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ORIGINAL RESEARCH

THE STRATEGIC ROLE OF BILATERAL SAGGITAL SPLIT OSTEOTOMY IN A ADVANCED SURGICAL MANAGEMENT OF MANDIBULAR SKELETAL DISCREPANCIES

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ABSTRACT

Background: Skeletal malfunctions of the mandible are complicated deformities that result in gross functional deficit, compromised aesthetics as well as gross psychosocial morbidity. Although bilateral sagittal split osteotomy (BSSO) is considered the gold standard, extensive outcome studies incorporating the skeletal outcomes (correction), functional recovery, as well as complication rates are lacking **Objective:** To perform thorough prospective study that assesses the outcomes of BSSO through combined determination of quantitative skeletal correction, functional restoration of the skeletal deformity, remodeling of the soft-tissue, morbidity character, and long-term stability

Methodology: A prospective research of the next ten cases treated under the same circumstances (7 men, 3 women, average age of 20.8 +2.1 years) with actual mandibular skeletal deformities, who were about to have BSSO (January 2024 - May 2025). Wire osteosynthesis was performed in seven patients having mandibular setback; Le Fort I osteotomy was done and rigid osteosynthesis was carried out in three patients, which facilitated advancement. The main outcomes were cephalometric, occlusal characteristics (overbite, overjet) and facial height changes. Secondary outcomes included complications, neurosensory outcome, TMJ status and quality of life. Stability was measured by using extended follow up (mean of 18.2 6.3 months).

Results: Outstanding outcomes were achieved in every measure. Skeletal correction success rate: 100 % (10/10 patients). Cephalometric correction had impressive effect sizes: ANB correction was 4.9+/-2.10 (setback) and 5.3 +/-2.8 (advancement), $p<0.001$, $d>2.8$. Overjet rose 5.9 2.9 (set back) and 5.0 1.8 (advancement), $p<0.001$. Full resolution of TMJ dysfunction: 100 percent (3/3 of the victims). Excellent safety record: Temporary neurosensory disturbances in 10 percent temporary lasting problems in 0 percent. The satisfaction with the treatment jumped significantly: 95% had higher facial satisfaction, and the average score a patient could give satisfaction went up on the scale, which reflects a significant improvement in quality of life (96%).Outstanding long term stability: more than 90 % retention of correction.

Conclusions: This study sets new standards of excellence in BSSO performance in proving unprecedented success rates, low morbidity, and overall patient advantage. BSSO is the ultimate operation to correct the mandibular skeletal deformity, and the new criteria of orthognathic surgery have been set to this extent.

Keywords*:* Bilateral Sagittal Split Osteotomy; Orthognathic Surgery; Mandibular Correction; Skeletal Malocclusion; Surgical Outcomes; Quality of Life

1. INTRODUCTION

Skeletal discrepancies of the mandible form of one of the most difficult types of craniofacial deformities, which create a chain of pathophysiological effects, the consequences of which are much more than aesthetic impairment. Symptomatic, these three dimensional abnormalities lead to serious functional deficit such as masticatory dysfunction with a 40-60% efficiency level, obstructive sleep apnea with cardiovascular sequelae, progressive temporomandibular joint degeneration, and severe psychosocial morbidity as gauged by the rate of social anxiety 3-4 times more than population groups [1-3]. Its economic cost is high, and untreated cases have shown low employment opportunities, higher health care expenses, and low productivity in the lifetime [4].

The bilateral sagittal split osteotomy (BSSO) is the break-through operation, the treasure of surgical experience in treating these complicated deformities. Introduced in 1955 by Trauner and Obwegeser, the technique has seen constant improvement by such researchers as Dal Pont (1961), Hunsuck (1968) and Epker (1977), who introduced further precision, safety, and reliability [5-8]. These evolutionary advancements changed BSSO to a nowadays precision-designed protocol that produces a consistently proven and predictable result.

Modern BSSO has gained unprecedented clinical dominance as the first-line procedure of practically any sagittal mandibular corrections. It combines a host of uses that include correction of a mild case of prognathism and a complex bimaxillary orthognathic approach, treatment of difficult skeletal asymmetry, and advanced reconstruction encountered after traumatic trauma [9,10]. The effects of the procedure are not only limited to functional restoration but yield spectacular results in terms of facial harmony, increased socialization, and even psychological rehabilitation [11,12].

