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Bioarchaeological Patterns of Violence in North Patagonia (Argentina) during the late Holocene. Implications for the Study of Population Dynamics

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ABSTRACT This work presents bioarchaeological patterns of interpersonal violence inferred for Northeastern Patagonia (Argentina) during the late Holocene. The main goal is to evaluate if there is a significant increase in the frequency of indicators of violence during the final late Holocene, prior to colonial times, in possible concordance with the Medieval Climatic Anomaly (*ca.* 1150–600 years BP). A sample of skulls (n = 797) was studied through a series of methodological steps that included the evaluation of their state of preservation and the study of potential injuries, taking into account the degree of ambiguity of the diagnosis. The sample was divided into three chronological groups: early (*ca.* 3500–2500 years BP), middle (*ca.* 2500–1500 years BP) and late (*ca.* 1500–400 years BP). The individuals were also separated according to sex, age category and geographical distribution. Although a temporal trend toward increased violence was detected, it was not statistically significant. There was also a higher percentage of positive cases in Northern individuals compared to the Southern ones, and between males compared to females, but neither case had statistically significant differences. Alternative mechanisms, such as population dispersals, exchange and use of *buffer* areas, that may have functioned to dispel social tensions, are proposed. Copyright © 2013 John Wiley & Sons, Ltd.

Key words: North Patagonia; Late Holocene; interpersonal violence; bioarchaeology
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Introduction

For the second half of the 20th century, a renewed version of the traditional *rousseauian* notion about small-scale societies as inherently peaceful has prevailed. Most cross-cultural studies were conducted at this time (Ember and Ember, 2001), and some of them led to biased interpretations (Keeley, 1996). However, a growing number of studies have shown the existence of relatively high levels of violence in these societies (Bohannan, 1960; Lee, 1979; Eckert and Newmark, 1980; Lambert, 2002; Gat, 2006; Chacon and Mendoza, 2007; Martin *et al.*, 2012, among other).

In the context of the study of the causes of violence, several authors have investigated the relationship between human behavior and climate changes occurred during the Holocene (e.g. Fagan, 2000, 2008). This period was characterized by increased climate variability in the short term, particularly during the last millennium. A global event that took place within that period, although with different consequences in the diverse regions, was the Medieval Climatic Anomaly (MCA). For example, in North America, Jones *et al.* (1999) and Jones and Schwitalla (2008) have noted cultural shift patterns coherent with climatic variations inferred for the MCA in the California region. Also, in the Maya lowlands, climatic factors could have led to the collapse of the local farming system (Anselmetti *et al.*, 2007; Mueller *et al.*, 2009). In Patagonia, modifications related to water availability have been proposed, although it seems not to have been a homogeneous phenomenon (Agosta *et al.*, 2005; Schäbitz, 2003; Stine, 1994; Villalba, 1994). For Southern Patagonia, records in Lake Cardiel indicate that humidity began decreasing since 2500 years BP. This increasing drought would have been reached its maximum expression

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around 900 years BP according to the MCA (1021–1228 DC, Stine, 1994, 2000). Human populations of this area would have adopted a logistic strategy (García Guraieb, 2010; Goñi, 2010). For North Patagonia, an alternating pattern of drought and humidity was postulated, although the scenario seems to have been complex (Favier-Dubois, 2003; Agosta *et al.*, 2005). Northeast and Northwest Patagonia show differences in precipitation, with a trend towards increasing precipitations in the Northeast during the last 3000 years (Schäbitz, 2003).

Some authors have suggested that the levels of intergroup violence tend to increase under certain circumstances (e.g. demographic growth, spatial circumscription, reduced availability of resources, among other) (Keeley, 1996; Lambert, 2002). Therefore, frequencies of trauma-related violence could be related with environmental and cultural variables (Milner, 1995; Lambert, 1997, 2002; Larsen, 1997; Martin, 1997; Walker, 1997, 2001). Different proposals have been stated about the dynamics of Northeastern Patagonia human populations during the final late Holocene (Figure 1), and their respective implications have led to the formulation of different expectations. On the one hand, some authors (Berón, 2007; Gómez Otero, 2007; Martínez, 2008/2009; Prates, 2008; Favier-Dubois *et al.*, 2009) argue that populations maintained relations of coexistence, complementarity and exchange. If this were the case, low levels of violence would be expected. On the other hand, Barrientos and Perez (2004) proposed a population expansion from the NE of Patagonia to the SE of the Pampa region which would have involved a population replacement in possible concordance with the MCA (*ca.* 1150–600 years BP) (Stine, 1994). Some expected consequences of this greater environmental stress would include reduced residential mobility, concentration of populations in productive areas, saturation of required spaces and increased demographic density (Barrientos and Perez, 2004). This could have intensified competitive relationships and led therefore to a scenario that favored the increase of interpersonal violence.

