**Write-up (List of Failures of Existing Products and Procedures):**

Research was done on existing bone-shaping devices and their corresponding orthopedic surgical procedures in order to formulate a list of common failures of the devices and complications of the procedures. In general, reports on existing bone-shaping robots lack any enumeration of failures of the device performing its specified bone-shaping task correctly. Rather, the failures found which were related to the actual devices mostly spoke about problems in device-bone mounting and excessive load or stress in the area of the mount connections. On the other hand, numerous different reports and articles were found about complications of surgeries done with existing bone shaping devices. These problems range from poor fusion of fractured bone after surgery (non-union) to significant misalignment of critical bone joints and failure of implants due to improper placement. These failures are important to find and understand, since they are directly related to the performance of the bone shaping devices, especially the device accuracy. The following is a list of failures that was generated from the research:

* Bone damage due to improper surgical procedure or excessive forces causing mechanical failure in the device or the bone structure
* Loosening of device components (any or all) due to improper device placement or fastening or due to forces exceeding the tolerance threshold of the device postoperation (implants)
* Mechanical failure of the device as a result of excessive force during implantation or during normal patient activity (implants)
* Mechanical failure of the device as a result of improper mounting to the base bone during operation (bone-shaping surgery)
* Allergic reaction to any of the device components or elements which the body is exposed to during the implantation procedure
* After implantation, excessive pressure from the implant on back tissues which can result in tissue damage
* Infection related to surgery from improper sterilization of equipment or the surgical environment or improper sterile practices of the surgical staff
* Loss of neurological function or impairment of neurological function due to insults or obstructions to the nervous system (during surgery and after completion)
* Cardiovascular damage, including hemorrhage from improper healing during or postoperation as well as damage to bone vasculature
* Mechanical failure of the device such as loosening of its connection(s) with the bones.
* Early failure of implant due to asymmetric loading, which is a direct cause of inaccurate bone-shaping and/or referencing
* Poor knee mechanics and/or loosening of the components due to improper implant alignment with respect to bones and soft tissues (direct cause of inaccurate surface shaping)

**Abstracts:**

1. **Orthopedic surgical device for simultaneous bone removal on both sides of a fixation pin**

A slotted bone rasp for reciprocal planing of opposed bone surfaces joined by a fixation [pin](http://www.patentgenius.com/patent/7572260.html) so that the bone surfaces are made congruous and parallel to each other preparatory to bone fusion irrespective of pin orientation includes a shank with a pair of legs defining a slot for accommodating the pin and the legs having a flat side and an opposed abrasive side for remodeling the bone surfaces. Each leg includes an inner opposed convex surface whereupon the slot is narrowest at its midline so that the rasp is laterally pivotal transverse to the pin axis providing oblique angulations of the plane of bone removal relative to the pin axis; and the rasp also being rotatable to at least 90 degrees arc of rotation about the pin for 360 degree coverage of the bone surface creating two parallel bone surfaces in maximal end-to-end contact for successful bone fusion.

1. MBARS: Mini Bone Attached Robotic System for Joint Arthroplasty:

A mini bone attached robotic system (MBARS) was developed for shaping of the bone cavity in joint arthroplasty. While the system is designed for a general use in joint replacement procedures, the initial implementation was for patellofemoral arthroplasty (PFA) procedure. The current application is image-based, with the plans to develop an image-free approach in which all data collection and planning is performed intra-operatively in the robot coordinate system, eliminating the need for external tracking in the operating room. Experiments conducted using the first MBARS prototype supported the feasibility of the approach. The applied methodology could be extended to other orthopaedic procedures to improve the accuracy and operational time. Moreover, it enables use of the next generation, more anatomically shaped implants and related minimally invasive surgical procedures.

1. Robot-aided system for surgery

United States Patent 5154717

A system and method for positioning a tool relative to a patient's bone to facilitate the performance of a surgical bone alteration task. The system comprises a bone immobilization device for supporting the bone in a fixed position with respect to a reference structure, and a robot that includes a base fixed in position with respect to the reference structure. The robot also includes a mounting member, and a manipulator connected between the base and the mounting member and permitting relative movement therebetween. The tool to be positioned by the system is mounted to the mounting member. The mounting member is caused to move relative to the reference structure in response to movement commands, so that the tool can be moved to a desired task position to facilitate performance of the task. The system preferably also includes a template attachable to the mounting member, a feature of the template representing a portion of a task. Preferably, the template is secured to the mounting member, and the template is then manually manipulated such that the template feature is properly oriented with respect to the patient's bone. The template position is then recorded as a reference position that may thereafter be combined with a geometric database defining the task to determine the position of the tool. Particular embodiments for a bone immobilizer, a template and a saw guide are also described, together with a stabilizing device for the robot and a safety device for the robot base.

1. Endoprosthetic bone joint devices

United States Patent 4106130

An endoprosthetic bone joint device of ball-and-socket form has a socket component with a compound concave surface therein including a cup bounded by an annular trough, the co-operating ball normally seating in the cup but being alternatively seatable in the trough when dislocation would otherwise occur.

1. Prosthesis-to-bone interface system

United States Patent 4064567

A woven basket is placed over the stem of a prosthesis and receives bone cement therewithin and through its intersticies. The resulting prosthesis-to-bone interface greatly improves the distribution of forces transferred to the bone.

**Search Details:**

?Bone-shaping surgical devices?

?Bone-shaping robots?

?Orthopedic Implant Surgery?

**Works Cited:**

1. Nelson, inventor; **Orthopedic surgical device for simultaneous bone removal on both sides of a fixation pin. Foreign Patent** 09284791. August 11, 2009.
2. Scales J T, inventor; Endoprosthetic bone joint devices. US patent 4,106,130. August 15, 1978.
3. Burstein A, inventor; Prosthesis-to-bone interface system United States Patent 4064567. December 27, 1977.

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1. Cheng, Boyle. Human Factors Analysis: Polyaxial Vertebral Hook. UPMC Welsh Neurosurgical Research Laboratory, 2008.