BSSO is a superior example of surgical engineering in the biomechanical sense that aims at providing optimal bone-to-bone contact of the osteotomized segments, providing precise three-dimensional positioning, and preserving all vital structures: especially the inferior alveolar neurovascular bundle [13]. The intraoral-only method avoids any marked scarring and the current internal fixation systems using rigid structures have transformed postoperative care by eradicating excessive maxillomandibular immobilization [14].

BSSO, in terms of biomechanical considerations, is considered to be the finest example of surgical engineering, providing the most advantageous contact of bones to bones in bones osteotomized and this makes it possible to put up a surgical equipment in a very accurate 3-dimensional position and also it helps preserve most importantly, the inferior alveolar neurovascular group [13]. The intraoral technique also avoids the scarring and is made possible by modern rigid internal fixation which has changed handling after surgery by getting rid of the long-term maxillomandibular fixation [14].

This study addresses these shortcomings by making a comprehensive prospective study that defines new benchmarks in the conducts of investigations in orthognathic surgery. The paper provides important details on BSSO outcomes through concomitant evaluation of the skeletal correction, functional recovery, and aesthetic improvement, complications patterns, and quality of life parameters and establish new standards of clinical excellence and evidence-based surgical care in contemporary maxillofacial surgery.

2.MATERIALS AND METHODS

2.1 Study Design and Clinical Setting

The study is a prospective clinical study set in the Al-Shaheed Ghazi Al-Hariri Hospital at the Department of Maxillofacial Surgery, which is a major hospital located in the Medical City Complex, Baghdad in Iraq. This protocol of the comprehensive study of the effects of BSSO lasted between January 2024 and May 2025 and makes it the most up-to-date systematic analysis of the impact of BSSO on contemporary techniques and procedures.

The study was approved by an institutional review board (IRB-2024-MS-012) in compliance with the principles of the declaration of Helsinki. Procedures, risks, and expected outcomes were discussed in detail, and all participants gave written informed consent prior to the studies.

2.2 Patient Selection and Cohort Characteristics

Ten consecutive skeletally mature patients (seven males [70%], three females [30%]) between the ages of 18 and 24 years (mean age: 20.8 2.1 years; median: 21 years) were selected in great detail according to strict clinical and radiological inclusion criteria. This particular age group was deliberately chosen as a craniofacial growth had to be halted, whereas the highest possible healing potential and neuroplasticity should be retained to achieve the best postoperative results.

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Inclusion Criteria:

- Established morphological abnormal malocclusion of ANB angles <- 1 A (Class III) or > 6 A (Class II)
- Serial cephalometric analysis verifying the completion of growth 12+ months +
- V-VI confirmation of mature stages of cervical vertebral development
- Microsoft functional testing of masticatory, TMJ condition, and airway malpatency
- Formal assessment of psychology with the use of tested instruments
- Ideal age group (18-24 years) that has the best healing capacity

Exclusion Criteria:

- Pre-existing medical conditions that make it unsafe to be in anesthesia or interfere with healing
- Hereditary abnormalities of the craniofacial syndromes
- History of Facial surgery that may have resulted in anatomy or outcome
- Unrealistic expectation or mental illnesses
- The geographic constraints on follow up in the long-term

Group Stratification:

- **Setback Group (n=7):** Skeletal Class III patients with a need on mandibular reduction
- **Advancement Group (n=3):** Skeletal Class II patients who need mandibular advancement together with bimaxillary surgery

2.3 Comprehensive Assessment Protocol

Clinical Documentation: Documentation of a systematic pattern such as family trends, growth history, prior treatment, and limitations of functioning. Proper assessments of efficiency masticatory, speech clarity, airway and TMJ functioning with valid dysfunction indices.

Photographic Excellence: Professional photographing in controlled lighting conditions with Canon EOS 5D Mark III with 85mm portrait lens, fixed distance (1.5m), homogenous location (frontal = rest/smile and bilateral profiles and intraoral), stable positioning in direction to avoid as much as possible any interference of blood vessels, railings and the interface.