In southern South America, both individuals in hunter–gatherer contexts with evidences of violence and sites with probable defensive functions have been recorded (Vignati, 1947; Goñi, 1983/1985; Politis *et al.*, 1992; Barrientos, 1997; Gómez Otero and Dahinten, 1997/1998; Constantinescu, 2003; Barrientos and Gordón, 2004; Berón *et al.*, 2007; García Guraieb, 2010; Scabuzzo, 2010; Flensborg, 2012). Habitually, only smaller samples or isolated cases were studied with focus on some particular feature (e.g. projectile points embedded). The absence of systematic methodologies that consider large samples has resulted in biased estimates regarding trauma frequencies and hampered comparisons on a population scale. However, this situation has begun to change in recent years (Luna, 2008

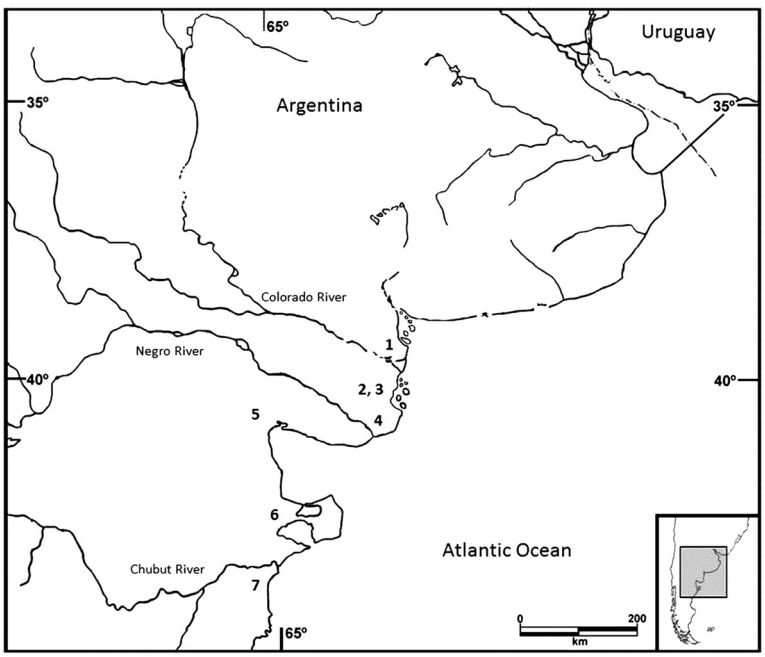

Figure 1. 1: Colorado River; 2: Gama Island; 3: San Blas Peninsula, 4: lower valley of Negro River, Laguna del Juncal, Viedma, Carmen de Patagones, 5: San Antonio Oeste (1–5: Northern Group); 6: Puerto Madryn, Valdes Peninsula, 7: lower valley of Chubut River, Gaiman, Trelew (6–7: Southern Group).

[2009]; Flensborg, 2012; García Guraieb, 2010; Gordón, 2011). It is important to note that research has been more extensive regarding agricultural populations from southern South America (e.g. Standen and Arriaza, 2000).

In this work, we analyze bioarchaeological records of violence in burial sites corresponding to hunter–gatherers that inhabited Northeastern Patagonia. The sample spans a period ranging from the time of occupation – at least 4500–5000 years ago (Gómez Otero and Dahinten, 1997/1998) – to the final late Holocene (*ca*. 400 years BP), when the first contacts with European colonial society would have occurred. The main goal of this study is to evaluate whether there is a significant increase in the frequency of indicators of violence in the last period (1500–400 years BP), prior to colonial times and in possible concordance with MCA (*ca*. 1150–600 years BP). Because of the current state of knowledge in this research field, this paper does not propose unequivocal relationships linking these variables, rather latter are considered as a source of hypothesis at an exploratory level.

