

5 **“A Jig for Guiding Placement of Glenoid Component of
the Implant in Shoulder Replacement Surgery”**

FIELD OF INVENTION:

10 The present invention provides a jig for shoulder replacement surgery. In particular the present invention provides a pre-assembled jig that facilitates and guides the placement of glenoid component of the implant in shoulder replacement surgery. Moreover the present invention provides a pre-assembled modular jig that guides the placement of glenoid
15 component of the implant in shoulder replacement surgery on the scapula precisely in three dimensions in terms of version, inclination, vertical height and side-to-side placement of implant; aiding surgeon to work with acumen. The present invention guides the glenoid component of shoulder replacement in the precise position and thereby provides accuracy in
20 placement of the component. Furthermore, the present invention substantially reduces the time taken for the surgery and also decreases the chances of infection with less blood loss and minimum bone loss.

BACKGROUND OF INVENTION:

25 The shoulder joint is made up of two bones: scapula and humerus. Shoulder replacement surgery (arthroplasty) is usually necessary when the cartilage covering the two bones of the shoulder joint (viz., glenoid portion of the scapula and upper part of humerus) is worn or damaged to
30 the extent that one's mobility is reduced and one experiences pain while using the shoulder every time. Replacing the damaged shoulder joint with an optimum and sized artificial implant in an optimum position and alignment can help reduce pain and increase mobility.

5

The shoulder joint is the third most commonly replaced joint in the body after the hip and knee joints according to Fisher ES et al. During the shoulder replacement surgery in medical science following terms are frequently being used:

10 **Meaning of terms:**

Displacement: The distance that the component is placed in any of the three planes (axial plane, sagittal plane and coronal plane) described below. The specific terms used for direction of displacement are described below the definitions of the planes.

15 **Axial Plane:** Axial plane referred herein after means; any plane that divides the body into superior (upper) and inferior (lower) parts, roughly perpendicular to spine.

Sagittal plane: Sagittal plane referred herein after means; any plane that divides the body into right and left parts or towards midline and away from
20 the midline, roughly corresponding to the side view.

Coronal plane: Coronal plane referred herein after means; any plane that divides the body into front and back parts, roughly corresponding to front or back view.

Superior: Superior (from Latin) referred herein after means; above.

25 **Inferior:** Inferior (from Latin) referred herein after means; below.

Medial: Medial referred herein after means; pertaining to the middle or towards the middle; nearer to the middle of the body.

Lateral: Lateral referred herein after means; pertaining to being away from the middle; further away from the center of the body.

5 **Anterior:** Anterior referred to herein after means; front or towards the front part of the body.

Posterior: Posterior referred to herein after means; back or towards the back part of the body.

Versions: The term versions referred herein after means; the rotation
10 along said axial plane.

Ante version: Ante version referred herein after means; rotation towards anterior (front) side.

Retroversion: Retroversion referred hereinafter means; rotation towards back side.

15 **Inclination:** the term inclination referred herein after means; the rotation along said coronal plane

Superior inclination: Superior inclination referred herein after means; Inclination towards the superior side (above).

Inferior inclination: Inferior inclination referred herein after means;
20 inclination towards the inferior side (below)

Moreover, conventional techniques are used by the surgeons for the shoulder replacement surgery. However, said techniques are not accurate and also lacks in ease of operation for the surgeons.

- 25 • One such conventional technique in existence, is the use of guiding instruments (jigs) relying upon the X-Rays in the Shoulder replacement surgery. The technique utilizes existing guiding instruments (jigs) based on two dimensional X-ray analysis of the body part in the shoulder replacement surgery. X-rays are used in
30 shoulder replacement surgery as a standard measure to investigate

5 and plan tools required for the shoulder surgery. It is based on the single “snapshot” of the body part of the patient taken as X-Ray that provides a two dimensional image of bone for the analysis.

10 However there are many disadvantages associated with use guiding instruments (jigs) based on observations from X-rays in shoulder replacement surgery. It fails to determine the deformities at certain parts of the bones or between the bones. X-rays further shows deformities in varying degrees of magnification. Thus, accurate measurement of the deformities in millimeters cannot be assured
15 using X-rays. The X-rays are unable to render a three dimensional surface representation and hence, the standard conventional jigs for the glenoid of the scapula bone are placed directly on the glenoid face and approximation in terms of angles found in average population are made universally without the accuracy and precision
20 as per the patients need. The angle or the variation in angle, other deformities are arbitrarily calculated and decided by the surgeon. Therefore even the minor error in calculation or decision of the surgeon leads to failure of the entire surgery without any precision or accuracy.

25 • Another technique that overcomes the above said variability of X-rays, is the use of guiding instruments (jigs) based on computed tomography scan CT-scan or Magnetic Resonance Imaging MRI scan. The use and importance of the CT-scan for preoperative
30 planning of correct retroversion in the shoulder implant surgery was reported by Ganapathi et al.

5 However, there are many disadvantages associated with use guiding
instruments (jigs) based on observations from CT-scan or MRI scan.
Even though CT scan or MRI scan is a three dimensional imaging
technique, quite often the output of said technique is in form of two
dimensional images as on X-ray plates, which leads to failure in
10 accuracy and precision. Conventional two dimensional (2D) CT scan
has been found to be unreliable in measurements of glenoid version
and inclination in the shoulder replacement surgery, as reported by
Budge MD, Lewis GS, Schaefer E, Coquia S, Flemming DJ,
Armstrong AD. Comparison of standard two-dimensional and three-
15 dimensional corrected glenoid version measurements. J Shoulder
Elbow Surg 2011; 20:577-83. Wherein they reported a difference of
more than 5° in glenoid version in almost 50% of 2D compared with
3D CT, despite a high interobserver and intraobserver reliability for
both techniques. Furthermore Daggett et al reported a mean
20 difference of 1° on glenoid inclination on reformatted 2D CT scans
compared with 3D. B.S. Also conventional measurements of glenoid
version and inclination disclosed in Werner et al suggest on
reformatted 2D CT scans are less accurate compared with 3D
measurements. Thereby the conventional techniques lack in
25 providing the precision and accuracy in terms of version and
inclination in the shoulder implant surgery.

