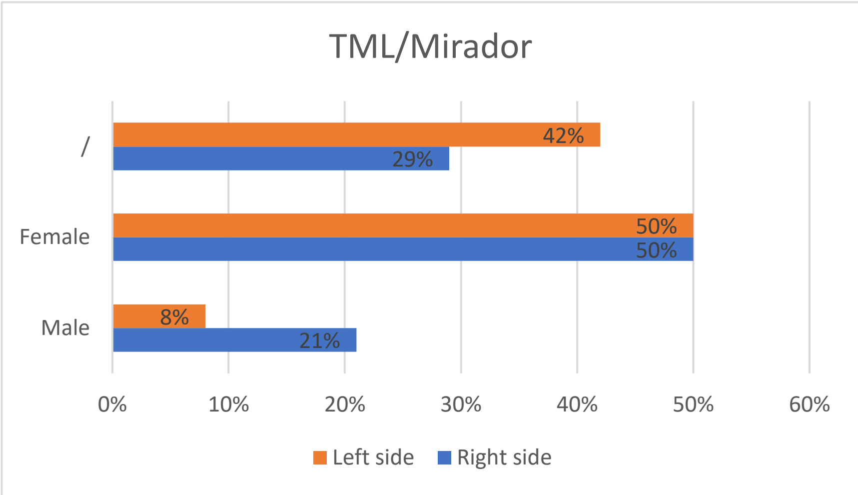


[Fig-15]: Statistical analysis of Height of symphysis diameter in male and female mandibles (mm).

GNI /Guineu	Num	Percentage
Male	3	7%
Female	8	20%
/	29	73%
Total	40	100%

[Table-11]: Statistical analysis of Height of symphysis diameter in male and female mandibles (mm).

6.3.2. Breadth mandibular body (TML):

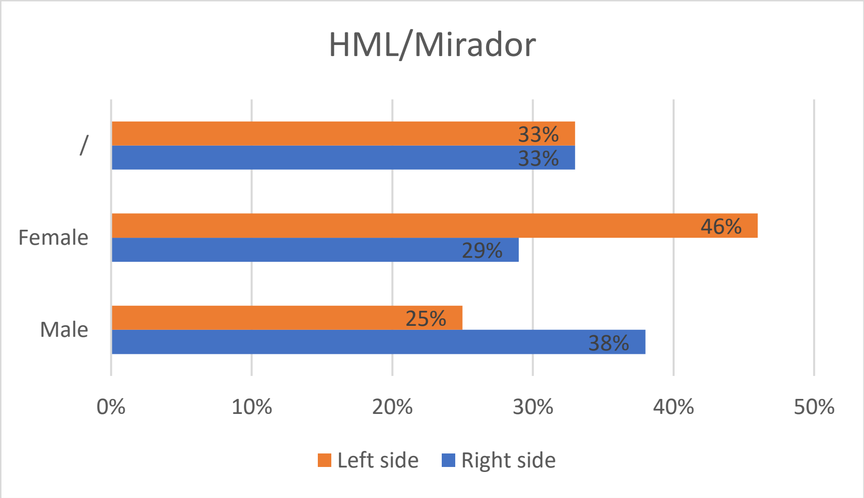


[Fig-16]: Statistical analysis of Breadth mandibular body diameter in male and female mandibles (mm) in both sides.

TML /Guineu	Num/ Right side	Percentage	Num/ Left side	Percentage
Male	1	2%	1	2%
Female	7	18%	4	10%
/	32	80%	35	88%
Total	40	100%	40	100%

[Table-12]: Statistical analysis of Breadth mandibular body diameter in male and female mandibles (mm) in both sides.

6.3.3. Height of mandibular body (HML):



[Fig-17]: Statistical analysis of Height of mandibular body diameter in male and female mandibles (mm) in both sides.

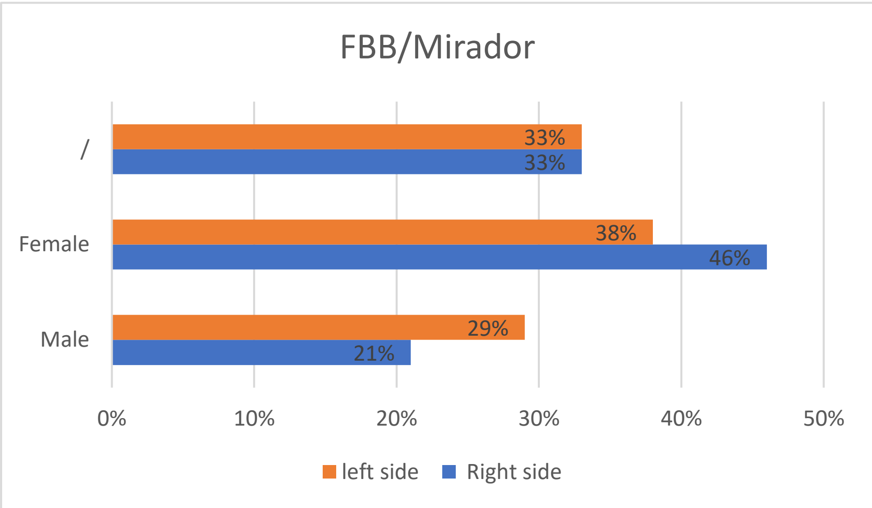
HML /Guineu	Num/ Right side	Percentage	Num/ Left side	Percentage
Male	2	5%	2	5%
Female	6	15%	3	7%
/	32	80%	35	88%
Total	40	100%	40	100%

[Table-13]: Statistical analysis of Height of mandibular body diameter in male and female mandibles (mm) in both sides.

Foramen height (FBB): The height of FBB range between 16.17 and 9.21mm. In the population of El Mirador this parameter determines 46% of the females on the right side and 38% on the left side, the males showed 21% on the right side, 29% on the left side and 33% are undefined [Fig-18]. For Cova de la Guineu, there is 12% on both sides, and 12% of females observed on the right side and 8% on the left side. 76% are undefined in the right side and 80% in the left [Table-14].

Foramen-to-chin distance (MFA): The length of this parameter range between 29.67 and 22.84 mm, for El Mirador. 33% of females presented on the right side, 29% showed on the left side, and for males 29% presented on the right side and 25% on the left side. 38% of mandibles are not determined in the right side and 33% on the left side [Fig-19]. For Cova de la Guineu, 12% males observed on the left side, 7% on the left side and 5% are females on the right side ,7% on the left side.83% mandibles are indeterminate on the right side, 86 % on the left side [Table-15].

6.3.4. foramen height (FBB):

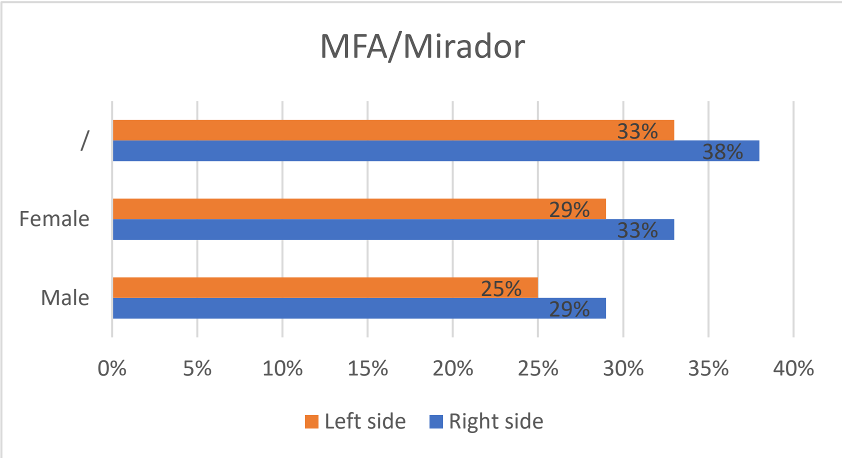


[Fig-18]: Statistical analysis of foramen height diameter in male and female mandibles (mm) in both sides.

FBB /Guineu	Num/side Right	Percentage	Num/side Left	Percentage
Male	5	12%	5	12%
Female	5	12%	3	8%
/	30	76%	32	80%
Total	40	100%	40	100%

[Table-14]: Statistical analysis of foramen height diameter in male and female mandibles (mm) in both sides.

6.3.5. Foramen-to-chin distance height (MFA):

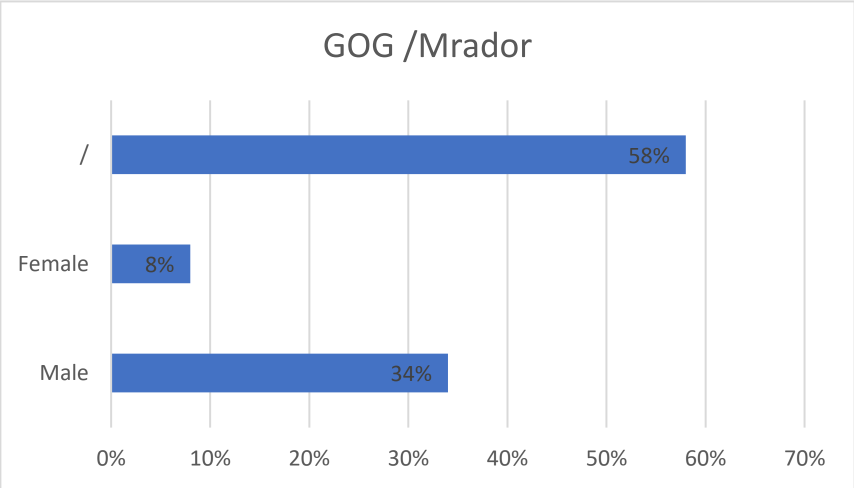


[Fig-19]: Statistical analysis of foramen-to-chin distance height diameter in male and female mandibles (mm).

MFA /Guineu	Num/ Right side	Percentage	Num/ Left side	Percentage
Male	5	12%	3	7%
Female	2	5%	3	7%
/	33	83%	34	86%
Total	40	100%	40	100%

[Table-15]: Statistical analysis of foramen height diameter in male and female mandibles (mm) in both sides.

6.3.6. Bigonial breadth (GOG):



[Fig-20]: Statistical analysis of Bigonial breadth diameter in male and female mandibles (mm).