Materials and methods

The analyzed sample

A sample of skulls (n = 797) from Northeastern Patagonia was analyzed (Figure 1). These materials belong to the bioanthropological collections of the Museo de La Plata (UNLP) and the Ethnographical Museum 'Juan B. Ambrosetti' (UBA). These collections were made during the second half of the 19th century and the first half of the 20th century (Moreno, 1876; Bórmida, 1953/1954). The main nonrandom factor that contributed to decide the makeup of these collections was the preservation of each piece; only in exceptional cases the presence of trauma can be argued to have influenced these decisions. Furthermore, there is no information in either published (e.g. Lehmann-Nitsche, 1910) or unpublished (e.g. museum records) sources that would indicate that a significant part of the sample came from collective burials produced by one or few events of violence. Consequently, violence is not expected to be over-represented in these samples.

Individuals were grouped according to their provenance. Those from the vicinity of the valleys of the Colorado and Negro rivers were grouped as North Group (54.7%; n = 436) (Figure 1, 1–5). Those from the area of the valley of Chubut river were labeled as South Group (45.29%; n = 361) (Figure 1, 6–7). Regarding sex distribution, 49.86% (n = 365) of the individuals are male, and 42.21% (n = 309) are female.

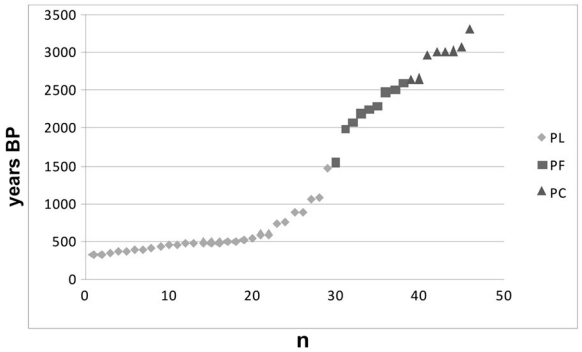

Figure 2. Diachronic distribution of artificial cranial modifications in North Patagonia. (Ref. PC: pseudo-circular modification; PF: plano-frontal modification; PL: plano-lambdic modification).

Sex determination was based on geometric morphometric studies (Pérez, 2006). When this information was not available, the expression of morphoscopic traits was analyzed (Buikstra and Ubelaker, 1994). The sex of subadults (n = 65) was not established. With respect to age categories, 8.15% (n = 65) are subadults, 17.69% (n = 141) young adults, 45.16% (n = 360) middle-aged adults and 14.42% (n = 115) old adults. Age determination was based on closure stage of the sutures in the latero-anterior system (Meindl and Lovejoy, 1985). Of the remaining individuals, 103 (12.42%) are adults that could not be assigned to more specific categories and 13 (1.63%) are individuals whose sex and age could not be determined due to high degree of fragmentation.

The analysis of skulls was prioritized because large samples are required to detect patterns in low-frequency variables. Because of the way in which collections were built, it is not possible to link cranial and postcranial skeletons. Moreover, the central hypothesis is diachronic, and thus it was necessary to use some indicator to seriate the samples in chronological terms. On the basis of certain features (i.e. artificial cranial modifications, radiocarbon dates and contextual information), individuals were assigned to three moments: middle/late Holocene (*ca*. 3500–2500 years BP); late initial Holocene (*ca*. 2500–1500 years BP) and late final Holocene (*ca*. 1500–400 years BP). A diachronic sequence of cranial modification is presented in Figure 2. This distribution is supported by published radiocarbon dates (Table S1). Artificial cranial modification data were also taken from a geometric morphometric study (Pérez, 2006). When this information was not available, it was determined using traditional methods (Dembo and Imbelloni, 1938). Artificial cranial modification categories comprise 348 (43.66%) unmodified individuals, 55 (6.9%) pseudo-circular, 66 (8.28%) plano-frontal and 287

