Loca, a 4-month-old female Staffordshire bull terrier, was bitten by another dog so severely that her right zygomatic arch (cheekbone) and mandible (jawbone) were fractured, and her temporomandibular joint (TMJ) suffered extensive damage. In addition, there were multiple puncture wounds on her face and neck.

UC Davis’ Dentistry and Oral Surgery Service (DOSS) knew this would be a challenging surgery, but there were promising aspects to it. First, Loca was young, which meant there was a good chance that the damage to the TMJ could correct itself with natural bone regrowth – something that may occur in dogs of Loca’s early age. Second, this case offered them the opportunity to utilize a new face mask they developed with biomedical engineering students.

Designed to be used as a cast for a fractured skull while it heals, the mask was the result of a long-standing collaboration between the oral surgeons and the UC Davis College of Engineering (COE). To assist with surgery preparation, DOSS has utilized COE’s Biomedical Engineering (BME) Department many times over the years to 3D print skull models in BME’s Translating Engineering Advances to Medicine (TEAM) Laboratory.

Recently, DOSS has been working with BME students to design an apparatus that could help the healing process of maxillofacial fractures, much like a traditional cast helps leg fractures heal. The result was the Exo-K9 Exoskeleton – a custom, 3D printed exoskeleton for dogs with maxillomandibular injuries. This innovative approach to harnessing the capabilities of 3D printing at the TEAM lab could lead to helping dogs with severe fractures where internal fixation is not a possibility due to various limitations.

A cone-beam CT scan on Loca fully characterized the extent of the injuries to Loca’s facial bones, jawbone, TMJ, and also a small fracture in the vertebrae of her neck. A salvage surgery was then performed to remove bone fragments from her right zygomatic arch and right caudal mandible.

While Loca was recovering from surgery, the BME students got to work in the TEAM lab printing the first Exo-K9 to be used on a patient. Based on Loca’s exact specifications from her CT scan, the mask’s dimensions would precisely fit her head, and could help optimize the healing process.

Loca did extremely well throughout her 3-day hospitalization. She almost immediately began eating soft food and remained comfortable on her pain medications. In addition to the Exo-K9, Loca was fitted with a padded neck bandage to provide stabilization of her neck fracture and limit her range of mobility during the healing process.

Loca returned to UC Davis for a 1-month recheck appointment that involved another cone-beam CT scan to characterize her fracture healing and further assess for any evidence of dental trauma to her permanent developing teeth. As suspected, new bone was forming in the place of her former TMJ.

Additionally, she had two molar teeth that appeared to be developing malformed on her right lower jaw. It was unclear at that time if the teeth would erupt normally or if they would need to be extracted. Based on an initial interpretation, the latter was more likely.

Almost three months later, Loca received her third cone-beam CT scan which revealed that her previous surgery sites healed well and that the new TMJ formation was progressing nicely. The CT scan and full-mouth dental radiographs showed that her first and second molars on her right mandible were indeed malformed. Those teeth were extracted without complication.

Loca continues to recover well from her injuries, and all indications show the Exo-K9 to be a viable component to maxillofacial injury healing.