GOG/Guineu	Num	Percentage
Male	0	0%
Female	0	0%
/	40	100%
Total	40	100%

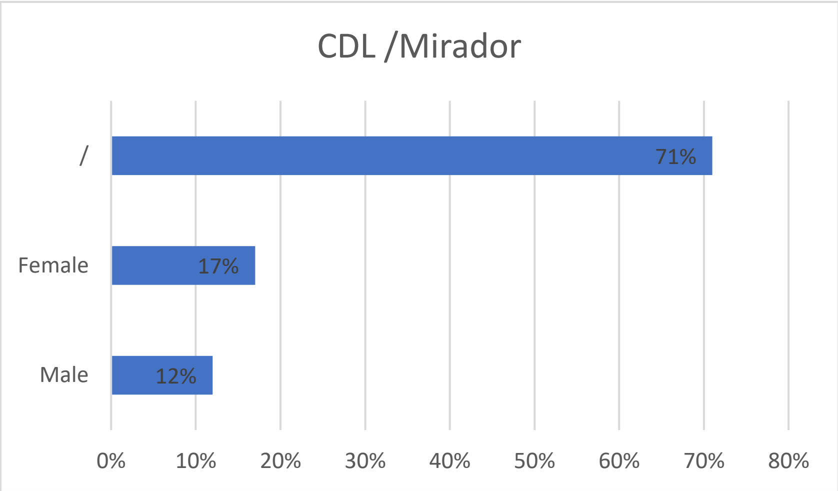
[Table-16]: Statistical analysis of Bigonial breadth diameter in male and female mandibles (mm).

Bigonial breadth (GOG): The bigonial breadth of the mandible range between 85.35 mm to 101.27 mm. For El Mirador, this parameter is present on 34% of males, 8% are females and 58% of the mandibles are undefined [Fig-20]. No mandible has been able to determine with bigonial width in Cova de la Guineu [Table-16].

Bicondylar breadth (CDL): The bicondylar width of the mandible for our population ranges from 109.20 to 121.42 mm. We found with this parameter very low percentage for the population of El Mirador, 17% of females and 12% of males and 71% are undetermined [Fig-21]. No mandible was determined in Cova de la Guineu [Table-17].

Mandibular length (MRL): The mandible length of MRL is between 47.33 mm to 35.44 mm, we found 38% of mandibles are females on the right side, 33% on the left side, the males presented 13% on both sides. 50% mandible without determination on the right side and 54% on the left side [Fig-22]. For Cova de la Guineu cave, 0% males were present on the right side and 2% on the left side, for females 0% on both sides [Table-18].

6.3.7. Bicondylar breadth (CDL):

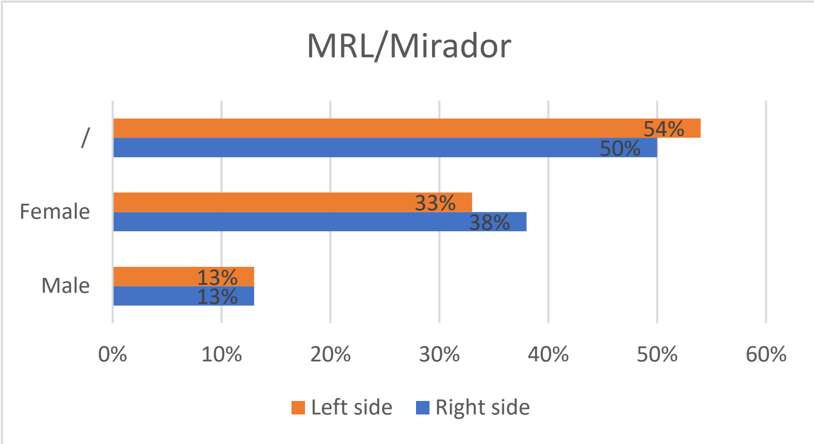


[Fig-21]: Statistical analysis of Bicondylar breadth diameter in male and female mandibles (mm).

CDL /Guineu	Num	Percentage
Male	0	0%
Female	0	0%
/	40	100%
Total	40	100%

[Table-17]: Statistical analysis of Bicondylar breadth diameter in male and female mandibles (mm).

6.3.8. Maximum ramus breadth (MRL):

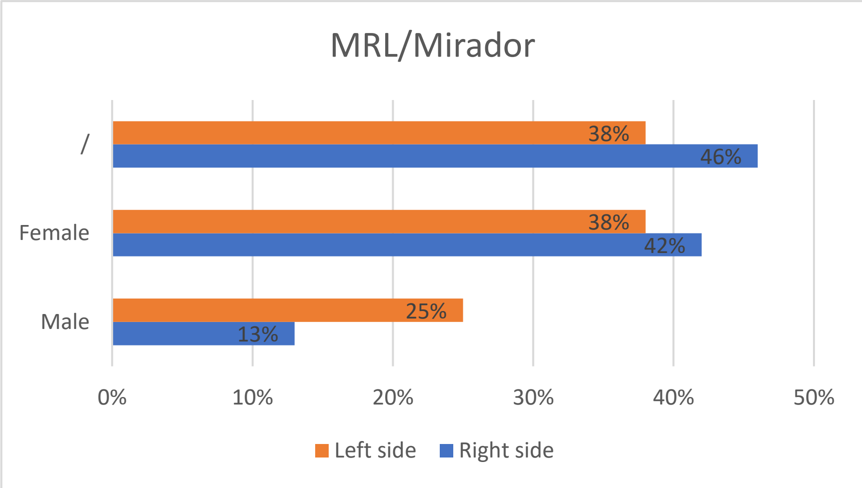


[Fig-22]: Statistical analysis of Maximum ramus breadth diameter in male and female mandibles (mm) in both sides.

MRL /Guineu	Num/side right	Percentage	Num/side left	Percentage
Male	0	0%	1	2%
Female	0	0%	0	0%
/	40	100%	39	98%
Total	40	100%	40	100%

[Table-18]: Statistical analysis of Maximum ramus breadth diameter in male and female mandibles (mm) in both sides.

6.3.9. Minimum ramus breadth (WRK):



[Fig-23]: Statistical analysis of Minimum ramus breadth diameter in male and female mandibles (mm) in both sides.

WRK /Guineu	Num/side Right	Percentage	Num/side Left	Percentage
Male	0	0%	1	2%
Female	3	7%	1	2%
/	37	93%	38	96%
Total	40	100%	40	100%

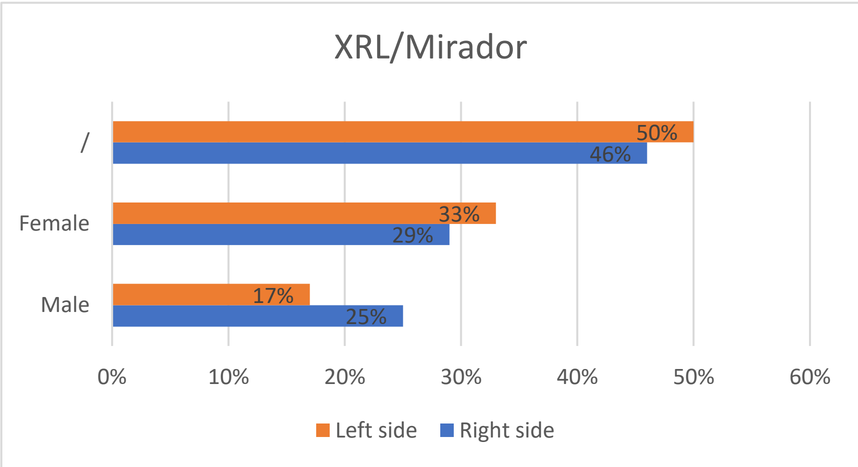
[Table-19]: Statistical analysis of Minimum ramus breadth diameter in male and female mandibles (mm) in both sides.

Minimum ramus breadth (WRK): for t breadth of the ramus was between 36.76 and 26.13 mm. For the mandibles El Mirador, 42% of the females showed on the right side and 38% showed on the left side. The males showed 13% on the right side and 25% on the left side, 46% mandibles not determinate [Fig-23]. For Cova de la Guineu site, 0% males were present on the right side, 2% on the left side, for females presented 7% on the right side, 2% on the left side, 93% mandible without determination on the right side and 96% on the left side [Table-19].

Maximum ramus height (XRL): The coronoid height of the mandible is 43.91 to 75.12 mm. 29% had females on the right side and 33% are on the left side, and 25% males on the right side and 17% on the left side. 46% mandible without determination on the right side and 50% on the left side [Fig-24]. For Cova de la Guineu having 0% male on the right side and 2% on the left side, and for females had 0% on both sides [Table-20].

Mandibular length (MLT): The mandibular length of the mandible is 75.44 to 61.74mm. For El Mirador we found 25% of mandibles are males and 17% are females and 58% mandible not determinate [Fig-25]. For Cova de la Guineu having 0% on both sides [Table-21].

6.3.10. Maximum ramus height (XRL):

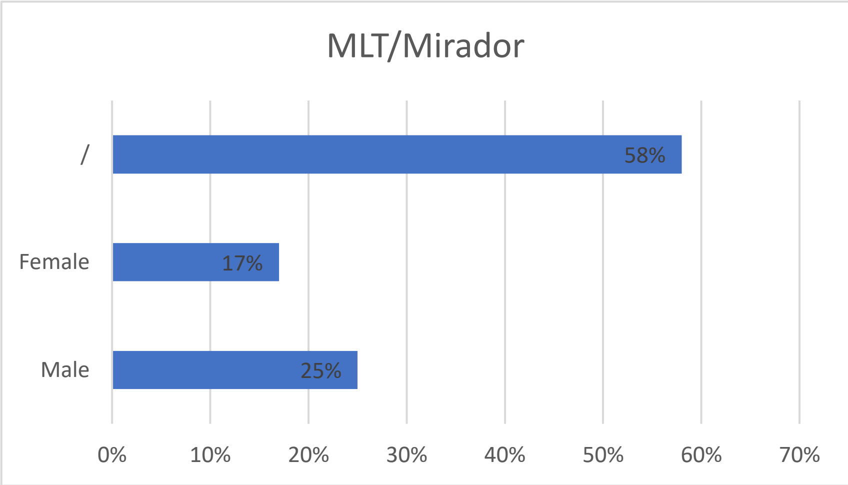


[Fig-24]: Statistical analysis of Maximum ramus height diameter in male and female mandibles (mm) in both sides.

XRL /Guineu	Num/side Right	Percentage	Num/side Left	Percentage
Male	0	0%	1	2%
Female	0	0%	0	0%
/	40	100%	39	98%
Total	40	100%	40	100%

[Table-20]: Statistical analysis of Maximum ramus height diameter in male and female mandibles (mm) in both sides.