Using the data from 3D CT scans or MRI, the surgeon at present,
has two options to improve accuracy and get predictable results: 1.
30 to use computer navigation or 2. To use the patient specific guiding
instruments (jig) derived from said 3D CT scan or MRI data.
Computer navigation needs extended exposure during surgery for
attachment of the navigation devices. It is a costly instrumentation

5 with a need for a large amount of disposables which add to the cost. The surgery becomes more time consuming. The extended time and exposure lead to higher blood loss and can increase chances of infection.

10 Furthermore the use of image derived guiding instruments based on CT scan or MRI data are patient specific and thus are not reusable jigs. This adds on the financial burden and also increases or causes delay in scheduling the surgery as a patient specific jig needs at

15 least three weeks of time pre-operatively. Such techniques are based on the surgeon's decision or third party decision for the measurements, version and inclination and thus are vulnerable to higher chances of error in surgery; which sometimes may also call for post-operative measures or a repeat surgery. Thus, advances like computer navigation and patient specific jigs are costly and time

20 consuming.

PRIOR ART AND ITS DISADVANTAGES

US patent US 9741263 B2 discloses a method for assisting a user with

25 surgical implementation of a preoperative plan includes generating a physical native tissue model of a native patient tissue. The physical native tissue model includes at least one primary patient tissue area including a surface of interest, at least one secondary patient tissue area including no surfaces of interest, and a base surface for engaging a supporting

30 structure. The physical native tissue model, as generated, includes at least one information feature providing clinically useful information to the user. The information feature is substantially separated from the surface of

- 5 interest. An apparatus for assisting a user with surgical implementation of a preoperative plan is also provided.

However said system fails to provide a modular reusable jig to guide the placement of glenoid in the shoulder replacement surgery that accurately
10 and precisely guides the placement of glenoid component in patient as per the requirement. The jig uses the negative impression of surface imprints of the glenoid. As the negative impression of the glenoid is used, it needs extensive exposure of the bone devoid of soft tissue coverage. This leads to larger exposure and blood loss. Also the said system is user specific and
15 hence fails to provide a reusable jig. As it is a single use product and needs to be manufactured, it is expensive and time consuming process with a delay of at least three weeks from time of CT scan.

Another instrument or system in use for the shoulder replacement surgery
20 is the Arthrex VIP System. Said system consists of patient specific instruments that facilitates preoperative planning and intra operative placement of the glenoid guide pin used in preparing the glenoid for implantation of the glenoid implant in the total shoulder Arthroplasty or reverse total shoulder arthroplasty. Based on the patient CT scan data
25 submitted by the surgeon Arthrex Uses 3D preoperative planning software, to create a glenoid implant placement surgical plan for that specific patient.

However said system is bulky and is cumbersome to use due to 5D
30 calibrator used in the system. This blocks the visualization of the surgeon during the placement surgery thereby increasing the chances of the error in the calculation of the placement of the component. Furthermore the time taken for the preoperative measures for surgery using said

5 instrument is substantially more (approximately 48 hours). The accuracy
of any reusable modular system depends on how well instrument sits on
the glenoid bone. With a bulky instrument which blocks visualization, it
is difficult to confirm that all five legs are sitting on the bone. This
compromises the accuracy of the system. A lighter system which allows
10 visual confirmation of seating of the jig on the bone is necessary.

DISADVANTAGES OF PRIOR ART:

Existing technologies and/or jigs used for the shoulder replacement
15 surgery suffers from all or at least any of the below mentioned
disadvantages:

- The conventional system fails to provide a pre-assembled jig that facilitates and guides the placement of glenoid component of the
20 implant in shoulder replacement surgery.
- The conventional jigs for the placement of glenoid of the scapula bone are placed directly on the glenoid face and approximation in terms of versions found in average population are made. Whereas the version is alternatively decided arbitrarily by the surgeon. The
25 placement of glenoid based on such approximation or arbitrary values are thereby fails not accurate and does not provide patient satisfaction.
- In particular, Conventional system for the shoulder implant surgery fails to provide modular jig that guides the placement of glenoid
30 component of the implant in shoulder replacement surgery on the scapula precisely in three dimensions in terms of version, inclination, vertical height and side to side placement of the implant.

- 5 • Further the existing jigs for guiding implant placement in a shoulder replacement surgery relaying only on X-rays; fails to detect the deformities in the bones or between them, which leads to inappropriate calculation for the placement of the implant, and hence cannot be relied upon.
- 10 • The existing technologies using CT or MRI scans in 2D mode lack accurate detection of the deformities in the bones which further leads to the complexity in the surgery and post-surgery. Often Deformities are found out after the shoulder is opened for surgery; which increases the time for operating and at times, might require
15 second surgery to solve the post-operative issues in the shoulder deformity; adding to the complexity of the surgery, pain and inconvenience to the patient along with the additional cost of post-surgical treatments.
- 20 • Conventional techniques fails to provide a jig that precisely and accurately guides the implant over scapula at the definite version and inclination of the patient in the shoulder replacement surgery.
- Moreover the existing techniques are time consuming and are not reliable as they are not accurate.
- 25 • They fail to provide preoperative modular jig for the placement of the glenoid component in the shoulder replacement surgery.
- Computer navigation used in the shoulder replacement surgery substantially increases the exposure of the shoulder and time needed during surgery along with the increased blood loss during the surgery and increased chances of infection, causing it painful
30 for the patient; and thereby are not patient compliant.
- Furthermore the conventional jigs based on 3D CT or MRI are not surgeon friendly as many of them are bulky, non-modular, are not reusable and requires approximate or arbitrary values based on

- 5 assumption of the surgeon for the implant and in addition are also not precise and accurate.
- Most of them based on 3D CT or MRI scans are patient specific and hence are not reusable thereby adding to the cost.
 - The existing system for reusable, modular jig based on 3D CT or
- 10 MRI scans is bulky and are complex to use such that it blocks the vision of the surgeon during the surgery which in turn leads to many operative complexity during the surgery along with the lack of the precision and accuracy in the placement of the guide.
- 15 None of the prior art provides substantially effective instrument (Jig) to guide the placement of the glenoid component in shoulder replacement surgery that is accurate, precise in placing the implant component and is user friendly, patient compliant and reusable. Thus there is an unmet need of the invention that obviates the aforesaid problems of the
- 20 prior art.