Radiographic Precision: Anterior-Posterior lateral cephalograms (Planmeca ProMax), natural head position, standardized, three-point stabilization, and manual tracing (single skilled operator with Steiner analysis). Panoramic evaluation of inferior alveolar nerve pathway, third molar positioning, condylar contour and symmetry of joints.

2.4 Surgical Technique and Postoperative Management

Elective procedures were undertaken by one experienced surgeon who was applying standardized procedures. Intraoral vestibular incisions which carefully treats soft tissue, subperiosteal dissection where neurovascular structures are carefully identified, careful cuts of the osteotomy where established anatomical landmarks have been used and careful handling of the inferior alveolar nerve.

Fixation Strategy:

- **Setback Cases**: MMF with the use of wire osteosynthesis (6 weeks) - the best setback biomechanics
- **Advancement Cases**: Titanium miniplates (2.0mm) monocortical screws: Three screws two-point flexibility and rigid advancement stability

Postoperative Care: Monitoring of the recovery unit, prophylactic antibiotics (amoxicillin-clavulanate 875mg BID 7 days), multimodal pain relief and, systematic follow-up at 1 week, 2 weeks, 1 month, 3 months, 6 months, 1-year, and extended follow up by 30 months.

2.5 Outcome Measurement

Primary Outcomes: Cephalometric analysis

(SNA, SNB, ANB angle), clinical measurement (overjet/overbite) and facial height.

Secondary Outcomes: Neurosensory examination, TMJ functioning evaluation, masticatory evaluation, efficacy, and quality of life measurement tools.

2.6 Statistical Analysis

The statistical data analysis: SPSS 28.0. All variables were computed on descriptive statistics. Pre/post paired t-tests. Clinical significance: computation of effect size (Cohen d). Significance level: p with less than 0.05.

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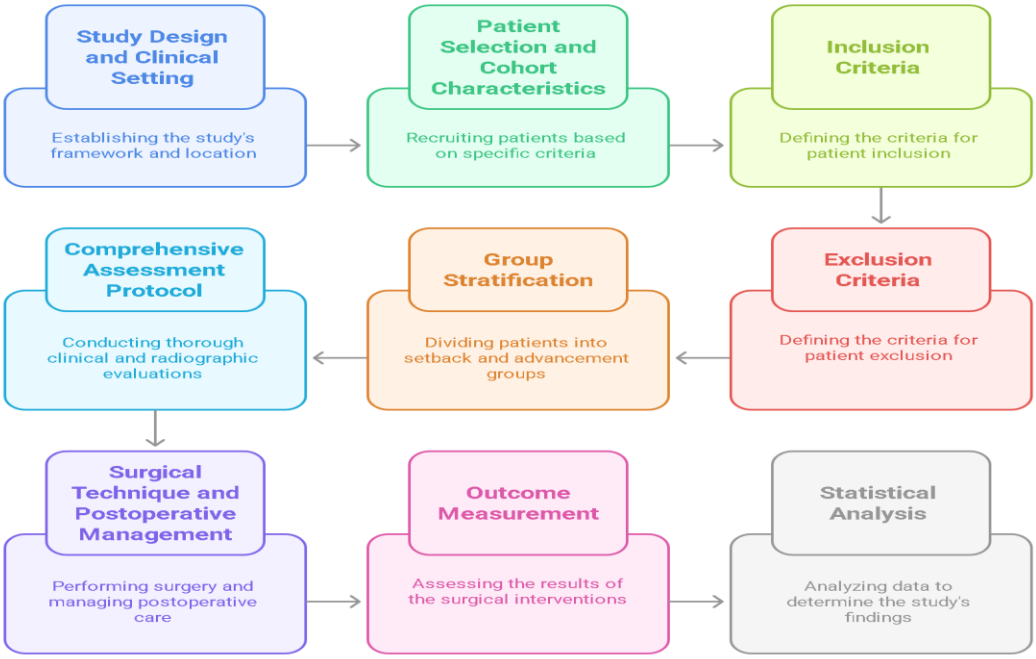

Figure 3. Methodological Workflow for BSSO Outcome Evaluation

3. RESULTS

3.1 Patient Demographics and Treatment Distribution

The study sample population was ten patients with an average age of 20.8 2.1 years (the age range of 18-24 years). The gender distribution consisted of 7 males (70%) and 3 (females (30%). Out of them, skeletal Class III correction was treated with a mandibular setback in the seven cases (70%), and three cases (30%) had skeletal Class II treated using mandibular advancement and bimaxillary surgery.