6.3.11. Mandibular length (MLT):

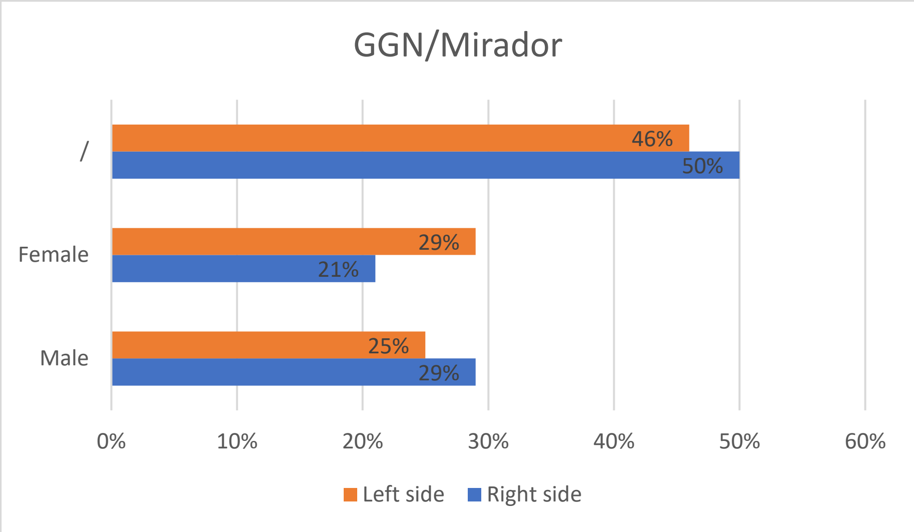


[Fig-25]: Statistical analysis of Mandibular length diameter in male and female mandibles (mm).

MLT /Guineu	Num	Percentage
Male	0	0%
Female	0	0%
/	40	100%
Total	40	100%

[Table-21]: Statistical analysis of Mandibular length diameter in male and female mandibles (mm).

6.3.12. Length of the body (GGN):

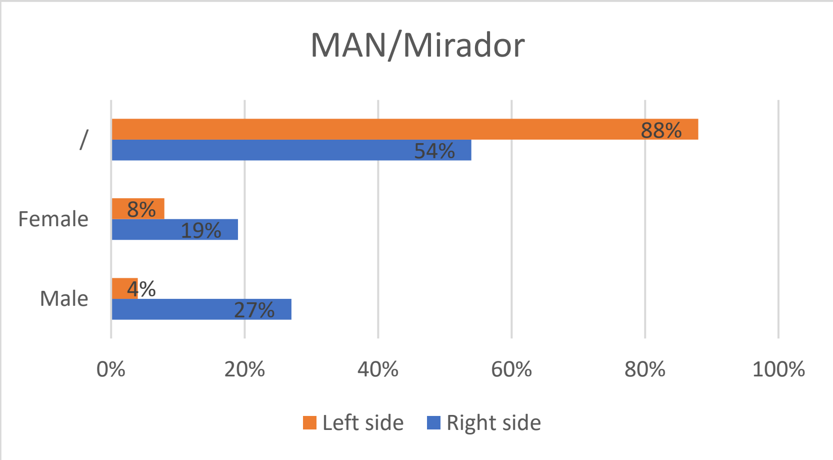


[Fig-26]: Statistical analysis of Length of the body diameter in male and female mandibles (mm).

GGN /Guineu	Num/ Right side	Percentage	Num/ Left side	Percentage
Male	0	0%	0	0%
Female	1	2%	0	0%
/	39	98%	40	100%
Total	40	100%	40	100%

[Table-22]: Statistical analysis of Length of the body diameter in male and female mandibles (mm) in both sides.

6.3.13. Mandibula angle (MAN):

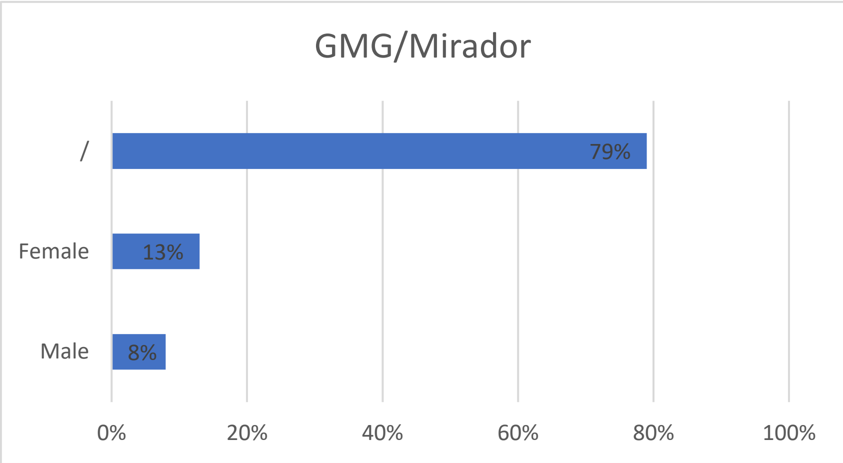


[Fig-27]: Statistical analysis of Mandibula angle diameter in male and female mandibles (mm) in both sides.

MAN /Guineu	Num	Percentage
Male	0	0%
Female	0	0%
/	40	100%
Total	40	100%

[Table-23]: Statistical analysis of Mandibula angle diameter in male and female mandibles (mm).

6.3.14. Mental angle (GMG):



[Fig-28]: Statistical analysis of Mental angle diameter in male and female mandibles (mm).

GMG /Guineu	Num	Percentage
Male	0	0%
Female	0	0%
/	40	100%
Total	40	100%

[Table-24]: Statistical analysis of Mental angle diameter in male and female mandibles (mm).

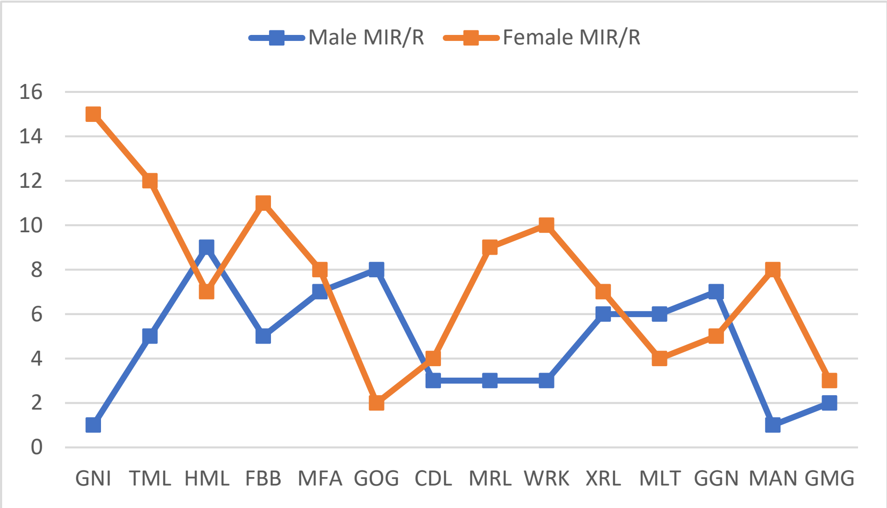
Length of the body (GGN): The diameter length of the body is 88.35 to 72.77 mm, for El Mirador we found 29% females on the right side ,25% on the left and 21% presented male on the right side ,29 % on the left side. 50% of mandibles are indetermined on the right side and 46% on the left side [Fig-26]. For Cova de la Guineu 0% for males on both sides, females had 2% on the right side and 0% on the left side. [Table-22].

Mandibular angle (MAN): The mandibular angle is between 113.39 to 136.04. For El Mirador we found 27% of mandibles females on the right side ,4% on the left and 5% presented male on the right side ,2 % on the left side. 54% of mandibles are indetermined on the right side and 88% on the left side [Fig-27]. For Cova de la Guineu having 0% on both sides [Table-23].

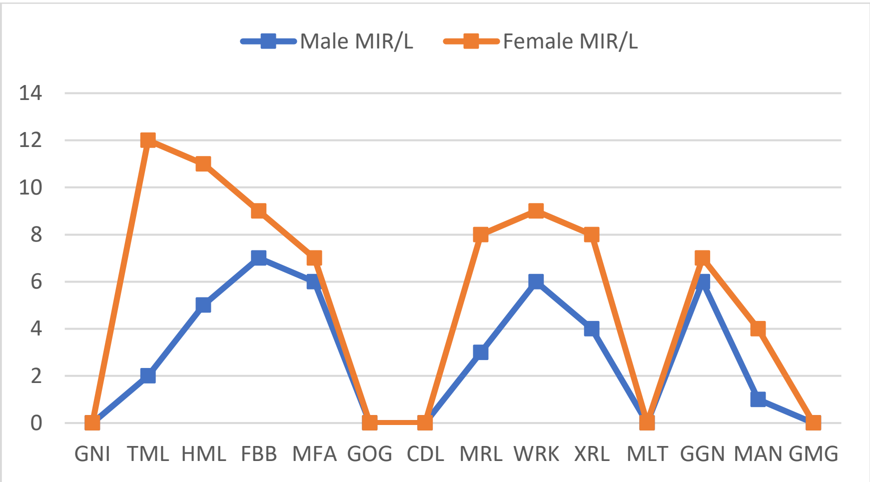
Mental angle (GMG): the diameter of mental angle shows a measurement between 70.67mm and 67.91mm. It presented the females with 13% and 8% found in the females. 79% of mandibles are undetermined [Fig-28]. While of Cova de la Guineu has 0% for both sexes [Table-24].

Variable	Male		Female		Male		Female	
Side	R	L	R	L	R	L	R	L
GNI	1	/	15	/	3	/	8	
TML	5	2	12	12	1	1	7	4
HML	9	5	7	11	2	2	6	3
FBB	5	7	11	9	5	5	5	3
MFA	7	6	8	7	5	3	2	3
GOG	8	/	2	/	0	/	0	/
CDL	3	/	4	/	0	/	0	/
MRL	3	3	9	8	/	1	/	0
WRK	3	6	10	9	0	1	3	1
XRL	6	4	7	8	0	1	0	0
MLT	6	/	4	/	0	/	0	/
GGN	7	6	5	7	0	0	1	0
MAN	1	1	8	4	0	0	0	0
GMG	2	/	3	/	0	/	0	/

[Table-25]: Sexing of the mandible by individual metrical parameters in both sides for both sites.



[Fig-29].: Graph corresponding to the degree of sexual dimorphism between the Right mandibles on both sites



[Fig-30]: Graph corresponding to the degree of sexual dimorphism between the left mandibles on both sites.

-The first graph showed that more females are determined on the right side, compared to mandibular males on right side [Fig-29].

-Then in the second graph showed that more females are determined on the left side, compared to mandibular males on left side [Fig-30].

-In the two graphs we observe for the El Mirador population, that the female sex is more dominant than the male sex, in the first graph showed the right side of the mandible, the female sex is higher with the measurements GNI, TML, FBB, MFA, MRL, WRK, XRL and MAM, and the males are present on HML, GOG and GGN [Fig-29].