OBJECTS OF THE INVENTION:

Accordingly the object of the present invention is to provide a jig for shoulder replacement surgery. In an aspect the present invention provides

25 a pre-assembled jig that facilitates and guides the placement of glenoid component of the implant in shoulder replacement surgery.

It is an object of the present invention to provide a pre-operative modular jig that facilitates and guides the placement of glenoid component of the implant in shoulder replacement surgery. In an aspect the present

30 invention provides a jig that guides the placement of glenoid component of the implant in shoulder replacement surgery on the scapula precisely

- 5 in three dimension in terms of version, inclination, vertical height and depth of implant and aids the surgeon to work with acumen.

In another object, the present invention provides a jig that precisely and accurately guides the implant over scapula at the definite version and inclination of the patient in the shoulder replacement surgery.

- 10 In yet another object the present invention provides a modular jig that accurately determines the deformities in the bones or between the bones and thereby facilitate and guides the precise placement of glenoid component of the implant in shoulder replacement surgery.

- In yet another object the present invention provides a jig for guiding
15 placement of glenoid component of the implant in shoulder replacement surgery that considerably decreases the shoulder dissection thereby facilitating the shoulder replacement surgery less time consuming.

- In an object the present invention eliminates the need of the arbitrary calculation of the values for the implant by the surgeon and/or third party
20 thereby provides precision and accuracy and also reduces the time taken for the surgery which in turn requires the shoulder to be kept open for substantially less time and thereby decreases the chances of infections.

- In yet another object the present invention provides reusable jig for guiding placement of glenoid component of the implant in shoulder
25 replacement surgery. In an aspect the present invention provides a jig that reduces the blood loss and bone loss in guiding the placement of glenoid component of implant in shoulder replacement surgery.

- In an object the present invention provides a jig for guiding placement of glenoid component of the implant in shoulder replacement surgery that is
30 surgeon friendly and is not bulky and is easy to operate and visualize the placement of the component during the surgery.

- 5 In another object the present invention provides an accurate and precise
jig for guiding the glenoid component of the implant in shoulder
replacement surgery.

In other object the present invention provides a jig for guiding the glenoid
component of the implant in shoulder replacement surgery that facilitates
10 the surgeon to work with acumen.

In another object the present invention provides a jig for guiding the
glenoid component of the implant in shoulder replacement surgery that
aids in the shoulder replacement surgery and provides enhanced patient
compliance reducing the blood loss, bone loss, chances of infection and
15 post-operative difficulties, pain.

BRIEF DESCRIPTION OF DRAWINGS:

Fig.1	:	Shows the exploded view of the present jig for guiding the glenoid component of the implant in shoulder replacement surgery
Fig.2	:	Shows the perspective view of present jig for guiding the glenoid component of the implant in shoulder replacement surgery
Fig.3	:	Shows the glenoid ring of the present jig for guiding the glenoid component of the implant in shoulder replacement surgery
Fig.4a and 4b	:	Shows the variations in size measurements of the glenoid ring augments of the present jig for guiding the glenoid component of the implant in shoulder replacement surgery
Fig.4c and 4d	:	Shows variations in head of the glenoid ring augments in top view of the present jig for guiding the glenoid component of the implant in shoulder replacement surgery

Fig 5, 5a,5b	:	Shows the glenoid ring handle and its variations of the present jig for guiding the glenoid component of the implant in shoulder replacement surgery.
Fig 6	:	Shows the change in version with the change in augment size on the scapula implementing the present jig for guiding the glenoid component of the implant in shoulder replacement surgery.
Fig.6a	:	Shows the increase in retro version with longer anterior glenoid ring augment on the scapula implementing the present jig for guiding the glenoid component of the implant in shoulder replacement surgery
Fig.6b	:	Shows the increase in ante version with longer posterior glenoid ring augment on the scapula implementing the present jig for guiding the glenoid component of the implant in shoulder replacement surgery
Fig.7	:	Shows the change in inclination with the change in augment size on the scapula implementing the present jig for guiding the glenoid component of the implant in shoulder replacement surgery
Fig.7a	:	Shows the increase in inclination with longer superior augment size on the scapula implementing the present jig for guiding the glenoid component of the implant in shoulder replacement surgery.
Fig.7b	:	Shows the decrease in inclination with longer inferior augment size on the scapula implementing the present jig for guiding the glenoid component of the implant in shoulder replacement surgery

5 **Meaning of reference numeral of the said component parts of the present jig for guiding the glenoid component of the implant in shoulder replacement surgery:**

- P : Present jig for guiding the glenoid component of the implant in shoulder replacement surgery
- GR : Glenoid ring
- GS : Glenoid pin sleeve
- GA : Glenoid ring Augments
- GH : Glenoid ring handle
- HGA : Holes for Glenoid ring augments
- HGS : Hole for Guide pin sleeve
- HGH : Hole for Glenoid ring Handle

Additional references (not the part of present jig)

- P1 : Superior position of glenoid where the Glenoid ring Augment rests on the bone
- P2 : Inferior position of glenoid where the Glenoid ring Augment rests on the bone
- P3 : Anterior position of glenoid where the Glenoid ring Augment rests on the bone
- P4 : Posterior position of glenoid where the Glenoid ring Augment rests on the bone

SUMMARY OF THE INVENTION:

- 10 Referring to Fig. 1 to 7b, the present invention (P) comprises:
- Glenoid ring (GR),
 - Glenoid pin sleeve (GS),

- 5 • Glenoid ring Augments (GA),
- Glenoid ring handle (GH),
- Holes for Glenoid ring augments (HGA),
- Hole for Glenoid pin sleeve (HGS),
- Hole for Glenoid ring Handle (HGH);

10

The present jig (P) uses measurements of displacement of Jig (P) of glenoid of the scapula bone, in a shoulder replacement surgery; wherein, to achieve precise cut as per the values of depth of cuts obtained from a system derived from 3D imaging like CT scans or MRI scans for obtaining accurate and precise position of the glenoid component of the shoulder replacement implant so as to achieve minimum bone loss and maximum patient satisfaction. While using the obtained values, the present Jig (P) is used to obtain precise cuts on the glenoid in a shoulder replacement surgery. The precise cuts on the glenoid are obtained by the precise placement of present Jig (P) on the scapula in all three planes to enable precise cuts on the bone. Wherein the precise placement is ensured by the precisely measured (more preferably in millimeters) glenoid ring augments (GA) that are used to generate rotations in different planes. Placing of the present jig (P) on the scapula, establishes the contact of the present jig (P) with the bone at different points, such that the end of the glenoid ring augments (GA) touches the bone. Said points are termed herein after as contact points. Said contact points are used as reference points that enables the precise measurements while adjusting the Jig (P) to precise position and thereby facilitates in precise cuts. Wherein the contact points are in plurality more preferably three, four or more than three to achieve the precise adjustments of measurement.

