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Fighting may have shaped evolution of human hand

Fighting may have shaped the evolution of the human hand, according to a new study by a US team.

The University of Utah researchers used instruments to measure the forces and acceleration when martial artists hit a punch bag.

They found that the structure of the fist provides support that increases the ability of the knuckles to transmit "punching" force.

Details have been published in the Journal of Experimental Biology.

"We asked the question: 'can you strike harder with a fist than with an open palm?'," co-author David Carrier told BBC News.

"We were surprised because the fist strikes were not more forceful than the strikes with the palm. In terms of the work on the bag there is really no difference."

Of course, the surface that strikes the target with a fist is smaller, so there is more stress from a fist strike.

"The force per area is higher in a fist strike and that is what causes localised tissue damage," said Prof Carrier.

"There is a performance advantage in that regard. But the real focus of the study was whether the proportions of the human hand allow buttressing (support)."

The team found that making a clenched fist did indeed provide protective buttressing for the delicate bones of the hand. Making a fist increased the stiffness of the second meta-carpo-phalangeal, or MCP, joint (these joints are the knuckles visible when the hand is clenched as a fist) by a factor of four.

It also doubled the ability of the proximal phalanges (the bones of the fingers that articulate with the MCP joints) to transmit a punching force.

Dual use

In their paper, Prof Carrier and Michael H Morgan from the University of Utah's school of medicine, point out that the human hand has also been shaped by the need for manual dexterity. But they say that a number of different hand proportions are compatible with an enhanced ability to manipulate objects.

"There may, however, be only one set of skeletal proportions that allows the hand to function both as a mechanism for precise manipulation and as a club for striking," the researchers write.

"Ultimately, the evolutionary significance of the human hand may lie in its remarkable ability to serve two seemingly incompatible, but intrinsically human, functions."

Prof Carrier commented: "The question for me is 'why wasn't this discussed 30, 40 years ago.' As far as I know it isn't in the literature."

Asked whether the idea that aggression may have played a key role in shaping the human body might previously have been unpalatable to researchers, Prof Carrier explained: "I think we're more in that situation now than we were in the past.

"I think there is a lot of resistance, maybe more so among academics than people in general - resistance to the idea that, at some level humans are by nature aggressive animals. I actually think that attitude, and the people who have tried to make the case that we don't have a nature - those people have not served us well.

"I think we would be better off if we faced the reality that we have these strong emotions and sometimes they prime us to behave in violent ways. I think if we acknowledged that we'd be better able to prevent violence in future."

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Inside JEB

FIGHTING SHAPED HUMAN HANDS


Dave Carrier

The human hand is a finely tuned piece of equipment that is capable of remarkable dexterity: creating art, performing music and manipulating tools. Yet David Carrier from the University of Utah, USA, suggests that the human hand may have also evolved its distinctive proportions for a less enlightened reason: for use as a weapon (p. 236).

Carrier recalls that the idea occurred to him during an impassioned discussion with fellow biomechanic Frank Fish about sperm whales. Explaining that he had published a paper suggesting that the whales might use their spermaceti organs as battering rams, Carrier says 'Frank didn't buy the argument and at one point he raised his fist and said, "I can hit you in the face with this, but that is not what it evolved for."' A light went on in Carrier's head. Sure, the human hand evolved for dexterity, but he adds, 'You could manipulate the proportions of a chimp hand in ways that would enhance manual dexterity, but they would not necessarily end up with the proportions that we have.' Maybe there was more to Fish's challenge than met the eye.

According to Carrier and colleague Michael Morgan, modern chimpanzees have long palms and fingers with a short thumb, while the human palm and fingers are much shorter and the thumb longer and stronger. Carrier explains that this squat arrangement allows us to clench our hand into a fist when we fold the thumb across the fingertips; however, chimp fingers form an open doughnut shape when curled. Could the tightly packed human fist provide internal support – buttressing – to the digits to protect them from damage during combat? In addition, Carrier wondered whether curling the fingers into a fist could allow punching men to deliver a more powerful blow (increase the peak force of an impact) than slapping with the open hand. Carrier and Morgan decided to find out whether hands are more effective when balled into a fist or wielded in a slap.

'Fortunately, Michael had a lot of experience with martial arts and he knew people who were willing to serve as subjects', Carrier recalls. Asking the athletes to thump a punchbag with their hands in a range of shapes (from open-handed slaps to closed fists) using various delivery styles (over arm, sideways and head on), Morgan and Carrier measured the force of each impact. However, they were surprised to see that the punch did not deliver more force per blow. 'In terms of the peak forces or the impulse, it did not matter whether the subjects were hitting with a clenched fist or open palm', Carrier says.

Next the duo tested whether buttressing the hand by curling the fingers and thumb stiffens the structure. They asked the martial arts experts to roll their hands into variations of the fist shape – two with the thumb extended sideways – and then push the first joint of the index finger against a force transducer to measure the rigidity of the knuckle joint in the presence and absence of the buttressing thumb. Impressively, the knuckle joint was four times more rigid when supported by the thumb. And when the duo measured the amount of force that the athletes could deliver through the fist surface of the index and middle fingers, they found that the presence of the buttressing thumb doubled the delivered force by transmitting it to the wrist through the metacarpals (palm bones) of the thumb and the index finger.

So our short, square hands are perfectly proportioned to stiffen our fists for use as weapons and allow us – well, males predominantly – to deliver powerful punches without incurring injuries.

10.1242/jeb.083725

Morgan, M. H. and Carrier, D. R. (2013). Protective buttressing of the human fist and the evolution of hominin hands. *J. Exp. Biol.* **216**, 236-244.

Kathryn Knight

SANDFISH SWIM EFFORTLESSLY TO BURROW

Scincus scincus's popular name – sandfish – really does say what it does on the tin. These reptiles literally swim through sand and they are perfectly happy to remain submerged for the majority of the day to avoid heat and predators. Daniel Goldman, from the Georgia Institute of Technology, USA, says, 'There has been a lot of work looking at swimming in fluids, flying, and running on relatively flat rigid hard ground, but there has been much less work done on the movement of organisms on and within materials like sand that can behave as fluids and solids.' Explaining that submerged sandfish wriggle through sand using a technique similar to that of *C. elegans* nematodes, Goldman adds that no matter how fast the lizards move through the