-While in the second graph presented on the left side of the mandible, the female sex is more frequent with the measurements: TML, HML, MFE, MRL, WRK, XRL and GGN [Fig-30].

7. Discussion:

In medical-legal and physical anthropology, several bones are reliable and even efficient to determine the anatomical sex of skeletal remains. For example, the pelvis is a precise tool in the estimation of sex. However, unfortunately, frequently it is found fragmented or absent in many archaeological contexts. On the other hand, the mandible is the most impacted bone and well preserved for a long time compared to other bones. Mandibular morphological characteristics are different in each sex and can be observed on the bone, even are valuable clues to differentiate the sex. (Tejavathi et al., 2016). Several studies showed that the shape of the mandibular branch, the chin, and the posterior mandibular ramus flexure, showed different morphological features between males and females. (Tejavathi et al., 2016).

7.1. Morphological parameters:

Focusing on our study and regarding the morphological parameters, the shape of the chin, and specifically the square shape, is the most frequent with 33% present in El Mirador males, the bilobate shape 13% with a total of 46% for males and the pointed shape at 13%. For the Guineu population, the determination was very low because of the fragmentary characteristic of the sample. The 3% for the two bilobate and square shape and 5% for the pointed shape. As the percentage of male and female is almost the same, the result of our study summarizes that this parameter is not reliable for estimating sex. In their results, Naira and Nilton (2017), found the shape of chin presented significant statistical differences between the sex, that the square shape of the chin was the most common in black males with 82.7% and 61.9% for white males, females exhibited 73% in black females and 75% in white females.

This morphological parameter was also significant in males in the study of Tejavathi and collaborators, (2016) where they found the square shape in most of the males, the bilobed shape was 45.5%, the square shape 43.6% and pointed 10.9%, while the female mandible was either square 8.6% or bilobed 20.0% and pointed chin shows 71.4%.

The study by Rahul and colleagues, (2015) also reported that this parameter is reliable for determining sex, as the square chin shape in 32 males, and the pointed shape presented 18 females out of a total of 29 males and 21 females.

According to Najma, (2018) the square shape presented in its population with 47.50% was males and for the pointed shape presented females with 24.10%. Ongkana and Sudwan, (2010) in their study obtained on 24 females and 64 males that the chin of square shape and bilobed is more common in males, female mandibles with pointed shape. They obtained a statistical difference between males and females significant P = 0.003. with a percentage of 71.6% present in both sexes.

The gonial angle parameter presented in the results of Sikka and collaborators (2016), showed that the form was everted in 88.4% of males and reversed in 75% of females. On the other hand, in the study of Naira and Nilton (2017) for the shape of gonial angle there was a difference between males and females (p=0.01). In white males, the shape was everted more frequently than females, and females exhibited the inverted shape by 93.1% in black males, 95.2% in white males, 34.3% in black females, and 26.6% in white females.

According to Najma and associates, (2018) the everted shape is 60.8% in males, the inverted shape angle is 0.8% and the straight angle is 0%. In females, the inverted angle is 0%, the inverted form angle is 40% and the straight angle is 5%, with -p-value is 0.001 is statistically significant. The study by Rahul and associates, (2015) also reported that this parameter is reliable for determining sex, in their study the everted shape of the chin in 32 males, and the inverted shape presented 18 females out of a total of 29 males and 21 females.

Ongkana and Sudwan (2010) showed that on 24 females and 64 males that the divergence on the gonial angle female mandibles that are inverted and straight type, male mandible presenting everted type, it obtained a statistical difference between males and females significant P = 0.05. with a percentage of 71.6% present in both sexes.

In our study, for Cueva de El Mirador, the everted shape is presented in males with 25% on the right and left side, on the other hand the inverted shape frequenting the females with 21% on both sides, the straight shape is 12% on both sides. For Cova de la Guineu, the inversed shape is 2% on both sides and the everted shape is 3% on the right side and 0% on the left side, and the straight shape is 3% on the right side and 0% on the left side. We do not notice a difference between the female and male sex, so this parameter is a weak indicator to determine the sex with our samples.

The profile of the chin. The results of Naira and Nilton (2017) showed that this parameter does not mean a sex difference, both prominent and vertical shapes, are found in both populations, on the other hand in whites. Also showed that the prominent shape for both sexes and the vertical shape in blacks for both sexes. In 2016, Aparajitha and Anjali found the presence of muscular markers higher in males 81% with the prominent shape, while they were less important in females 89.6%. Najma and associates, (2018) found the predominant shape presented prominent muscular markers 13.6%, less prominent muscular markers are 12.5% in males, presented 13.3% and 17.5% are mandibles no muscular markers. The females presented 13.3% prominent muscular marking ,11.6% is less muscular markers and 13.3% no muscular markers, they found statistically P value, with 0.18 a low significant to estimate the sex. According to Singh and associates, (2015) also found that this parameter is reliable to determine the sex, in this study the prominent form of the chin in 32 males, and less prominent form presented 18 females out of a total of 29 males and 21 females.

In our study for El Mirador, the results show that the most frequent less prominent(vertical) shape presented 54% and the very weak prominent shape is presented 8%. And for Cova de la Guineu the vertical form at 8% and 2% presented the prominent shape. If we take in consideration that prominent is presented by females and vertical presented males, we have 54% females and 8% of males, for la Cueva de El Mirador. This indicator is reliable for our study because can we are finding both shapes on both sexes.

For the contour parameter of the base mandible there are two shapes: rocker and straight forms. Aparajitha and Anjali (2016) found the rocker shape in males in 58.9% of males and 41.1% presented the straight form in the female group. According to Naira and Nilton, (2017) the rocker shape more common than the straight shape and was presented in both black and white populations.

For this parameter, our study shows that the most predominant form in the populations studied, El Mirador, is the straight form with 41% on the right side and 59% on the left side, while the rocker form presented 17% on the right side and 8 % on the left side. For Guineu site, the feeble result is 10% straight form on the right side and 5% on the left side, the rocker shape is 3% on the right side and 7% on the left side. In this case this indicator does not help to determine sex with our samples.

Ongkana and Sudwan, (2010) obtained on 24 females and 64 males that the contour on the base of mandible, in females with the straight shape and in males with the rocker shape was higher, they obtained a statistical difference between males and females. significant P = 0.005. with a percentage of 71.6% present in both sexes.

The shape of the ramus of mandible, is based on two pinched shape and wide. In the study of Naira and Nilton (2017) the more dominant shape was the wide form in the two black and white types and even for both sexes with 65.90% in white males and 73.70% in blacks, concerning females showed 55.50% in whites and blacks. The pinched form had 34.10% and 26.30% in males, 44.50% in females, their study resulted no statistical differences were observed between both sexes.

For our study, and in the case of El Mirador sample, the pinched form of the mandible was the most frequent with 46% on both sides, and the wide form presented 12% for both sides. For Cova de la Guineu sample, the pinched form was presented with 2% on both sides, and the wide form is 0% on the right side and 2% on the left side. The results showed that the percentage of the shape pinched higher than the shape wide, but we can find the pinched shape in both sexes like the result of Naira and Nilton, that this indicator confirms does not determine of the sex.

The profile of the ramus of mandible showed three types; vertical shape, slanted and inverted. Naira and Nilton (2017) found that there were just two shapes for the two populations studied, the slanted shape was more frequent with 77.30% the white males and 63% are black. 68.40% for the black females and 94.40% are white, the very weak vertical shape is 5.6% observed on the female mandibles. the results Naira and Nilton, were found the slanted profile was statistically significant more dominant than the vertical shape between male and female on black and white individuals.

Regarding our study, for El Mirador mandibles, they show the slanted form 37% on the right side and 42% on the left side, and the inverted form showed 13% on the right side and 8% on the left side and the vertical form is 8% on both sides. For Cova de la Guineu the vertical form had 2% on both sides, the slanted form was 0% on both sides and the inverted form was 3% on both sides. In this case we cannot considerate this parameter as an indicator to determine the sex. The slanted form is more dominant in our sample, since the slanted shape presented both sexes.

Posterior mandibular ramus flexure showed scores observed on the right and left mandible flexion. In 2013, Shivaprakash and colleagues, reached a percentage of 76% of sex determined after their observations on the posterior flexion of the mandibular ramus of 55 male mandibles, the sex was determined with an accuracy of 80% in males and an accuracy of 71% are females. Loth and Henneberg's study, (1996), was based just on the flexure parameter of the posterior mandibular ramus flexure applied to mandibles of different populations of Africans and Americans (including whites, blacks, and Native Americans) found a gender accuracy of 94.2%.

Naira and Nilton (2017) show that the distribution of scores was found in males and females with percentages not differing sex for both populations. Ongkana, and colleagues (2010), in their study obtained on 24 females and 64 males that the posterior mandibular ramus flexure from the lateral present or absent in mandibles. Present in males with 50%, females showed 29.2%, while was absent in males with 50% and 70.8 in females, indicate the of the flexure. There is a statistical difference between males and females significant P = 0.0131.

In our study the results obtained with this parameter in the El Mirador population, the distribution of scores are 46% males and 17% of females and 37% are undetermined and for Cova de la Guineu this parameter motivated 12% of males, 5% of females and 83%. indeterminate.

The analysis of sex determination for Cueva de El Mirador population was made with DNA, obtained an almost similar result 50% are males, 17% are females and 32% out of a total of 28 individuals (Mathieson et al., 2015). For our study this parameter is reliable for determining the sex, according to the results of the DNA also that of Loth and Henneberg (1996) and Shivaprakash (2013), whereas the results of Naira and Nilton (2017) did not show the reliability of this parameter to determine the sex in his study.

In our study for the morphological method, showed that all seven morphological characteristics of the mandibular branch, including the shape of the chin, and the posterior mandibular ramus flexure are considered questionable parameters for the diagnosis of sex.

The percentage of female sexed was more present than male with five morphological characteristics. However, after confirmation of sex determination with DNA found that male individuals were more frequent in the population of El Mirador (Mathieson et al., 2015; Yustos M et al.,2020), same result found on the last indicators (the shape of the chin, and the posterior mandibular ramus flexure), showed that the results are reliable, of course after the comparative study with the DNA results, found that male individuals were more frequent than female.

7.2. Metrical parameters:

For the method of mandibular metric there are many quantitative studies with different parameters and different populations, previous studies showed presence of variations in mandibles studies after having different measurements for populations like that of Mexico and Xigui (include the citation of this study, is Villanueva and colleagues, (2017). These studies concluded the reliability of mandibular metric parameters to determinate the sex.

In our study, the statistical analysis was incomplete because the fragmentary nature and reduced quantity of our samples, our statistical analysis is incomplete we know that for each statistical analysis we need statistically significant to evaluate the results like the standard deviation, P value and t test.