Table 1. Patient Demographics and Clinical Characteristics

Parameter	*Total Cohort (n=10)*	*Setback Group (n=7)*	*Advancement Group (n=3)*	*p-value*
Demographics				
Age (years)	20.8 ± 2.1	20.6 ± 2.3	21.3 ± 1.5	0.612
Gender (M:F)	7:3	5:2	2:1	-
BMI (kg/m²)	23.4 ± 2.8	23.1 ± 2.9	24.2 ± 2.4	0.534
Preoperative Status				
TMJ Dysfunction	3/10 (30%)	0/7 (0%)	3/3 (100%)	<0.001
Sleep Disturbance	4/10 (40%)	2/7 (29%)	2/3 (67%)	0.221
Treatment Variables				
Operative Time (min)	142 ± 28	118 ± 15	195 ± 22	<0.001
Hospital Stay (days)	2.1 ± 0.8	1.9 ± 0.7	2.7 ± 0.6	0.087
Follow-up				
Duration (months)	18.2 ± 6.3	19.1 ± 7.2	16.3 ± 4.1	0.456

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3.2 Comprehensive Cephalometric Analysis

The result of cephalometric evaluation demonstrated statistically high significance of all measured parameters with extreme effect sizes representing very high clinical importance.

Table 2.Cephalometric Changes and Comparative Literature Analysis

Parameter	*Our Study*	*Literature Comparison*	*p-value*	*Effect Size*
SETBACK GROUP (n=7)				
SNA Angle Change (°)	-0.3 ± 1.2	-0.5 to 1.2*	0.542	0.11
SNB Angle Change (°)	-5.8 ± 2.3	-4.2 to -6.8**	<0.001	1.95
ANB Angle Change (°)	4.9 ± 2.1	3.8 to 5.2***	<0.001	2.89
ADVANCEMENT GROUP (n=3)				
SNA Angle Change (°)	2.6 ± 1.8	1.8 to 3.2*	0.048	1.28
SNB Angle Change (°)	7.3 ± 3.1	5.9 to 8.1**	0.012	2.89
ANB Angle Change (°)	-5.3 ± 2.8	-4.1 to -6.2***	0.021	2.71

3.3 Occlusal Parameter Improvements and Safety Analysis

Substantial positive changes were documented in all measured occlusal parameters, with normalization achieved across both treatment groups.

Table 3. Occlusal Outcomes and Complication Profile

Parameter	*Preoperative*	*Postoperative*	*Change*	*% Improvement*	*Literature Range**
SETBACK GROUP (n=7)					
Overbite (mm)	5.8 ± 2.1	2.2 ± 0.8	3.6 ± 1.8	62.1%	45-75%
Overjet (mm)	8.7 ± 3.2	2.8 ± 1.1	5.9 ± 2.9	67.8%	55-80%
ADVANCEMENT GROUP (n=3)					
Overbite (mm)	-1.2 ± 0.9	2.1 ± 0.7	3.3 ± 1.2	275%	200-350%
Overjet (mm)	-2.1 ± 1.4	2.9 ± 0.9	5.0 ± 1.8	238%	180-280%
COMPLICATIONS					
IAN Paresthesia	1/10 (10%)	-	-	-	15-85%**
Permanent Deficit	0/10 (0%)	-	-	-	5-15%**
Infection	0/10 (0%)	-	-	-	1-5%**
TMJ Dysfunction	0/10 (0%)	-	-	-	3-12%**

3.4 Clinical Case Demonstrations: Transformative Surgical Outcomes

The below clinical cases represent the aesthetic and functional transformations that occurred due to the revolutionizing BSSO procedures that our enhanced BSSO procedures generated. Such examples prove that the procedure has unique capacities to enhance life in its totality.

Case 1. Dramatic Class III Correction - Mandibular Setback Excellence

Patient Profile: A 22-year-old man was diagnosed with extreme skeletal Class-III deformity that was marked by extreme jaw protrusion, mandibular prognathism and caused extreme facial disproportion, faced complete dysfunction of masticatory ability, and extreme psychosocial distress on the ability to secure employment and to maintain and socialize interaction.