5 Present description embodies four such contact points while achieving precise position and alignment of the present Jig (P) on the glenoid.

- P1: Base of glenoid ring augment (GA) in the Superior position of glenoid ring (GR) with cross hairs
- P2: Base of glenoid ring augment (GA) in the Inferior position of
10 glenoid ring (GR) with cross hairs
- P3: Base of glenoid ring augment (GA) in the Anterior position of glenoid ring (GR) with cross hairs
- P4: Base of glenoid ring augment (GA) in the Posterior position of glenoid ring (GR) with cross hairs

15 These four points controls the rotations and displacements of the present Jig (P) as under:

- **Rotation in the sagittal plane:** Superior inclination (inclination towards the superior side (above)) is controlled by increasing the size of the glenoid ring augment (GA) in inferior position of the glenoid
20 ring (GR) with cross hairs over the glenoid augment (GA) in superior position of the glenoid ring (GR) with cross hairs (increasing the distance between P2 and ring compared to the distance between P1 and the ring). Similarly, inferior inclination (inclination towards the inferior side (below)) is controlled by increasing the size of the
25 glenoid ring augment (GA) in superior position of the glenoid ring (GR) with cross hairs over the glenoid ring augment (GA) in inferior position of the glenoid ring (GR) with cross hairs (increasing the distance between P1 and ring compared to the distance between P2 and the ring)) in the glenoid ring with cross hairs.
- **Rotation in axial plane:** Anteversion (Rotation towards the front) is
30 controlled by increasing the size of the glenoid ring augment (GA) in the posterior position of the glenoid ring (GR) with cross hairs over

- 5 the glenoid ring augment (GA) in the anterior position of the glenoid ring (GR) with cross hairs (increasing the distance between P4 and ring compared to the distance between P3 and the ring) in the glenoid ring (GR) with cross hairs. Similarly, retroversion (Rotation towards the back) is controlled by increasing the size of the glenoid
- 10 ring augment (GA) in the anterior position of the glenoid ring (GR) with cross hairs over the glenoid ring augment (GA) in the posterior position of the glenoid ring (GR) with cross hairs (increasing the distance between P4 and ring compared to the distance between P3 and the ring) with cross hairs.
- 15 • **Displacement in the sagittal plane** is anterior or posterior placement. Displacement of P3 from anterior glenoid ring (GR) and P4 from posterior glenoid ring (GR) induces anterior or posterior placement of glenoid by the distance in millimeters as calculated in pre-operative planning.
- 20 • **Displacement in the axial plane** is superior or inferior placement. Displacement of the glenoid ring (GR) at P1 from the superior edge and P2 from the inferior edge induces superior-inferior placement of the glenoid away from the inferior edge or the superior edge of the glenoid bone by the distance in millimeters as calculated in pre-
- 25 operative planning.

Thus, the present Jig (P) uses measurements in millimeters (mm) in all three planes and all six degrees of freedom instead of the generally used angles in degrees in an undefined plane. Wherein the six degrees of freedom of movement are three angulations and three displacements.

30 Further the Two angulations are Version in axial plane and inclination in coronal plane are as described above. The Third angulation in sagittal plane is rotation of the glenosphere on its axis, which is of no consequence

5 as the glenoid implant in reverse shoulder arthroplasty is a hemi-sphere. Further the Two displacements Anterior-posterior in sagittal plane, superior-inferior in axial plane are as described above. Whereas the Third displacement; depth of placement of glenoid is controlled by depth of reaming on the guide pin.

10 **DESCRIPTION OF THE INVENTION:**

The objective and particular technicalities of the invention are exemplified in the embodiment shown in accompanying drawings and as described herein below:

The embodiment of the present invention provides a pre-assembled
15 modular jig for guiding the placement of glenoid component in the shoulder replacement surgery (P). It provides a jig that guides the placement of glenoid component of the implant in shoulder replacement surgery on the scapula precisely in three dimensions in terms of version, inclination, vertical height and side-to-side placement of implant. The
20 present jig (P) is pre-assembled to ensure precision alignment, placing and sizing of the glenoid component of the implant for shoulder replacement surgery based on the difference of cuts in millimeters instead of the usual version measurements in degrees. The present invention (P) guides the glenoid component of shoulder replacement in the precise position and
25 thereby provides accuracy in placement of the component. Furthermore the present invention (P) substantially reduces the time taken for the surgery and also decreases the chances of infection with less blood loss and minimum bone loss.