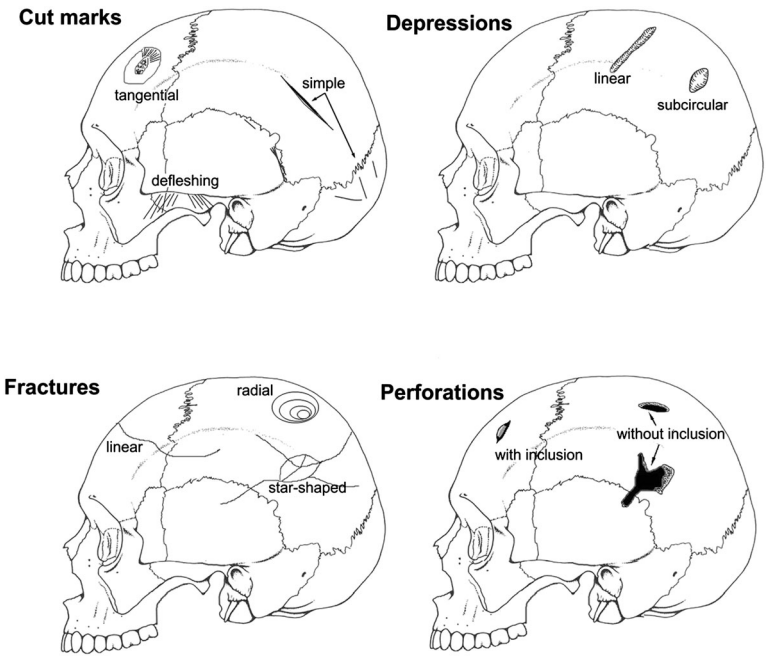

Figure 3. Osseous modifications: recorded variables.

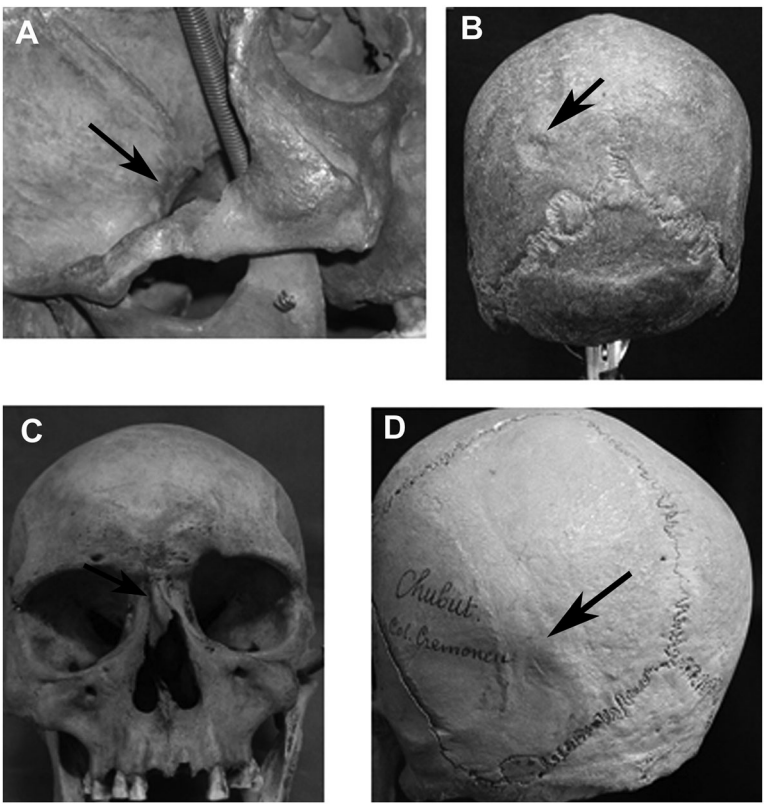

Figure 4. Patterns of trauma included in L1. A: Ind. 997 (ChRV) healed fracture in right zygomatic; B: Ind. 812 (NRV) subcircular depression without associated fractures in left parietal; C: Ind. 1841 (ChRV) healed nasal fracture; D: Ind. 1058 (ChRV) subcircular depression without associated fractures in left parietal. (Ref: ChRV: Chubut River Valley; NRV: Negro River Valley. All individuals belong to the collections of Museo de La Plata).