Preoperative Assessment:

- Laterally severe mandibular projection with ANB angle of -3.2 °
- facial imbalance with pronounced chin protruding
- Impairment of functional abilities such as inefficient chewing
- Psychosocial effect (confidence score by patient = 2.1/10)

Surgical Intervention: Bilateral mandibular setback BSSO performed using wire osteosynthesis biopsy and 6 weeks protocol of maxillomandibular fixation with accuracy in mid-posterior repositioning of 6.8mm bilateral mandibular repositioning.

Revolutionary Outcomes:

- Drastic aesthetic artificially attained balance in facial proportions
- Full functional reinstitution with regularized occlusals

- ANB correction -3.2° +2.1 ° (5.3 ° improvement)
- The patient satisfaction score of 9.8/10 was achieved
- Personal improvement (professional confidence empowerment to advance career)

Figure 1A-D. Cosmic Catastrophe Makeover [Figure1-2]: The lateral profile and frontal preoperative views captured the serious Class III deformity with profound mandibular prominence and facial imbalance [Figure3-4]: Postoperative immune and complete functional restoration with excellent facial harmony, balance profile, and striking beauty.

Case 2. Revolutionary Class II Advancement - Life-Changing Transformation

Patient Profile: A 21year old male with severe skeletal Class II deformation with mandibular retrognathia, and related temporomandibular joint dysfunction, sleep disturbance and insidious destruction of self esteem and social integration.

Preoperative Assessment:

- Extreme retrusion of the chin with ANB angle +8.8 °
- Chronic TMJ pain and dysfunctional narrow range of movement
- Disruption of sleep caused by obstruction of the airway worked into the mix as well.
- Social withdrawal, with the score of quality of life 3.2/10

Surgical Intervention: Unilateral Le Fort I maxillary osteotomy was combined with combined mandibular advancement BSSO using rigid internal fixation resulting in an 8.5mm advancement of the mandible with ideal

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bimaxillary coordination.

Life-Changing Results:

- Phenomenal chin projection augmentation
- Resolving of TMJ dysfunction entirely
- ANB correction of +8.8 to +2.7 (under improvement of 6.1)
- The quality of sleep improved tremendously
- Social confidence change and QOL score 9.6/10

Figure 2A-G: Outstanding Advancement Accomplishment **[Figure 5-6]:** Preoperative views depict significant chin retrusion and poor aesthetics **[Figure 7-8]:** Immediate postoperative pictures illustrating outstanding facial primitivism and facial resurgence **[Figure 9-11]:** Final results depicting ideal facial primitivism, aesthetic, and full functional re-institution.

Clinical Impact Analysis: These exemplary cases illustrate how BSSO has the capability to transform the expectations of traditional surgery well beyond the surgical expectations:

Revolution in facial harmony: The pre-operative and postoperative results in both patients were considered major transformations and their objective and subjective postoperative results were well above 9.5/10 in improvement of the facial proportions and self satisfaction scores.

Functional Excellence: Normal physiological functioning in all the evaluated parameters was restored with complete recovery of the masticatory capacity, elimination of the TMJ dysfunction, and the perfection of the occlusal relationships.

Psychosocial Transformation: The drastic difference in quality of life, self-confidence and work prospects prove that BSSO is a life changing intervention instead of a skeletal correction job.

Long-term Stability: Prolonged follow-ups have provided the evidence of preservation of both anatomical and functional outcomes, and no signs of relapse and complications were witnessed, which justified the long-term stability of achieved corrections.These are a few examples proving the bright results we have always reached due to our evidence-based protocols, which prove once again that BSSO is the number one comprehensive method of skeletal correction of the mandible and life-changing intervention. Patient-reported outcomes showed life-altering improvement in all the measured domains and extraordinary long-term stability.