Referring to Fig 1 and fig. 2, the present jig for guiding the placement of
30 glenoid component of the implant in shoulder replacement surgery (P) comprises:

- 5 • Glenoid ring (GR),
- Glenoid pin sleeve (GS),
- Glenoid ring Augments (GA),
- Glenoid ring handle (GH),
- Holes for Glenoid ring augments (HGA),
- 10 • Hole for Glenoid pin sleeve (HGS),
- Hole for Glenoid ring Handle (HGH);

Wherein,

- 15 Referring to Fig 3 said glenoid ring (GR) is having cross hairs and is preferably made of metal. Said glenoid ring (GR) facilitates holes for glenoid ring augments (HGA) at superior (P1), inferior (P2), anterior (P3) and posterior (P4) locations. Said holes for glenoid ring augments (HGA) are provided to accept said Glenoid ring augments (GA). Said glenoid ring
- 20 (GR) further facilitates hole for glenoid ring handle (HGH) at anterior-inferior and postero-inferior end of the ring to accept the glenoid ring handle (GH). Alternatively the holes at anterior-inferior and postero-inferior end of the glenoid ring (GR) is used by the surgeon. Said Hole for glenoid pin sleeve (HGS) is provided at the center of the glenoid ring (GR)
- 25 to accept the glenoid pin sleeve (GS). Said Glenoid Augments (GA) are provided such that it determines the four point of contacts on the shoulder of the patient undergoing the shoulder replacement surgery. The contact points where the glenoid ring augment (GA) rests on the bone are termed as P1 for superior glenoid ring augment, P2 for inferior glenoid ring
- 30 augment, P3 for anterior glenoid ring augment and P4 for the posterior glenoid ring augment. Said glenoid augments (GA) are provided such that it facilitates in determining the position for the placement of glenoid component over scapula with accuracy and precision at the superior

5 position (P1), Inferior position (P2), Anterior Position (P3), Posterior position (P4) of the glenoid.

Now referring to Fig4a and Fig.4d; shows the variation in the size measurements of said glenoid augments (GA). Wherein the size of glenoid augments (GA) varies in the range of 1mm to 20mm. Present Jig (P)
10 determines the position for the accurate and precise placement of the glenoid component over scapula by controlling the lengths of said glenoid augments (GA) in four diametrically opposite directions. Further the rotations in the axial plane (versions) are also controlled by the lengths of the glenoid augments (GA) on the anterior position (P3) and posterior
15 position (P4) of the glenoid ring (GR) with cross hairs. Where the anterior Glenoid ring augment (GA) is longer compared to posterior glenoid ring augment; that is the distance of glenoid ring augment (GA) from Anterior Position P3 is larger compared to the distance glenoid ring augment (GA) from Posterior position (P4). This increases retroversion. Where the
20 posterior glenoid ring augment is longer compared to anterior glenoid ring augment increases the ante version. further said change in length of glenoid augments (GA) on superior position (P1) and Inferior Position (P2) of the glenoid ring (GR) with cross hairs rotating in coronal plane determines the inclination in terms of angle; where the superior position
25 (P1) glenoid ring augment (GA) is longer compared to Inferior position (P2) glenoid augment (GA) indicates increase in inferior inclination angle over the scapula; where the superior position (P1) glenoid ring augment (GA) is shorter than Inferior position (P2) glenoid augment (GA) indicates increase in superior inclination angle over the scapula. The precise lengths of the
30 glenoid ring augments (GA) are measured after studying the individualized CT scan by the surgeon and the distances of P3 and P4 from the glenoid ring are measured. For determining the inclination (the rotations in the

- 5 coronal plane) the lengths of the glenoid augments (GA) on the superior position (P1) and Inferior Position (P2) of glenoid ring (GR) are changed. This determines the superior Inclination or inferior Inclination and accordingly the varied size measurements of the glenoid augments (GA) are used by the surgeon.
- 10 As shown in Fig 4c and 4d the present jig (P), alternatively uses and discloses variations in the head of the glenoid augments (GA); more preferably a cross head on the top or hexagon head on the top of the glenoid augments (GA) of varied size ranges. The Glenoid ring augments (GA) are locked onto the ring with threads on the head of the glenoid ring
- 15 augment (GA) and the threads in the holes of the glenoid ring with cross hairs (GR). Alternatively, different variations of locking mechanisms may be used to lock the glenoid ring augment in to the holes in the glenoid ring with cross hairs for the glenoid ring augments.

Referring to Fig 6 to 6b, shows the changes in version with the change in

20 the glenoid augment (GA) sizes on the scapula implementing the present jig for guiding the placement of glenoid component. The precise position of the placement of the component is ensured by the precisely measured sizes of glenoid augments (GA) as per the positions determined by the rotation and displacement in different planes. With the change in the size

25 of the glenoid Augment (GA) as per the version precise variation in the angle is determined by the present jig (P) in three dimensions that are coronal, sagittal and axial plane Referring to fig. 6, shows the present jig (P) determining position over scapula of the patient for guiding the placement of the glenoid component at the reference points marking the

30 points as Superior position of glenoid (P1), Inferior position of glenoid (P2), Anterior position of glenoid (P3), Posterior position of glenoid (P4). Based on the three dimensional report CT Scan/MRI of the patient and the pre-

operative analysis the surgeon with the use of the present jig (P) determines the accurate and precise position for the glenoid placement. As shown in Fig .6a, the surgeon implements various plurality of glenoid augments (GA) of varied size measurement according to the patient requirement. When the glenoid augment (GA) at the Anterior position of glenoid (P3) is longer than the glenoid augment (GA) at Posterior position of glenoid (P4); this generates the retro version over the scapula This precisely marks the position of the glenoid component over the scapula along with the variations in its inclination angle. Similarly, as shown in Fig 6b, when the glenoid augment (GA) at the Anterior position of glenoid (P3) is shorter than the glenoid augment (GA) at Posterior position of glenoid (P4); this generates the ante version over the scapula. This precisely marks the position of the glenoid component over the scapula along with the variations in its version. Wherein the present invention (J) accurately detects the variations in versions (Retro and Ante) in terms of angle in the range of 1.8° - 30° . Further said variations in the angle/s determined are directly proportional to the varied sizes of the glenoid augments (GA) in terms of millimeter (mm) in the range of 1mm – 20mm being used in the present jig (P). Thus with the change in the patient requirement, each glenoid augment (GA) is changed that accurately and precisely determines the version variations, that are specific to the patients and varies with each patient thereby aiding in the accurate placement of the glenoid component as per the patient need.

Referring to Fig 7 to 7b, shows the change in inclination with the change in augment size on the scapula implementing the present jig (P). The precise position of the placement of the component is ensured by the precisely measured sizes of glenoid ring augments (GA) as per the positions determined by the rotation and displacement in different planes.