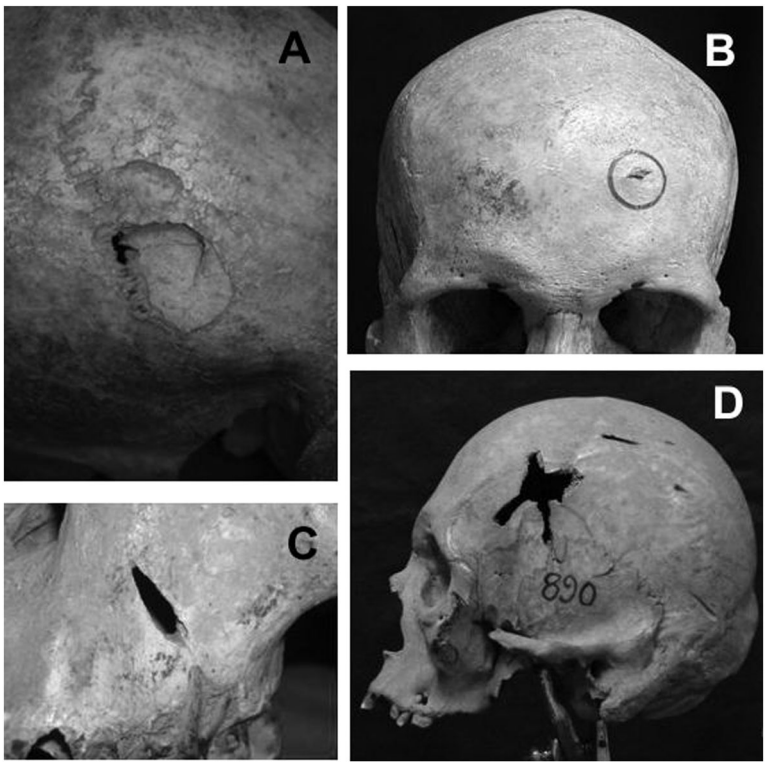

Figure 5. Patterns of trauma included in L2. A: Ind. 783 (NRV) subcircular depression with concentric fractures. B: Ind. 1844 (ChRV) perforation with inclusion (a projectile point embedded). C: Ind. 1082 (ChRV) perforation without inclusion; D: Ind. 890 (NRV) multiple associated trauma (perforation without inclusion and linear depressions). (Ref: ChRV: Chubut River Valley; NRV: Negro River Valley. All individuals belong to the collections of Museo de La Plata).

(36.01%) plano-lambdic. In addition, 5.14% (n = 41) present indeterminate modification. Only modified individuals (n = 408) were considered for the assessment of diachronic tendencies. For the assessment of sex, age and geographical patterns, all individuals were taken into account.

Secondary burials performed in the area were characterized by one or more individuals whose anatomical units often exhibit cut-marks attributable to defleshing activities. Also, bones present red coloration due to the use of pigments such as ocher. This modality occurred from the final late Holocene to Spanish–Indian contact (*ca*. 1000–300 years BP) (Barrientos, 1997; Martínez *et al*., 2006).

Methodology for the record of trauma

The frequency and type of osseous injuries attributable to violence were recorded. Variables were defined on the basis of bibliographical sources (e.g. Merbs, 1989; Milner, 1995; Lovell, 1997; Galloway, 1999) and as a function of the sample, represented by skulls only. Cultural modifications were grouped into four categories with different patterns (Figure 3). We recorded the location and healing status of traumas.

A systematic methodology has been proposed to record trauma (Gordón, 2011, 2012). As a first step, we evaluated the incidence of taphonomic factors and integrity of the skulls in order to ensure adequate comparability among samples. Occurrence of the following variables was recorded: roots, post-deposition fractures, loss of bone matter, fragmentation, carbonate deposits, manganese oxide, weathering stage, rodent marks, modern man-made marks and copper oxide (Gordón, 2009a, 2011). If any of the samples should present lower integrity and/or intense post-depositional activity compared to the rest, this could introduce bias into the frequency of recorded indicators of violence. Those marks potentially produced during the preparation of the bodies for secondary burials were also recorded. Traumas produced by metal weapons were excluded because these occurred in the area later, from the mid-17th century (Gordón and Bosio, 2012).

Recent research in forensic anthropology and bioarchaeology has attempted to improve the distinction

between accidental and violence-related trauma (e.g. Guyomarc'h *et al.*, 2010). However, the diagnostic of traumatic injuries is not always an easy process (Ortner and Powell, 2006). In this sense, the frequency of indicators of violence was evaluated at two levels of analysis. At the first level (L1), cases with a low degree of ambiguity and those that could potentially, but not necessarily, correspond to cases of violence were considered as positive. For example, healed fractures (Figure 4a and 4c) and certain subcircular depressions (Figure 4b and 4c) were taken as ambiguous since these could have been produced accidentally. At the second level (L2), only cases with low or null degree of ambiguity were considered as positive. These included: perforations with embedded projectile points (Figure 5b), perforations without projectiles but with morphologies suggesting presence of the latter (Figure 5c), linear depressions with bony chips on the edges of fractures, multiple associated injuries (Figure 5d) and patterns of subcircular depressions with *perimortem* associated fractures (Figure 5a).