Talking about the average of each measurement, because of the fragmentation of the mandibles we could not get the average for each parameter. These averages help us to compare them with other averages obtained by other researchers in their analysis in both sexes.

The GNI measurement in our study for the population from El Mirador, the height varies from 33.72mm to 24.79mm, determined 63% females, 4% are male and 33% of undetermined mandibles, for Cova de la Guineu showed 7% males and 20% females. Villanuava and colleagues (2017) found the average in males of Mexico 31.97mm with SD is 3.89 mm, for females the average is 29.97mm and SD is 4.76, for the second Xigui population, the average in males is 36.54 mm, SD is 2.81.

On the other hand, in the studies of Deepak and colleagues (2015), males had an average of 22.02mm, while in females the average was 21.16 mm with error that is not statistically significant. (Deepak et al.,2015). Kumar and Lokanadham (2013) found the mean symphyseal height to be 29.63mm and SD to be 3.51. While our study showed that the symphyseal height was higher in females than in males.

In our study, the average mandibular body height HML ranged from 31.95mm to 25.22 mm. For El Mirador sample a sex determination for 38% of males on the right side and 25% on the left side, 92% of females on the right side and 46% are found on the left side and 33% are undefined. On the other hand, for Cova de la Guineu sample, 80% are indeterminate mandibles and 2% present on both sides and 18% females on the right side and 10% on the left side. Deep and associates (2015), found that the mean HML of males is 23.95 mm, with SD 0.40 and that of females, is 22.83 mm, with SD 0.30. Datta and collaborators (2015) observed a statistical difference between the two sexes after their results. The average height of the body of the mandible in males of 28.65mm and the SD at 2.58 and that has an average of 22.83 and SD at 3.73 in females. A determination of sex for 88% males and 76% of females. Villanueva and colleagues (2017) found the mean in males from Mexico 29.43 mm and SD 3.53, that of females is at 28.42mm and SD is at 3.31, while males from Xigui had an average for HML 32.74 mm with SD at 2.25, in the females the average is at 29.37 mm with SD at 2.29, showed a difference between the sex for the group of Xigui.

The TML diameter, in our study measures 11.86 mm and 8.30 mm in the population of Cueva de El Mirador, the length varies from 8.16 mm / 8.80 mm for the small dimension, the large between 11.04 mm / 11.86 mm. We see 50% of females on both sides, 21% are males on the right side and 8% on the left side. While for Cova de la Guineu 5% of males on both sides, 15% were females on the right side and 7% on the left side. Villanueva and colleagues (2017) found the mean 11.13 mm and SD 1.33, that of the females is 10.94 mm and SD 1.28 for the group from Mexico, for the group of Xigui the mean in males is at 12.36 mm and SD 1.88, the females 11.61mm and SD a 11.6. Najma and colleagues (2018) found the mean of the males of TML at 6.55mm and SD 0.572 and that of the females is 6.51mm with a SD 0.507, they indicate that they're the gender difference between male and female insignificant the ($p=0.69$). Deepak and associates (2015) presented the mean TML in males is 11.18 mm, with SD 0.14, that of females is 10.22 mm, with SD 0.02, and the p value was 0.06.

The FBB diameter showed on the paper of Villanueva and collaborators (2017) that the average in males from Mexico is 14.41 mm and SD, in females is 13.79 mm and SD 1.57, and according to their results this measurement showed a difference between the two sexes for the Xigui group with p value=0.0006. In our study the measurements of 16.17 mm and 9.21 mm vary, for the population of El Mirador this parameter determined 46% of the females on the right side and 38% on the left side, the males showed 21% on the right side, 29% on the left side. For Cova de la Guineu presented 5% on both sides, and 5% of females observed on the right side and 3% on the left side.

The MFA diameter presented in the study of Villanueva and collaborators (2017) observed an average in the males of Mexico 28.41mm and SD 2.05 and for the females 26.60 mm and SD at 1.2. and according to its results this measurement of Villanueva showed a difference between the two sexes for the Xigui group with p value =0.0003. On the other hand, in our study the measurements are varied between 29.67mm and 22.84 mm, for El Mirador, 33% of the females presented on the right side, 29% showed on the left side, and for the males 29% presented on the right side and 29 % on the left side. For Cova de la Guineu 12% males on the right side and 7% on the left side, 5% females on the right side and 7% on the left side.

The GOG diameter is presented in the study of Deepak and associates (2015). The bigonial width of the mandible in males has an average of 95.63 mm, an SD of 0.61 and in contrast in females, the average is 89.83 mm, an SD is 0.76 and the standard mean error 0.18. The sexual determination of the mandible with bigonial width is statistically significant in their studies. Vinay and collaborators (2013) showed the average bigonial width of the mandible GOG, in males presented 94.5 mm in females 87.4 mm in, he showed statistically presence of difference of values between the two males and females. Babita and colleagues (2017) showed the mean GOG in males was 94.69 mm with a SD of 2.46 and in females was 88.27 mm with a SD of 7.84, there are statistically difference with a p value> 0.0006 between males and females.

Other study performed by Datta and collaborators in (2015), found that of the bicondylar width of male mandible was found to be 95.70 mm with SD was 5.19 and 88.75 mm in females with SD was 6.78, there are differences in statistically significant of male and female was (p=0.0001). Najma and colleagues (2018) found the mean bicondylar in the male mandibles to be 78.7mm with an SD of 0.59 and in the female mandible to be 77.5 with an SD of 0.59. A difference of 0.125 between male and female mandibles.

Singh and collaborators (2015), presented in their results that the bigonial width (GOG) in females measures 84.3 mm, and that of males 96.2 mm, with a p value <0, 0001 and statistically indicated presence of difference between male and female.

In our study, the bigonial width of the mandible varied between 85.35 mm to 101.27 mm. For El Mirador, this diameter presented 33% of males, 8% are females. While Cova de la Guineu has 0% for both sexes. Villanueva and colleagues, (2017) found that the mean GOG in males from Mexico was 90.06 mm with a SD 5.41 and in females was 84.80 mm, SD 4.22, they showed that this indicator diameter for estimating sex.

The CDL diameter, in our study ranges from 109.20 mm to 121.42 mm. We found with this diameter very low percentage for the population of El Mirador, 17% of females and 13% are males. While Cova de la Guineu has 0% for both sexes. Villanueva and colleagues (2017) showed that the mean of this diameter is 116.85 mm and SD is 8.81 among males of Mexico, while it is at 111.33 mm and SD 6.11, found that this diameter showed a difference of sex. Deepak and colleagues, (2015) found that the CDL in males had an average of 95.63 mm, an SD 0.61 and in females, the average was 89.83 mm, an SD of 0.76. In other study, Babita and associates (2017) showed a mean CDL in males of 111.2 mm with an SD of 5.73 and in females was 107.89 mm with the SD of 4.03, a difference statistically with a p-value 0.02 between males and females. Vinay and collaborators in (2013) showed a mean of bicondylar width of mandible CDL, in males presented 113.4 mm and SD 0.55 in females was 108,2 mm and SD 0.70, their results showed statistically a difference between the values of two sexes. In other study, Datta and colleagues (2015), found an average of 95.70 mm in males with SD 5.19 and 88.75 mm in females with SD 6.78.

Najma and associates (2018) found the mean of CDL in males to be 85.9 mm with SD 0.518. While in females the mean was 8.12 with an SD of 0.446, they noted difference between the two sexes of the CDL mean is 0.47. Singh and collaborators (2015), presented in their results that the bigonial width CDL in females measures 101.7 mm and that of males 112.2 mm with p value <0, 0001. They indicated that were statistically significant and there is difference between the male and female, the CDL would concede as an indicator to estimate the sex.

The MRL diameter showed in our study the average ranges from 47.37mm and 35.61 mm for the mandibles of El Mirador, 38% are females on the right side and 33% on the left side, the males have 13%. While Guineu site, has 0% males on the right side and 2% on the left side, for females 0% on both sides. In the study of Deepak and collaborators, (2015) males have a mean of 38.93 mm, an SD of 0.33, while in females, the mean is 36.66 mm, an SD of 0.30. The study of Villanueva and colleagues, (2017) for the population of Mexico, the mean of MRL was 43.44 and SD was 3.06 for males and 41.46 mm and SD was 2.96, showed a difference than in the Xigui group. In the study of Shivaprakash and Ashok (2018) found maximum ramus breadth in male mandible varied between 28.84 mm to 42.28 mm with an average of 35.82 and SD 3.09. In females it was 27.44 mm to 41.42 mm, with an average of 34.19 and SD is 3.17 mm. with (p= 0.000). they showed presence the differences statistically significant between the male and female.

In our study the mean width of ramus WRK varied between 36.76 mm and 26.13 mm, for the Cueva de El Mirador mandibles, 42% of females on the right side and 38% on the left side, 13% of males on the right side and 25% on the side. While in Cova de la Guineu we found 0% male on the right side and 2% on the left side, for females 7% on the right side and 2% on the left side. The study of Villanueva and collaborators (2017) showed the mean of this WRK diameter was 32.19 mm and SD 2.57 while the females showed an average of 30.87mm and SD 2.38.

Deepak and colleagues (2015) found that in males had a mean of 31.34 mm, an SD 0.32, and the mean of females is 29 mm, SD of 0.23, with a p-value 0.006, which was insignificant. Najma and associates (2018) found the mean WRK to be 29.3 mm in males with an SD of 0.30. The mean was 29.3 mm in females with an SD of 0.32, there was a difference in the mean between the male and female with 0.003. In the study of Shivaprakash and Ashok (2018) found minimum ramus breadth in male mandible varied between 21.92 mm to 36.80 mm with an average of 28.89 mm and SD 3. In females it was 17 mm to 34.26 mm, with an average of 27.49 mm and SD is 3.18 mm. with (p= 0.000). they showed presence the differences statistically significant between the male and female.

The XRL diameter had in our study a measurement of 43.91 mm to 75.12 mm. For El Mirador showed 29% females on the right side and 33% on the left side, 25% of males on the right side and 17% on the left side. While Cova de la Guineu had 0% male on the right side and 2% on the left side, and for females had 0% on both sides. The study by Villanueva and collaborators (2017) gave the mean of XRL in the population of Mexico, males having an average of 68.91 mm with an SD of 4.98 and in females an average of 30.87 mm with a SD 4.68. They noted that there was a difference of sex. Deepak and colleagues (2015) found an average of 60.06 mm for males, with an SD of 0.52, while the average was 50.88 mm for females, SD of 0.38 and p value was 0.000. there is difference between the males and female with statistically significant. Datta and associates, (2013) found an average of 67.98 mm in males with an SD of 4.40, and 55.72 mm in females and was SD 5.33, with significant (p=0.0001) there are the deference between male and female.