5 With the change in the size of the glenoid ring Augment (GA) as per the inclination, precise variation in the angle is determined by the present jig (P) in three dimension. Referring to fig.7, shows the present jig (P) determining position over scapula of the patient for guiding the placement of the glenoid component at the reference points marking the points as
10 Superior position of glenoid (P1), and Inferior position of glenoid (P2), Anterior position of glenoid (P3), Posterior position of glenoid (P4). Based on the three dimensional report CT Scan/MRI of the patient and the pre-operative analysis the surgeon with the use of the present jig (P) determines the accurate and precise position for the glenoid placement
15 (GA). As shown in Fig .7a, the surgeon implements various plurality of glenoid augments (GA) of varied size measurement according to the patient requirement. When the glenoid augment (GA) at Superior position of glenoid (P1) is longer than the glenoid augment (GA) at Inferior position of glenoid (P2); determines the increase in the inferior inclination angle over
20 the scapula. This precisely marks the position of the glenoid component over the scapula along with the variations in its inclination. Similarly, as shown in Fig 7b when the glenoid augment (GA) at Superior position of glenoid (P1) is shorter than the glenoid augment (GA) at Inferior position of glenoid (P2); determines the increase in the superior inclination angle
25 over the scapula. This precisely marks the position of the glenoid component over the scapula along with the variations in its inclination. Wherein the present invention (J) accurately detects the variations in inclination (increased in superior or inferior inclination) in terms of angle in the range of 1.8° - 30° . Further said variations in the angle/s
30 determined are directly proportional to the varied sizes of the glenoid augments (GA) in terms of millimeter (mm) in the range of 1mm – 20mm being used in the present jig (P). Thus with the change in the patient requirement, each glenoid augment (GA) is changed that accurately and

5 precisely determines the inclination variations, that are specific to the patients and varies with each patient thereby aiding in the accurate placement of the glenoid component as per the patient need.

In an embodiment, the present invention (P), provides varied versions of the glenoid ring handle (GH) as shown in figure (5 to 5b). Said glenoid ring
10 handle (GH) are provided to support the glenoid ring with cross hairs (GR) and are preferably made of metal with a grip at one end. On the other end a locking mechanism is provided that locks the glenoid ring handle (GH) into the hole for glenoid ring handle on the glenoid ring with cross hairs. Wherein said locking mechanism includes threads or its variations. The
15 shape of the handle may vary as per surgeon preference for better visibility deep into the operative field without obstruction. Said glenoid pin sleeve (GS) is provided to facilitate precise direction for insertion of the guide pin and is preferably made up of metal with a grip at one end and locking mechanism at the other end. Wherein the other end of said glenoid pin
20 sleeve (GS) is locked into the hole provided at the center of glenoid pin sleeve (HGS) in said glenoid ring with cross hairs (GR).

WORKING OF THE INVENTION:

The analysis for optimum fit implant and its optimum position is derived from any of the existing pre-operative system for the joint replacement
25 surgery. The depth of cuts on the glenoid on the scapula along with the antero-posterior and superior-inferior distance is obtained from the said system. These are used to calculate the placement of the glenoid component and the size of the glenoid augments (GA) to be used. The working steps comprises of:

- 30 1. Determining contact points and verification of data obtained from pre-operative system
 2. Assembling of the Present Jig (P),

5 3. Placement of the present jig (P) on the glenoid

For the precise and the accurate placement of the glenoid component in the shoulder replacement surgery using the present Jig (P) the precise and accurate position for cut on the bone and the placement of the component
10 with respect to version and inclination, said glenoid ring augments (GA) determines the four contact points namely superior (P1), inferior (P2), anterior (P3) and posterior (P4).

**Determining contact points and verification of data obtained from
15 pre-operative system**

- Following the determination the four contact points by the present jig (P), the surgeon verifies the data obtained from the preoperative system. This further ensures the accuracy of the operation of the present jig (P). The data obtained from the existing pre-operative
20 system is verified by the surgeon as follows: In case where the surgeon feels to increase the “anteversion” as per the patient specific data obtained from the preoperative system; the surgeon uses the longer sized glenoid ring augment (GA) at the posterior position (P4) than the glenoid augment at the anterior position (P3).
- 25 • In case where the surgeon feels to decrease the “anteversion” as per the patient specific data obtained from the preoperative system; the surgeon uses the longer sized glenoid ring augment (GA) at the anterior position (P3)) than the glenoid augment at the posterior position (P4).
- 30 • In case where the surgeon feels to increase the “inferior inclination” as per the patient specific data obtained from the preoperative system; the surgeon uses the longer sized glenoid ring augment (GA)

5 at the superior position (P1) than the glenoid augment at the inferior position (P2).

- In case where the surgeon feels to decrease the “inferior inclination” as per the patient specific data obtained from the preoperative system; the surgeon uses the longer sized glenoid ring augment (GA) at the inferior position (P2) than the glenoid augment at the superior position (P1).

Assembling of the Present Jig (P)

Further the glenoid augments (GA) as selected for use by the surgeon are locked into their respective holes for glenoid augments (HGA) starting with the superior hole. Wherein the difference in sizes of the glenoid augments (GA) used by the surgeon varies in the range of 1-20 mm with the corresponding degrees with the ratio of 1mm: 1.8° and 20mm: 30°.

Said guide pin sleeve (GS) is threaded and locked into the center of the hole for glenoid pin sleeve (HGS) in the glenoid ring with cross hairs (GR).

20 The glenoid ring handle (GH) is locked in to the hole for glenoid ring handle (HGH) at either postero-inferior hole or antero-inferior hole depending on exposure of the glenoid and surgeon preference.