Data were analyzed by means of non-parametric statistical tests. Only statistically significant deviations ($p < 0.05$) were considered as potentially interpretable at the population level. Statistic analysis was made taking into account positive cases at L1 and then L2. Interpretations are based on the results of L2 analyses, since these are more conservative. However, L1 results are also important for comparisons. The diagnosis of positive cases at L1 (and doubtfully at L2) is expected to improve by using radiographic and experimental techniques.

Results

Trends in sample preservation

Even though a discussion of the state of preservation of the samples is not the focus of this paper, it is important to mention the most relevant results because interpretations are, in part, conditioned by these factors. We present a summary of the overall trends regarding the integrity and preservation of the samples (Gordón, 2009a, 2011).

The sample from the Southern group is better preserved than the Northern one, with respect to both integrity and taphonomic factors. Regarding sexes, practically no significant differences were detected; when these existed, survival was higher among males and associated with facial bones: left maxilla, palatine and nasal, and zygomatic bones. Regarding age, statistical differences were observed: the left parietal, occipital, temporals, ethmoid, maxillae, left nasal, vomer and left zygomatic are highly represented in adults. No differences were detected among adult categories.

Regarding diachronic tendencies, the analysis showed relatively constant levels of integrity. Few bones showed statistical differences, and these correspond to bone units that do not normally present traumatic injuries, such as the ethmoid and lacrimals. Most differences were observed between early and middle periods. Skull vault bones did not show substantial differences through time. A significant difference was recorded for rodent signs in the North group between the early and middle samples, with higher values in the early one. For the South group, no differences were observed in any post-depositional variable. Therefore, the idea that earlier samples would be significantly more altered than later samples cannot be supported.

Interpersonal violence in Northeastern Patagonia

This work focuses on those results associated to possible increases in violence during the later period, prior to Spanish contact. Experimental studies (Gordón, 2009b, 2011; Gordón and Bosio, 2012) have determined that certain type of traumatic injuries is associated with metal weapons and thus with times of Spanish-Indigenous contact. The results presented here do not take into account individuals that had this type of lesion. Thus, we sought to reduce biases associated to contact with colonial society.

Table 1 shows the percentages and *p* values for the frequencies of violence among North and South groups. The values are higher in the North group. The difference between these frequencies is highly significant only for L1.

Table 2 shows the results for total lesions, including percentages, from a diachronic perspective. An increase can be observed, with a decrease during the middle period at both levels.

At L1, a significant difference is recorded between the middle and late periods ($p = 0.0109$) when the entire sample is considered as a whole. The comparison

Table 1. Frequencies, percentages and statistical differences of individuals with injuries for the two levels of analysis and geographical groups ($p < 0.05$)

	North group	North group (%)	South group	South group (%)	p χ^2
Level 1	84	19.76	44	12.32	0.0069
Level 2	8	1.88	4	1.12	0.5678

Table 2. p-values and percentages of violence signals by geographical groups, periods and levels of analysis

	North group (%)	South group (%)	Total (%)
Early-Level 1	12/57 (21.05)	0/0	12/57 (21.05)
Early-Level 2	1/57 (1.75)	0/0	1/57 (1.75)
Middle-Level 1	3/38 (7.89)	2/27 (7.40)	5/65 (7.69)
Middle-Level 2	0/38	0/27	0/65
Late-Level 1	27/123 (21.95)	32/137 (23.35)	59/260 (22.69)
Late-Level 2	10/123 (8.13)	6/137 (4.37)	16/260 (6.15)
p-Level 1	0.1462	0.1076	0.0248
p-Level 2	0.2234	0.5843	0.0557

between early and middle periods shows a marginal difference ($p = 0.05 > 0.1$). However, no statistically significant differences were found when the diachronic pattern for each geographic group was evaluated. In the case of L2, the value falls on the boundary of statistical significance when the complete sample is considered. The paired comparisons show that the difference is found when samples from early and middle periods are pooled and compared against the late period ($p = 0.0365$). The middle and late samples differ marginally ($p = 0.0835$). Although there are no significant differences in each geographical group, a temporal increase occurred in both.

Table 3 shows the results of the analyses of contingency tables for sex differences by period for each area at both levels. In those cases where no p values are presented, frequencies were = 0 for both males and females. The distribution of indicators of violence was not significantly different between males and females from any geographical group and period.

Tables 4 and 5 show the diachronic patterns of violence per sex (females and males, respectively).

No diachronic differences are recorded for either sex in both geographic groups or in any of the levels. The only difference that can be observed in Table 5 refers to the whole sample when all traumatic lesions were analyzed (L1), and it is only marginal. The pairwise comparisons show a statistically difference between individuals from the middle and late periods ($p = 0.0459$).