Najma and colleagues (2018) found; the mean XRL ramus length of the male mandible was 51.5 mm with an SD of 0.65. While in females was 49.2 mm with SD of 0.64, an average difference between the two sexes was 0.22. The results of this diameter showed the presence of difference between the male and the female. According to Babita and colleagues (2017) the mean XRL in males was 31.43 mm with a SD of 3.33 and in females was 30.11mm with a SD of 2.33. statistically no sex difference with a p-value 0.12.

The MLT diameter in our study showed the mandibular length varied between 75.44 mm to 61.74 mm. At El Mirador sample we found 25% of mandibles are males and 17% are females. And for Cova de la Guineu 0% for both sexes. Villanueva and the other authors (2017) showed the MTL average in was 79.87 mm and SD 4.23 for the Mexican males, while in female it was 78 mm and SD 4.58 and in the XIG population the mean in males was 80.03 mm, SD 4.20 while in females the mean was 76 mm with SD 3.48, they showed difference between male and female with 0.0002. Datta and

colleagues (2013), found that the mean MLT was 76.6 mm in males with an SD of 4.39 and that of females was 70.64 mm with an SD of 4.77, a difference of gender was statistically significant (p <0.0001). Vinay and collaborators, (2013) found that in males the mean mandibular MLT length was 75.4 mm with a SD of 0.43, while in females it was 72.5 mm with a SD 0.51, resulted statistically a difference between the male and female mandible. On the other hand, Babita and colleagues (2017) offers a mean MLT in males of 72.91 mm with an SD of 5.39 and in females was 71.53 mm with SD of 5.24. It was found statistically with a p value> 0.05 is not significant in determining the sex.

The GGN diameter, in our study, the average was varied between 88.35 mm to 72.77 mm, in the El Mirador had 29% males and 21% females. While Cova de la Guineu had 0% for males on both sides, females had 2% on the right side and 0% on the left side. The GGN presented in the study of Villanueva and colleagues (2017) for the population of Mexico, shows a mean of 76.07 mm and SD was 4.35 while in females was 72.97 mm with SD 4.79. Showed presence of difference between male and female, they found statistically significant was 0.001.

Deepak and colleagues, (2015) found that the mean GGN in males was 72.26 mm with SD 0.43 and the mean in females was 70.16 mm with SD 0.56, with the p-value 0.11, their study of this diameter does not show a difference of sex. On the other side, Datta and collaborators (2013) noted that the diameter of GGN in males was varied from 65 mm to 82 mm with an average of 7.66 and SD of 4.39 and that female varies from 60 mm to 80 mm with an average of 70.64 mm and an SD of 4.77. A determination of sex for 80% of males and 72% of females with difference in mean is statistically significant (p = 0.0001.

Babita and collaborators (2017), showed the mean of GGN in males was 82.84 mm with a SD of 4.23 and in females had 80.92 mm with a SD of 4.09 a difference in p value of 0.12 between males and females.

In our analysis, the MAN diameter at El Mirador, for the gonial angle of the mandible was between 106.54° and 136.04° showed in males 27% on the right side and 4% on the left side while in females is 19% on the right side and 8% on the left side. While for Cova de la Guineu has 0% for both sexes. Villanueva and collaborators, (2017) showed that the mean angle in the Mexican population was 123.28° with an SD 6.98 while in females the mean was 124.42° with an SD of 7.07. Babita and colleagues (2017) showed a mean MAN in males of 126.73° with a SD of 2.71 and in females had 135.42° with a SD of 2.58° a difference of p value greater than 0.05 between males and females. Datta and associates, (2013) found Gonial angle the male mandible varied between 115° to 140° with an average of 126.6°, SD was 6 ° and that of the females varied between 123° to 150° with an average of 135.72°, SD was 8°. A difference between the sexes showed on the mandibles means statistically with (p = 0.0001). Deepak and collaborators, (2015) found s that the mean mandibular angle in males is 121.85°, SD 9.60°, while in females the mean is 130.94°, and SD from 7.79°. The p value is 0.001, results showed that this diameter is reliable for determining the sex prover statistically a difference between the two sexes on the angle of the mandible.

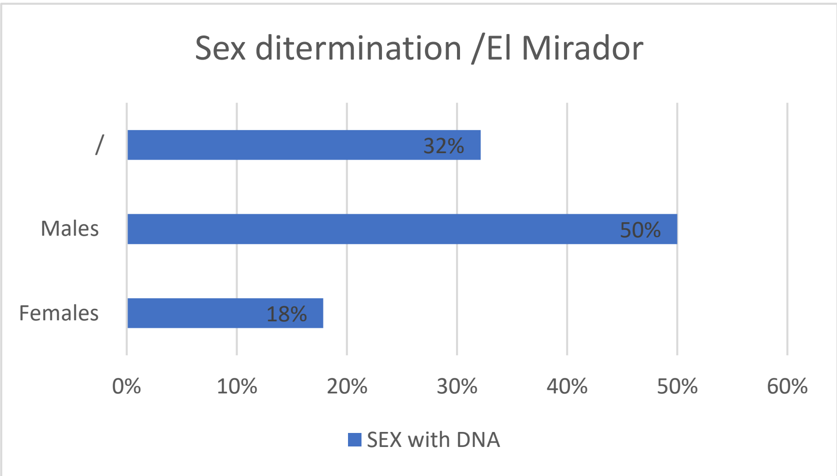
The last diameter GMG, Mental angle this diameter, in our study had two measurements the largest is at 70.67 mm, at El Mirador presented males with 2% and the smallest is 67.91 presented females also a very low percentage 13%. While Cova de la Guineu has 0% for both sexes. Villanueva and collaborators, (2017) presented that the mean of GMG was in males of Mexico 73.04 mm with a SD of 4.89 and that of female was at 74.69 mm with a SD of 4.15.

After the results of Villanueva and colleagues (2017) for the metrical method, GOG, XRL, HML, CDL and GGN diameters have statistically obtained reliable results for sexual differentiation with the mandible with the results of statistical analysis obtained by the mandibular diameters of the sex differences, another bone to determine the sex in the absence other identifiable bones.

(Deepak et al.2013). Different metric parameters were taken to determine the sex, most of these parameters showed a difference sex (Datta et al. 2015).

Means of values of metrical parameters obtained by the mandible, showed a difference between the male and the female, these parameters recognized the performing sexual dimorphism with the mandible (Najma M et al. 2018). Vodanović and colleagues (2006), carried out a mandibular metric method on bone remains coming from two archaeological sites in eastern mainland Croatia from the medieval period, on 85 individuals (59 males and 26 females). They used 18 parameters to examine for sexual diagnosis on the mandibles. This research provided good sex discrimination on the mandibles, Vodanović and colleagues (2006) found that there were three parameters WRK, MAN and GGN the mandibular body, angle mandibular and minimum branch width with an accuracy of 88.28% reliability for the three variables present among the most important characteristic with their reliability to determine the sex for archaeology and forensic.

Our results showed that the sex determination for the population of El Mirador with two morphological parameters then provided most females. The DNA results obtained that the most dominant in this population are male (Mathieson et al. 2015).



[Fig-31]: Statistical analysis of sex with DNA in la Cueva de El Mirador.

In our study the morphological parameters are reliable for determining the sex with the shape of the chin parameter and the posterior mandibular ramus flexure parameter. After the more efficient results of the DNA, which was to confirm the sex of Cueva de El Mirador individuals, the sexual diagnosis showed the number of males and females, the number is concerned 28 of individuals, the results show the presence of 14 (50%) individuals of sex males and 5(18%) are females. The DNA results obtained that the most dominant in this population are male [Fig-31].

For the morphological method we obtained reliable results with two parameters the shape of the chin, and the posterior mandibular ramus flexure.

Individuals/Cueva El Mirador	SEX with DNA	Individuals/Cueva El Mirador	Sex with morphological parameter (the shape of the chin)
Individual1	F	Individual 4	M
Individual10	M	Individual 6	M
Individual 11	M	Individual 21	M
Individual 13	M	Individual 17	M
Individual 16	F	Individual 7	F
Individual 17	M	Individual 5	F
Individual 18	M	Individual 8	M
Individual 19	M	Individual 19	M
Individual 2	F	Individual 12	M
Individual 20	M	Individual 2	F
Individual 21	M	Individual 10	M
Individual 3	F	Individual 20	M
Individual 4	F	Individual 3	M
Individual 6	M	Individual 23	M
Individual 7	M		
Individual 8	M		

[Table-26]: Statistical analysis of sex with DNA and morphological parameter the shape of the chin in la Cueva El Mirador.

For the first morphological parameter, the shape of the chin we were able to determine the sex for 14 individuals 11 are males and 3 are females, after verification with DNA results, individuals 4, individuals 7 and individual 3 their results are incorrect. [Table-26].

The second morphological parameter, the posterior mandibular flexure confirms that our results with a reliability for the sex termination, we found that the result for 15 individuals, 4 females and 11 males, of which there were two individuals their results are incorrect, individuals 4 and individual 2 are determinate males, whereas according to DNA results are female. and for other individuals their results obtained are the same as DNA results. [Table-27].

Individuals / Cueva El Mirador	Sex with DNA	Individuals/Cueva El Mirador	Sex with morphological parameter flexure posterior
Individual 1	F	Individual 4	M
Individual 10	M	Individual 6	M
Individual 11	M	Individual 21	M
Individual 13	M	Individual 17	M
Individual 16	F	Individual 7	M
Individual 17	M	Individual 1	F
Individual 18	M	Individual 13	M
Individual 19	M	Individual 5	F
Individual 2	F	Individual 8	M
Individual 20	M	Individual 19	M
Individual 21	M	Individual 15	F
Individual 3	F	Individual 18	M
Individual 4	F	Individual 2	M
Individual 6	M	Individual 20	M
Individual 7	M	Individual 3	F
Individual 8	M		

[Table-27]: Statistical analysis of sex with DNA and morphological parameter posterior mandibular ramus in La Cueva El Mirador.

8. Conclusion:

This work represents an opportunity to show different bones to estimate sexual dimorphism after the pelvis and skull for anthropological and forensic studies. The mandible is the most compact bone, the most durable, and the most conserved for long period. Previous studies have proven that the mandible has up to 92% accuracy in determining of sex.

- Certain morphological and metrical characteristics of human mandibles may exhibit sexual dimorphism and be used to determine sex.

- Studies have shown that the mandible of unknown sex can be determined with high performance accuracy using either morphological or metrical indicators, they have shown that the mandible has up to 92% accuracy in determining the sex.