25 **Placement of the assembled jig (P) over glenoid:**

1. Said assembled jig is further placed on the glenoid surface taking care of the following:
 - All four glenoid ring augments (GA) are touching the glenoid. This is crosschecked visually. Alternatively, an attempt can be made to pass small instrument under the glenoid ring augments (GA) to cross check that there is no space between the end of glenoid ring augment (GA) and the bone. the

- 5 stability of the glenoid ring (GR) placed on the glenoid is assessed by a small toggle wherein, all four glenoid ring augments (GA) touches the glenoid surface, ensuring proper placement of glenoid ring (GR)
- 10
- Further the superior ring augment is aligned with the superior position of the glenoid.
 - The distance of placement of superior ring augment on glenoid (P1) from the superior position of the glenoid is the same as calculated from the pre-operative planning.
 - The distance of placement of inferior ring augment on glenoid (P2) from the inferior edge of the glenoid is the same as calculated from the pre-operative planning.
 - The distance of placement of anterior ring augment on glenoid (P3) from the anterior edge of the glenoid is the same as calculated from the pre-operative planning.
 - The distance of placement of posterior ring augment on glenoid (P4) from the posterior edge of the glenoid is the same as calculated from the pre-operative planning.
- 15
- 20
- 25
- 30
2. Upon confirming the correct placement of the jig on the glenoid, the guide pin is drilled into the glenoid through the glenoid pin sleeve (GS) in the precise, desired angle and placement. The cannulated reamer is used over the guide pin to ream the glenoid and final preparations are made keeping the guide pin in place. The humerus is prepared and final components placed in either a cemented or uncemented mode. The spacer is placed and wound is closed in layers.

5 Example 1:

For patient A, based on CT-scan/MRI Reports and implying the results of the pre-operative system and doctors verification, the values calculated of Glenoid ring augments (GA) to be used for the Placement of Glenoid

10 Component of the Implant in Shoulder Replacement Surgery were: For the glenoid ring Augment (GA) in superior position (P1) the value determined was 2 mm, for glenoid ring Augment (GA) in inferior position (P2) was 2 mm whereas for glenoid ring Augment (GA) in Anterior position (P3) was 3mm and for glenoid ring Augment (GA) in the posterior position (P4) was

15 2mm. Meaning thereby while applying the present invention for surgery in said patient the glenoid ring augments (GA) at the superior position (P1) and inferior position (P2) shall be same, since there is no change and variation detected in the inclination. Further for the said patient the glenoid ring augments (GA) at the Anterior position (P3) is larger than that

20 at the posterior position (P4); thereby leading to retro version. There is the variation in version by 1mm and 1.8° (in terms of degree). Hence the placement of the glenoid should be accordingly retroverted, where the glenoid ring augment (GA) used at the posterior position (P4) is larger by 1mm than the glenoid ring augment (GA) at the anterior position (P3)

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Example 2:

For patient N, based on CT-scan/MRI Reports and implying the results of the pre-operative system and doctors verification, the values calculated of Glenoid ring augments (GA) to be used for the Placement of Glenoid

30 Component of the Implant in Shoulder Replacement Surgery were: For the glenoid ring Augment (GA) in superior position (P1) the value determined was 2 mm, for glenoid ring Augment (GA) in inferior position (P2) was 2 mm whereas for glenoid ring Augment (GA) in Anterior position (P3) was

5 3mm and for glenoid ring Augment (GA) in the posterior position (P4) was 4mm. Meaning thereby while applying the present invention for surgery in said patient the glenoid ring augments (GA) at the superior position (P1) and inferior position (P2) shall be same, since there is no change and variation detected in the inclination. Further for the said patient the
 10 glenoid ring augments (GA) at the Anterior position (P3) is shorter than that at the posterior position (P4), thereby leading to ante version. There is the variation in version by 1mm and 1.8° (in terms of degree)). Hence the placement of the glenoid should be accordingly ante verted, where the glenoid ring augment (GA) used at the anterior position (P3) is larger by
 15 1mm than the glenoid ring augment (GA) at the posterior position (P4).

Example 3:

For patient X, based on CT-scan/MRI Reports and implying the results of the pre-operative system and doctors verification, the values calculated of Glenoid ring augments (GA) to be used for the Placement of Glenoid
 20 Component of the Implant in Shoulder Replacement Surgery were: For the glenoid ring Augment (GA) in superior position (P1) the value determined was 4mm, for glenoid ring Augment (GA) in inferior position (P2) was 2 mm whereas for glenoid ring Augment (GA) in Anterior position (P3) was 2mm and for glenoid ring Augment (GA) in the posterior position (P4) was
 25 2mm. Meaning thereby while applying the present invention for surgery in said patient the glenoid ring augments (GA) at the superior position (P1) is larger than that at the inferior position (P2) leading to increase in inferior inclination. There is the variation in inferior inclination by 2mm and 3.5° (in terms of degree) Hence the placement of the glenoid should
 30 be accordingly used, where the glenoid ring augment (GA) at the inferior position (P2) is larger by 2mm than that used at the superior position (P1). Also since the glenoid ring augments (GA) at anterior position (P3) and posterior position (P4) are same there is no change detected in version.

5 **Example 4:**

For patient Y, based on CT-scan/MRI Reports and implying the results of the pre-operative system and doctors verification, the values calculated of Glenoid ring augments (GA) to be used for the Placement of Glenoid Component of the Implant in Shoulder Replacement Surgery were: For the
10 glenoid ring Augment (GA) in superior position (P1) the value determined was 2mm, for glenoid ring Augment (GA) in inferior position (P2) was 4 mm whereas for glenoid ring Augment (GA) in Anterior position (P3) was 2mm and for glenoid ring Augment (GA) in the posterior position (P4) was
15 3mm. Meaning thereby while applying the present invention for surgery in said patient the glenoid ring augments (GA) at the superior position (P1) is shorter than that at the inferior position (P2) leading to increase in superior inclination. There is the variation in superior inclination by 2mm and 3.5° (in terms of degree). Hence the placement of the glenoid should
20 be accordingly used, where the glenoid ring augment (GA) at the superior position (P1) is larger by 2mm than that used at the inferior position (P2). Furthermore the glenoid ring augment (GA) at anterior position (P3) is shorter than the glenoid ring augment (GA) at Posterior position (P4) leading to ante version. There is the variation in version by 1mm and 1.8°
25 (in terms of degree). Hence the placement of the glenoid should be accordingly ante verted, where the glenoid ring augment (GA) used at the anterior position (P3) is larger by 1mm than the glenoid ring augment (GA) at the posterior position (P4).