Regarding age, there are no significant differences when the four categories are compared. The only significant difference was found between adults and subadults ($p = 0.0367$). These results are consistent with the expectations, given the cumulative effects of traumatic injuries with age.

Discussion

A crucial issue on which there is still no agreement is the magnitude of the MCA in NE Patagonia and its effects on the dynamics of human populations. For this reason, the purpose of this work is not to propose a direct link between climatic and cultural variables, but rather to discuss this as a source of hypotheses for exploratory purposes.

Barrientos and Perez (2004) based their model on evidence recorded in southern Patagonia (Stine, 1994) where prolonged drought and increased temperatures were recorded between 930 and 720 years BP. Also, a subtropical species (*Dasypus hibridus*) dated at 995 ± 65 years BP in the SE of the Pampas has been interpreted as a possible indicator of increased medieval temperature (Tonni *et al.*, 1999). These authors suggested that the effects of the MCA would be applicable, with local or regional variables, to southern South America. However, Agosta *et al.* (2005) suggested that while in Patagonia this medieval warm period is linked with negative anomalies regarding rainfall, the analysis of different *proxy*-data shows that the scenario of climate anomalies is much more complex. Also, patterns of both drought and excess rainfall can be identified

Table 3. Sex differences by period and geographical groups at both levels of analysis. (Ref. L1: Level 1; L2: Level 2; F: Female; M: Male)

	North group		South group		Total	
	p (L1)	p (L2)	p (L1)	p (L2)	p (L1)	p (L2)
Early (F/M)	0.6872	0.9848	---	---	0.6872	0.9848
Middle (F/M)	0.6784	---	0.7661	---	0.2924	---
Late (F/M)	0.8097	0.2313	0.6685	0.8135	0.5109	0.6784

Table 4. Diachronic differences between female individuals by geographical groups at both levels of analysis. (Ref. L1: Level 1; L2: Level 2)

	North group		South group		Total	
	L1	L2	L1	L2	L1	L2
Early	5/27	0/27	0/0	0/0	5/27	0/27
Middle	0/14	0/14	0/9	0/9	0/23	0/23
Late	9/48	2/48	10/49	3/49	19/97	5/97
P	0.2121	0.4174	0.3126	1.0000	0.0693	0.2634

between northern and southern Patagonia (Favier-Dubois, 2003). Therefore, it is possible that this warming was not always expressed as a dry period. Villalba (1994) studied dendrochronological episodes showing high and low temperatures over the last thousand years in Northern Patagonia. The first interval, between 900 and 1070 years AD, would have been cold, followed by a warm period (1080–1250 years AD) which approximately coincides with the MCA. Then, there was a cold and wet interval (1270–1660 years AD). Schäbitz (2003) analyzed paleo-precipitation values of pollen profiles from Northeastern Patagonia sites that indicated a trend towards temperature increase during the last 3000 years, in contrast to those reported for the central-west of Northern Patagonia. However, the expression of such weather events at local scales can vary in both intensity and chronology (Agosta *et al.*, 2005).

In the case of Northern Patagonia, the evidence is not enough to support the conclusion that the MCA has impacted significantly on the evolutionary dynamics of human populations. The discussion on this issue is a current debate in regional archeology (Martínez and Martinez, 2011). In this regard, a significant increase in the levels of violence suggests some level of stress, but it would still be difficult to associate directly with the effects of MCA. On the basis of morphological evidence, a possible population replacement was proposed to have occurred between 1000 and 400 years BP in the SE Pampean region, starting with the entrance of groups from NE Patagonia (Barrientos and Perez, 2004). Under conditions of population replacement, significant increase in conflict levels would be expected. However, as mentioned above, other authors have suggested that in NE Patagonia, particularly in the area of the lower course of the Colorado River, there may not necessarily have been population replacement, but rather the populations inhabiting the area and those from the Pampean region would have been connected by relationships of coexistence, complementarity and exchange (Martínez *et al.*, 2006; Stoessel, 2006; Martínez, 2008/2009; Prates, 2008). Curtoni (2004) proposed that the lower section of the Colorado River was a 'soft frontier' of permeable territories, inhabited and negotiated by different groups. The existence of these areas, called by some authors 'buffer zones', has been suggested as social tension dissipation areas (Eerkens, 1999). This area could have had a buffering function for social and environmental stresses. From a theoretical perspective, the possibility may be advanced that until the first moments of native-Spanish contact, this area could have functioned as a buffer zone. A region exploited jointly, with common resources, could be useful for neighboring groups, while at the same time providing a spatial buffer that could dissipate social tensions. Ethnohistorical and archaeological information suggests the existence of inter-ethnic contacts and interaction networks between local, extra-regional or even trans-Andean groups (Villarino (1972 [1782–1783)). Nacuzzi (1998) proposed that the exchange between native groups must have had very old origins. In this sense, there could have been a certain continuity in a series of relationships between different groups. In this regard, an adaptive