Also, masticatory markings influence the shape of the mandibular branch. These morphological characteristics help to identify the sex.

-In this work, two methods morphological and metrical are represented using 21 different parameters.

The first morphological method, with 7 parameters observed on the parts of the mandibles such as the shape of the chin, the divergence of the gonial angle 3, the profile of the chin 4, the contour of the base of mandible 4, the contour of the base of mandible 5, the shape of the ramus of mandible, the profile of the ramus of mandible and the posterior mandibular ramus flexure. (Naira et al, 2017).

The second metrical method uses 14 variable parameters: GNI, TML, HML, FBB, MFA, GOG, CDL, MRL, WRK, XRL, MLT, GGN, MAN, GMG. (Villanueva et al 2017). The measurements of the right and left sides were considered and even statistically analysed (Villanueva et al.2017).

The mandibular branch showed statistically more significant dimorphic features with efficiency. According to our study, two of these morphological characteristics, chin shape and the posterior mandibular flexure, are the most important parameters in determining sex. Thus, from the results of our study, we can conclude that this parameter that the mandible is a reliable tool for sex determination and our study established baseline values for this population.

We can consider that the morphological and metrical characteristics of the mandibles are a reliable indicator for determining sex, but it is important to use other sources for sex identification such as the pelvis or DNA, especially when terminating unknown individuals such as our sample.

- The accomplishment of this work is to determine the sex for the two populations studied, to expand the paleoanthropological information for sex determination for the individuals from Cueva de El Mirador and Cova de la Guineu. The following conclusions were drawn from this study:

-In terms of the results of our work, the sex diagnosis carried on 64 preserved mandibles, from the Chalcolitic period, contains 24 mandibles from Cueva de El Mirador and 40 mandibles from Cova de la Guineu, the latter presented by fragments and poor state of conservation. sex determination for these populations using the metrical parameters was more delicate due to the poor state of conservation and the insufficient number of mandibles.

-Female sex is more frequently estimated on both sides (right and left) and even for both populations.

- Five morphological parameters showed that the female sex was the most frequent and two morphological parameters: the shape of the chin showed that the male sex was more frequent with 11 males and 3 females for the populations of El Mirador, and the posterior mandibular ramus flexure parameter showed that the male sex was more frequent with 11 males and 4 females for the populations of El Mirador and 5 males and 2 females for the populations of Cova de la Guineu.

-A reliability of sex determination with the parameter shape of chin of the morphological mandibular branch confirmed that the male sex more dominant for the population of El Mirador. with the parameter shape of chin, the following individuals: MIR202-6, MIR201-17 MIR203-21, MIR203-8, MIR201-19, MIR201-10, MIR203-20, are males, and individuals, MIR202-3, MIR202-4 and MIR203-7 are determinate females with shape chin, but with DNA males determined.

-A reliability of sex determination with the parameter posterior ramus of the morphological mandibular branch confirmed that the male sex more dominant for the population of El Mirador with the following individuals: MIR202-6 MIR201-17 MIR203-7 MIR203-1, MIR201- 13, MIR201-8, MIR203-19, MIR201-12, MIR202-20 are males. and individuals MIR203-2 and MIR202- 4 are determinate with posterior ramus males, while they determined females with DNA.

Most variables of metrical method showed that female sex is more frequent than the male sex, such as: GNI, TML, HML, FBB MFA, MRL, WRK, XRL AND MAN, two variables presented that the male sex is more frequent than the female sex are the GOG and MLT.

-Several difficulties of the same obstacles to consolidate the sexual dimorphism in the mandible summarized in a few lines:

- As for the metrical method, although we succeeded in determining gender, it was not reliable, due to the statistical values which to mark the difference between male and female.

-The lack of statistical value for the metric method showed questionable results for determining the sex for our study.

-Different studies on metrical method show different results for these parameters.

- Determination of non-metric parameters are also subjective and different from person to person. The morphological form can vary from one person to another, as I experienced from an example of observations with my supervisor. This is the interobserver error or bias. This should be considered in these types of studies.

- Lack of prehistoric reference collections, different notable measurements on mandibles those of Cueva de El Mirador of Chalcolitic period and that of Mexico and others are current. One of the obstacles to estimating sex reliably by both metric and morphological methods.

-A very insufficient number of mandibles determined for the Cova de la Guineu, and the poor and fragmentary state of conservation prevented us from seeing high percentage for sex.

-Lack of studies and information on the sexual dimorphism of the mandible for prehistoric populations in Europe in general and at Iberian Peninsula in particular.

9. Future Proposals:

-Enlarging the number of mandibles for more accurate and more efficient results.

- Application of both morphological and metric method to prehistoric groups to confirm the reliability of these methods in determining sex.

- Further studies on various diverse ethnic groups to confirm the reliability of these parameters in determining sex.

-Interobserver control of bias concerning morphological method.

-Having collections to compare the mandibles of El Mirador and Guineu with other mandibles bear a similar chronology, especially at Iberian Peninsula and in Europe in general.

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Mandible	HML		WRK		MRL		FBB		XRL		GNI	MFA		GOG	GGN		CDL	MLT	TML		MAN	GMG
	R	L	R	L	R	L	R	L	R	L		R	L		R	L			R	L		
MIR202-4	28,20	26,45	31,55	30,18	36,14	35,61	15,46	15,04	58,82	58,51	27,42	28,53	28,98	95,48	82,10	84,22	121,31	69,26	11,38	10,67		
MIR202-6	28,91	28,61	36,76	36,53	39,81	40,36	13,28	13,27	67,17	67,39	29,61	26,05	26,03	92,86	77,37	79,39	118,92	61,74	10,99	11,04		
MIR202-21	30,74	28,30	29,07	30,01	/	/	16,17	16,40	67,44	/	29,27	29,35	28,98	101,27	77,70	81,79	/	62,87	9,02	9,52		
MIR201-17	29,29	24,40	31,20	31,75	39,84	39,62	13,51	14,58	60,25	59,17	29,17	25,59	25,45	87,80	82,21	82,13	109,20	65,06	11,82	11,47	113,398	80,67
MIR203-1	28,82	27,68	32,46	33,62	36,13	37,45	13,09	13,68	65,03	66,30	27,26	26,04	26,85	85,35	82,59	82,58	114,21	71,64	8,55	9,82		
MIR203-7	26,16	25,22	30,07	32,76	42,46	/	9,35	9,02	66,19	/	23,27	25,80	26,70	93,75	83,90	83,96	/	72,90	8,64	8,65		
MIR203-19	30,61	30,25	/	32,86	/	47,30	14,73	14,95	/	75,12	30,53	29,82	28,94	98,35	86.72	81,34	/	61,78	11,48	10,34	136,049	70.029
MIR201-8	29,63	29,30	31,80	30,81	40,79	41,64	15,06	15,11	67,19	65,78	/	28,82	29,67	101,91	84,45	87,58	121,42	75,44	10,02	9,35		
MIR203-2	30,96	29,57	27,42	27,13	41,38	40,52	12,66	12,86	49,90	43,91	26,07	28,88	27,60	95,96	80,62	83,63	115,41	68,24	8,84	8,34		67.915
MIR201-10	27,27	27,68	33,60	35,55	40,25	40,54	12,54	12,93	60,43	63,63	26,63	24,24	25,69	94,40	82,84	81,58	114,51	64,40	10,62	9,27		
MIR202-20	31,23	/	/	/	/	/	13,25	/	/	/	33,72	28,74	/	/	82,50	/	/	/	9,84	/		
MIR203-3	29,68	27,70	30,95	30,83	39,08	/	13,10	13,18	67,74	63,68	29,15	26,66	62,14	/	/	/	/	/	9,42	9,84		
MIR203-5	21,96	/	29,36	29,11	35,44	36,80	9,21	9,69	46,72	49,83	24,86	23,46	/	/	72,77	/	/	/	8,16	/		
MIR201-13	/	26,70	/	32,34	/	43,23	/	15,30	/	64,16	/	/	/	/	/	/	/	/	/	8,93	/	/
MIR201-18	29,85	/	26,13	/	33,78	/	11,98	/	61,86	/	/	/	/	/	/	/	/	/	11,86	/	/	/
MIR202-22	/	/	/	/	/	/	/	/	46,93	/	/	/	/	/	/	/	/	/	/	/	/	/
MIR201-11	/	29,55	/	31,24	/	/	/	14,69	/	/	/	/	/	/	/	/	/	/	/	10,38	/	/
MIR201-23	/	/	/	/	/	/	/	/	/	/	29,07	/	/	/	/	/	/	/	/	/	/	/
MIR202-14	/	/	/	/	/	/	/	10,89	/	/	32,50	/	22,84	/	/	/	/	/	/	9,40	/	/
MIR201-16	/	/	/	29,71	/	37,62	/	/	/	55,61	/	/	/	/	/	/	/	/	/	/	/	/
MIR201-24	/	/	29,16	/	47,37	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
MIR201-6	26,73	/	/	/	/	/	12,93	/	/	/	24,74	26,27	/	/	/	/	/	/	10,94	/	/	/
MIR201-12	31,72	31,95	/	/	/	/	14,35	14,66	/	/	27,31	27,06	27,34	/	/	88,35	/	/	9,38	8,30	/	/
MIR201-15	/	27,76	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	11,38	/	/	/

[Table- 28]: data base of metrical method of la Cueva El Mirador cave

Mandible	HML		WRK		MRL		FBB		XRL		GNI	MFA		GOG	GGN		CDL	MLT	TML		MAN	GMG
Guineu cueva	R	L	R	L	R	L	R	L	R	L		R	L		R	L			R	L		
60	/	30.67	/	//	/	//	/	14.54	/	//	28.21	/	25.66	/	/	//	/	/	/	9.17	/	/
64	//	/	//	/	//	/	//	/	//	/	/	//	/	/	//	/	/	/	//	/	/	/
57	26.62	/	29.58	/	//	/	12.13	/	//	/	29.02	28.41	/	/	//	/	/	/	7.51	/	/	/
63	//	/	31.13	/	//	/	//	/	//	/	/	//	/	/	//	/	/	/	//	/	/	/
66	/	//	/	//	/	//	/	//	/	67.60	/	/	//	/	/	//	/	/	/	//	/	/
67	/	//	/	//	/	//	/	//	/	//	/	/	//	/	/	//	/	/	/	//	/	/
8	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
153	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
518	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
1/naci	29.23	/	/	/	/	/	12.95	/	/	/	28.14	24.03	/	/	/	/	/	/	8.15	/	/	/
2/naci	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
685	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
566	/	//	/	//	/	//	/	14.24	/	//	/	/	//	/	/	//	/	/	/	9.95	/	/
1820	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
195	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
815	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
7022	/	//	/	//	/	//	/	//	/	//	/	/	//	/	/	//	/	/	/	//	/	/
7000	/	//	/	//	/	//	/	12.90	/	//	/	/	//	/	/	//	/	/	/	//	/	/
7006	/	//	/	//	/	//	/	//	/	//	/	/	//	/	/	//	/	/	/	//	/	/
7024	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
7112	/	//	//	//	/	//	/	//	/	//	/	/	//	/	/	/	/	/	/	//	/	/
1319	/	24.54	/	//	/	//	/	11.93	/	//	20.30	/	24.72	/	/	//	/	/	/	//	/	/
3 naci	29.36	/	//	/	//	/	13.15	/	//	/	32.03	27.53	/	/	//	/	/	/	8.54	/	/	/
4 naci	/	27.58	/	29.98	/	//	/	13.96	/	//	33.37	/	29.60	//	/	//	/	/	/	//	/	/
56	28.69	28.34	/	34.17	/	43.75	14.78	15.81	/	/	28.19	28.38	28.98	/	/	/	/	/	10.34	11.14	/	/
211	/	//	/	/	/	/	/	/	/	/	21.20	/	24.98	/	/	/	/	/	/	8.98	/	/
424	/	35.50		/	/	//	/	15.34	/	//	37.53	/	27.88	/	//	/	//	/	/	8.45	/	/