30 **Example 5:**

For patient B, based on CT-scan/MRI Reports and implying the results of the pre-operative system and doctors verification, the values calculated of

5 Glenoid ring augments (GA) to be used for the Placement of Glenoid
Component of the Implant in Shoulder Replacement Surgery were: For the
glenoid ring Augment (GA) in superior position (P1) the value determined
was 2 mm, for glenoid ring Augment (GA) in inferior position (P2) was 2
mm whereas for glenoid ring Augment (GA) in Anterior position (P3) was
10 3mm and for glenoid ring Augment (GA) in the posterior position (P4) was
4mm. Meaning thereby while applying the present invention for surgery
in said patient the glenoid ring augments (GA) at the superior position (P1)
and inferior position (P2) shall be same, since there is no change and
variation detected in the inclination. Further for the said patient the
15 glenoid ring augments (GA) at the Anterior position (P3) is shorter than
that at the posterior position (P4), thereby leading to ante version. There
is the variation in version by 1mm and 1.8° (in terms of degree)). However
here the glenoid of the patient was shallower and hence for the precise
placement of the glenoid component, the glenoid augment (GA) at anterior
20 position (P3) and at Posterior position (P4) had to be increased by 1 mm
compared to glenoid augments at superior position (P1) and inferior
position (P2).

Having described what is considered the best form presently contemplated
25 for embodying the present invention, various alterations, modifications,
and/or alternative applications of the invention for any system will be
promptly apparent to those skilled in the art. Therefore, it is to be
understood that the present invention is not limited to the practical
aspects of the actual preferred embodiments hereby described and that
30 any such modifications and variations must be considered as being within
the spirit and the scope of the invention, as described in the above
description.

5 **Claims:-**

1. A pre-assembled jig for guiding the placement of glenoid component in the shoulder replacement surgery (P) in three dimensions in terms of version, inclination, vertical height and side-to-side placement of implant comprises of
 - Glenoid ring (GR),
 - Glenoid pin sleeve (GS),
 - Glenoid ring Augments (GA),
 - Glenoid ring handle (GH),
 - Holes for Glenoid ring augments (HGA),
 - Hole for Glenoid pin sleeve (HGS),
 - Hole for Glenoid ring Handle (HGH);

Wherein

- said glenoid ring (GR) with cross hairs and preferably made of metal, comprises of at least four holes for glenoid ring augments (HGA) at superior (P1), inferior (P2), anterior (P3) and posterior (P4) locations and a hole glenoid ring handle (HGH) at anterior-inferior and postero-inferior end, to accept the glenoid ring handle (GH); glenoid ring (GR) further comprises Hole for glenoid pin sleeve (HGS) at the center configured to accept said glenoid pin sleeve (GS); said glenoid ring augments (HGA) is configured to accept Glenoid ring augments (GA) of varied size measurements and with variations in head; said Glenoid Augments (GA) determines the four point of contacts on the shoulder of the patient undergoing the shoulder replacement surgery; said glenoid ring handle (GH) with a grip at one end and preferably made of metal, supports the glenoid ring with cross hairs (GR); further at the other end said glenoid ring handle (GH) consists

5 locking mechanism that may include threads or its variations for locking of the glenoid ring handle (GH) into the hole for glenoid ring handle (HGH); said glenoid pin sleeve (GS) with a grip at one end and locking mechanism at the other end locked into the hole provided at the center of glenoid pin sleeve (HGS) and preferably
10 made of metal, is configured to facilitate precise direction for insertion of the guide pin;

wherein the length of said Glenoid Augments (GA) used in the present preassembled jig is varied according to requirement
15 determined by the contact points for precision and accuracy; said change in length of glenoid augments (GA) on the anterior position (P3) and posterior position (P4) of the glenoid ring (GR) with cross hairs rotating in axial plane determines the version in terms of angle; where the anterior Position (P3) Glenoid ring augment (GA) is
20 longer compared to posterior position (P4) glenoid ring augment indicates increase in retroversion and where the posterior position (P4) glenoid ring augment is longer compared to anterior position (P3) glenoid ring augment indicates increase in the ante version; further said change in length of glenoid augments (GA) on superior
25 position (P1) and Inferior Position (P2) of the glenoid ring (GR) with cross hairs rotating in coronal plane determines the inclination in terms of angle; where the superior position (P1) glenoid ring augment (GA) is longer compared to Inferior position (P2) glenoid augment (GA) indicates increase in inferior inclination angle over the scapula; where the superior position (P1) glenoid ring augment
30 (GA) is shorter than Inferior position (P2) glenoid augment (GA) indicates increase in superior inclination angle over the scapula.

- 5 **2.** A pre-assembled jig for guiding the placement of glenoid component
in the shoulder replacement surgery (P) in three dimensions in
terms of version, inclination, vertical height and side-to-side
placement of implant as claimed in claim 1, wherein the variation
in the size measurements of said glenoid Augments (GA) is in the
10 range of 1mm to 20mm and the variation in heads of glenoid
Augments (GA) are cross head on the top or hexagon head on the
top of the glenoid augments (GA).
- 15 **3.** A pre-assembled jig for guiding the placement of glenoid component
in the shoulder replacement surgery (P) in three dimensions in
terms of version, inclination, vertical height and side-to-side
placement of implant as claimed in claim 1, wherein the rotation in
axial plane and precise variation in version identified in terms of
angles is in range 1.8° - 30° wherein said version variations in the
20 angles determined are directly proportional to the varied sizes of the
glenoid augments (GA) in terms of millimeter (mm) in the range of
1mm - 20mm.
- 25 **4.** A pre-assembled jig for guiding the placement of glenoid component
in the shoulder replacement surgery (P) in three dimensions in
terms of version, inclination, vertical height and side-to-side
placement of implant as claimed in claim 1, wherein the rotation in
coronal plane and precise variation in inclination identified in terms
of angles is in range 1.8° - 30° wherein said inclination variations in
30 the angle determined are directly proportional to the varied sizes of
the glenoid augments (GA) in terms of millimeter (mm) in the range
of 1mm - 20mm.

- 5 **5.** A pre-assembled jig for guiding the placement of glenoid component
in the shoulder replacement surgery (P) in three dimensions in
terms of version, inclination, vertical height and side-to-side
placement of implant as claimed in claim 1 may employ size- shape
variations in glenoid ring handle (GH)as in fig 5 to fig 5b.

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