Table 5. Diachronic differences between male individuals by geographical groups at both levels of analysis. (Ref. NG: Northern Group; SG: Southern Group; L1: Level 1; L2: Level 2)

	NG		SG		Total	
	L1	L2	L1	L2	L1	L2
Early	7/26	1/26	0/0	0/0	7/26	1/26
Middle	2/22	0/22	2/17	0/17	4/39	0/39
Late	15/67	8/67	21/83	3/83	36/150	11/150
P	0.2838	0.1346	0.3724	0.9875	0.1447	0.1894

interpretation of violence, not only as a disruptive behavior but also as a necessary one in the maintenance of social ties, could be considered (de Waal, 2000).

On a spatial scale, injury frequencies are higher in the North group, even though the latter is the sample with significantly lower levels of integrity and greater prevalence of taphonomic variables. The differential frequency of injuries probably plays an analogous role to the one proposed by Lyman (1994) for intrinsic factors (e.g. age) as accelerators of the effects of extrinsic factors (e.g. sediment pH). In this sense, samples that present higher rates of traumatic injuries also show poorer preservation states.

These results suggest that if social tensions occurred in the region during the final late Holocene, before contact with European society, human populations must have relieved such stress by other mechanisms beyond habitual violence. Populations under stress may respond in different manners. They may migrate to unoccupied or marginal spaces, limit population growth or make organizational or technological changes to optimize the efficiency of resource exploitation (Rafferty, 1985).

Therefore, on the basis of the evidence, the levels of violence in NE Patagonia cannot be said to have undergone significant increases during the late period (1500–400 years BP). This does not necessarily imply that there is no relationship between demographic increase and greater occurrence of situations of competition and conflict. In fact, there is a general pattern toward increased levels of interpersonal violence. However, violence seems to have been another kind of social relationship within the complex web that existed among the groups in the area, which was necessary to maintain links between them (Keeley, 1996; de Waal, 2000; Martin *et al.*, 2012).

It is possible that both partial population replacement and complementary relationships occurred to some extent during the final late Holocene, shaping population dynamics. However, the expected levels of violence in either case would differ, and the results are adjusted to what is expected under conditions of interaction rather than replacement.

Final considerations

This work represents a contribution to understand the pattern of violence in NE Patagonia during the middle-late Holocene. The evidences of trauma recorded in a wide diachronic sample do not support the existence of a significant increase in situations of violence in these groups during the last analyzed period (1500–400 years BP). Although MCA would have been of great magnitude in the area, it did not have significant effects on human dynamics. An interesting fact is that the level of violence does not necessarily increase with climate changes. However, as mentioned, this is an important issue in the current debate. Diverse demographic mechanisms could have taken place, such as seasonal population movements, as well as exchange of goods, information, raw materials and individuals, which would have generated cultural and biological mixtures. In this context, Keeley's (1996) proposal that such fluxes are able to maintain both peace and conflicts seems coherent. In addition, some researchers (e.g. de Waal, 2000; Martin *et al.*, 2012) have proposed that the manifestations of violence, at a certain level, play an important role in the maintenance and reinforcement of social ties. From this perspective, conflict behavior is not seen as anti-social or negative, but rather as a necessary part of the social network. The pattern of violence recorded for these NE Patagonia populations agrees with this idea showing a diachronic increase.

Regarding methodology, this work is a systematic analysis in which a large sample composed of museum collections was studied. The strategy of two levels of analysis allowed us to control, or at least to be aware of, potential biases. It also opened the possibility of exploring other techniques (e.g. radiographs) to reduce the percentage of doubtful cases. In this sense, future experimental studies will attempt to replicate traumatic injuries caused by throwing weapons. This point is particularly relevant because the interpretations depend, partially, on correct diagnoses. The improvement of both techniques and methodology for recording injuries will help improve the descriptions of violence patterns.

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