1546	/	//	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
683	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
10	//	/	/	/	/	/	13.65	/	/	/	/	/	/	/	/	/	/	/	10.96	/	/	/
123	//	/	//	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
3353	21.13	/	29.28	/	/	/	12.13	/	/	/	21.20	24.64	/	/	71.81	/	/	/	11.39	/	/	/
6	//	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
3302	26.35	/	/	/	/	/	13.92	/	/	/	/	/	/	/	/	/	/	/	8.25	/	/	
3304	28.11	/	//	/	/	/	12.35	/	/	/	/	/	/	/	/	/	/	/	10.16	/	/	/
3	/	//	/	/	/	/	/	10.92	/	/	/	/	/	/	/	/	/	/	/	/	/	/
3300	25.17	/	/	/	/	/	11.19	/	/	/	22.96	29.20	/	/	/	/	/	/	9.95	/	/	/
1836	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
434	//	/	/	/	/	/	16.65	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
3352	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/

[Table-29]: data base metrical method of la Cova de Guineu.

Mandibles	Chin shape	Gonial angle		Chin profile	Base mandible contour		Ramus shape		Ramus profile		Posterior mandibular ramus flexure	
		R	L		R	L	R	L	R	L	R	L
MIR202-4	b	e	e	a	c	c	e	e	b	b	b	b
MIR202-6	b	S	s	b	d	c	f	f	b	b	a	b
MIR202-21	b	E	/	b	c	c	e	e	b	b	b	b
MIR201-17	c	E	e	b	c	c	e	e	b	b	c	b
MIR203-7	a	E	e	b	d	c	e	e	b	b	d	b
MIR203-1	c	S	s	a	c	c	e	e	b	b	d	b
MIR201-24	/	/	/	/	/	/	/	/	/	/	/	/
MIR201-16	/	/	i	/	/	/	/	/	/	/	/	/
MIR201-9	/	/	/	/	/	/	/	/	/	/	/	/
MIR201-13	/	/	i	/	/	c	/	e	/	b	/	b
MIR203-5	a	I	i	b	c	c	e	e	c	c	b	b
MIR201-8	c	E	e	b	c	c	e	e	b	b	c	c
MIR203-19	b	/	s	b	/	d	/	f	/	a	/	a
MIR201-12	c	/	s	b	/	c	/	/	/	/	/	/
MIR202-14	/	/	/	b	/	c	/	/	/	/	/	/
MIR201-15	/	/	/	/	/	/	/	/	/	/	/	/
MIR201-18	/	I	/	/	c	/	e	/	b	/	b	/
MIR203-2	a	S	i	b	c	d	e	e	c	c	c	c
MIR202-10	C	I	i	b	c	c	f	f	a	a	b	b
MIR202-20	C	S	/	b	d	/	f	/	a	/	/	/
MIR203-3	C	S	s	b	c	c	e	e	b	b	a	a
MIR202-22	/	I	/	/	d	/	e	/	c	/	b	/
MIR201-11	/	/	s	/	/	c	/	e	/	b	/	/
MIR201-23	C	/	/	/	/	/	/	/	/	/	/	/

[Table-30]: data base of morphological method of la Cueva El Mirador cave

Mandible	Chin shape	Gonial angle		Chin profile	Contour of the base mandible contour		Ramus shape		Ramus profile		Posterior mandibular ramus flexure	
Side	**/**	**R**	**L**		**R**	**L**	**R**	**L**	**R**	**L**	**R**	**L**
GUIN-60	/	/	/	/	/	d	/	/	/	/	/	/
GUIN-64	/	/	/	/	/	/	/	/	/	/	/	/
GUIN-57	c	s	/	b	s	/	e	/	c	/	d	/
GUIN-63	/	/	/	/	/	/	/	/	/	/	b	/
GUIN-66	/	/	/	/	/	/	/	/	/	/	/	a
GUIN-67	/	/	/	/	/	/	/	/	/	/	/	/
GUIN-8	/	/		/	/	/	/	/	/	/	/	/
GUIN-153	/	/	/	/	/	/	/	/	/	/	/	/
GUIN-518	/	/	/	/	/	/	/	/	/	/	/	/
GUIN-*1/nci*	/	/	/	/	/	/	/	/	/	/	/	/
GUIN-2/naci	/	/	/	/	/	/	/	/	/	/	/	/
GUIN-685	/	/	/	/	/	/	/	/	/	/	/	/
GUIN-566	/	/	/	/	/	s	/	/	/	/	/	/
GUIN-1820	/	/	/	/	/	/	/	/	/	/	/	/
GUIN-195	/	/	/	/	/	/	/	/	/	/	/	/
GUIN-815	/	/	/	/	/	/	/	/	/	/	/	/
GUIN-7022	/	/	/	/	/	/	/	/	/	/	/	A
GUIN-7000	/	/	/	/	/	/	/	/	/	/	/	/
GUIN-7006	/	/	/	/	/	/	/	/	/	/	/	/
GUIN-7024	/	/	/	/	/	/	/	/	/	/	/	/
GUIN-7112	/	/	/	/	/		/	/	/	/	/	/
GUIN-1319	/	/	/	/	/	/	/	/	/	/	/	/
GUIN-3 naci	/	/	/	/	/	/	/	/	/	/	/	/
GUIN-4 naci	a	/	s	a	/	d	/	e	/	c	/	B
GUIN-56	b	/	/	b	/	s	/	f	/	b	/	B
GUIN-211	/	/	/	/	/	/	/	/	/	/	/	/
GUIN-424	/	/	/	/	/	d	/	/	/	/	/	/
GUIN-1546	/	/	/	/	/	/	/	/	/	/	/	/
GUIN-683	/	/	/	/	/	/	/	/	/	/	/	/
GUIN-10	/	/	/	/	/	/	/	/	/	/	/	/
GUIN-123	/	/	/	/	s	/	/	/	/	/	/	/
GUIN-3353	/	/	i	/	s	/	e	/	b	/	c	/
GUIN-6	/	/	/	/	/	/	/	/	/	/	/	/
GUIN-3302	/	/	/	/	s	/	/	/	/	/	/	/
GUIN-3304	/	/	/	/	d	/	/	/	/	/	/	/
GUIN-3	/	/	/	/	/	/	/	/	/	/	/	/
GUIN-3300	c	/	/	b	/	/	/	/	/	/	/	/
GUIN-1836	/	/	/	/	/	/	/	/	/	/	/	/
GUIN-434	/	/	/	/	/	/	/	/	/	/	/	/
GUIN-3352	/	/	/	/	/	/	/	/	/	/	/	/

[Table-31]: data base of morphological method of la Cova Guineu.

Code	Name	Definition
GNI	Height of symphysis	Direct distance from infradentale to gnathion. Can be estimated in slightly eroded samples at the lateral incisors; if the alveolus is markedly reabsorbed the specimen should not be measured. Infradentale: the midline point at the superior tip of the septum between the mandibular central incisors. Gnathion: the most inferior midline point on the mandible (Buikstra and Ubelaker)
TML	Breadth of mandibular body	Maximum breadth measured in the region of the mental foramen perpendicular to the long axis of the mandibular body (Buikstra and Ubelaker)
HML	Height of mandibular body	Direct distance from the alveolar process to the inferior border of the mandible perpendicular to the base at the level of the mental foramen (Buikstra and Ubelaker).
FBB	Foramen height	Distance between the mental foramen and the basal border of the mandible (Vodanovi´c et al.).
MFA	Foramen-to-chin distance	Distance between the mental foramen and the mental tubercle (Vodanovi´c et al.)
GOG	Bigonial breadth	Direct distance between right and left gonia. Place the tips of the callipers at the most prominent outer point in the mandibular angles. Gonion: point along the rounded posterior corner of the mandible between the ramus and the body. To determine the point, imagine extending the posterior ramus border and the inferior corpus border to form an obtuse angle. The line bisecting this angle meets the curved mandibular border in gonion (Buikstra and Ubelaker)
CDL	Bicondylar breadth	Direct distance between the most lateral points on the two condyles (Buikstra and Ubelaker)
MRL	Maximum ramus breadth	Distance between the most anterior point of the mandibular branch and the line connecting the most posterior point of the condyle and the angle of the mandible (Buikstra and Ubelaker)
WRK	Minimum ramus breadth	Minimum width of the mandibular branch measured perpendicular to the height of the rami (Buikstra and Ubelaker)
XRL	Maximum ramus height	Direct distance from the highest point on the mandibular condyle to gonion (Buikstra and Ubelaker)
MLT	Mandibular length	Distance from the anterior margin of the chin, from a central point in a projected straight line along the posterior border of the two mandibular angles. Place the posterior border of the mandibular branch and the fixed plate with the most anterior point of the mental tubercle in the movable posterior part of the jaw callipers. The mandible can be stabilised by applying pressure with one or two fingers on the left second molar (Buikstra and Ubelaker).
GGN	Length of the body	Direct distance from gonion to gnathion (Vodanovi´c et al.)
MAN	Mandibular angle	Angle formed by the lower border of the body and the posterior border of the rami. The mandible can be stabilised by applying pressure with one or two fingers on the left second molar (Buikstra and Ubelaker)
GMG	Mental angle	Angle between lines connecting mental tubercle with right and left gonion (Vodanovi´c et al.)

[Table-32]: Definition of mandibular measurements **(**E. Álvarez Villanueva et al.2017).