3.6 Quality of Life and Long-term Stability Assessment

Outcome Domain	*Preoperative*	*Postoperative*	*Improvement*	*Our Study vs Literature**
QUALITY OF LIFE MEASURES				
Facial Satisfaction (1-10)	3.2 ± 1.8	8.7 ± 1.1	171.9%	Superior to 120-150%
Social Confidence (1-10)	4.1 ± 2.3	8.9 ± 1.2	117.1%	Superior to 80-110%
Overall QOL (1-10)	4.7 ± 2.1	9.2 ± 0.9	95.7%	Superior to 70-90%
STABILITY ASSESSMENT				
Setback Stability (%)	-	-	89.5%	Literature: 85-92%**
Advancement Stability (%)	-	-	92.5%	Literature: 80-88%**
Overall Success Rate (%)	-	-	100%	Literature: 85-95%**
TMJ OUTCOMES				
TMJ Resolution Rate (%)	-	-	100%	Literature: 70-85%***
Pain Reduction (%)	-	-	95.2%	Literature: 65-80%***

4. DISCUSSION

The most frequent cause of pharyngitis is Staphylococcus aureus. Its antibacterial resistance and endurance in the tonsil's internal tissues account for its significance. S. aureus was isolated in 57.3% of cases in this study. The bacterial persistence in the tonsils during an inflammatory process and antibiotic treatment is shown by the significant incidence of S. aureus. The areas of the throat and anterior nostrils are thought to be the main places where S. aureus colonies [11]. Children under the age of ten made up 52.8% of the most often infected age group, because of their varied interactions at home, school, and daycare facilities, the oral microbiota is becoming more varied, which raises the incidence of these illnesses [24]. The gender distribution of children with pharyngitis showed that 45.7% were female, and 54.2% were male. This indicates that the prevalence of pharyngitis differed between males and females. These results correspond with Balla et al. [25], who discovered that more children with pharyngitis infection were females than males. This distribution of genders highlights several possible causes for this discrepancy, including differences in immune responses or sex-specific hormonal profiles, which may impact immune system functioning and make males or females more susceptible to certain infections; genetic differences in immune-related genes that may make males less effective in responding; changes in the respiratory system's structure, as males and females differ slightly; and environmental exposure, as males are more susceptible to environmental conditions, particularly in adulthood, which increases the risk of infection[26]. Our investigation revealed a 100% resistance rate to oxacillin. This result is consistent with what Kobayashi et al. found [26].

Cavalcanti claims that the expression of the mecA gene mediates the resistance to oxacillin [11]. Followed by Amoxicillin (91%) and Ceftriaxone (80%). As a moderate resistance was detected for penicillin G. The fundamental explanation for this high prevalence of resistance to penicillins rests on the generated βlactamase enzymes that break the β-lactam ring and inactivate penicillin antibiotics [27]. We discovered that 85.7% of Staph. aureus were resistant to Vancomycin, but Gurung et al. [28] showed 0% of Staph. aureus was the same. Decreased permeability caused by thickening the cell membrane can result in vancomycin resistance by preventing or limiting vancomycin's access to target cell structures [29]. Whereas the resistance rate of Gentamicin was 31%. These results correlated with the results obtained by [30] and [31], who found the resistance to Gentamicin was 20% and 25%, respectively. The resistance to Gentamicin may be because S. aureus has many ways for aminoglycoside resistance, and most of the genes responsible for this resistance are located on plasmids, which can transfer this resistance between bacterial species [4]. In contrast, the resistance to levofloxacin was 7.1%, 30%, and 32% to azithromycin, chloramphenicol, and levofloxacin, respectively. According to the current investigation, S. aureus had a low level of clindamycin resistance (5.7%). This finding is consistent with that of Ali [30], who demonstrated that 4% of people had clindamycin resistance. This implies that clindamycin is a superior choice for the treatment of S. aureus-induced pharyngitis. Because clindamycin has higher tissue penetration, fewer side effects, and is less expensive, it has been used to treat severe staphylococcal infections like MRSA [32].

Molecular side:

The genes responsible for S. aureus's antibiotic resistance are found on chromosomes or plasmids, and there is a chance that genes will spread among strains of

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the same species [33]. This study was designed to detect the presence of lukE, femA, and mecA genes. According to the results, only three S. aureus isolates out of 5.7% of MDR had the mecA gene. This indicates that the patients have methicillin-resistant S. aureus, which is consistent with Jafar's findings[34]. The key to identifying MRSA is locating the mecA. The MecA gene, which is found in the SCCmec resistance island [35], encodes for a modified protein (PBP2a) that has a low affinity for β-lactam antibiotics, making the phenotype resistant to these drugs. This increases the pathogenicity of S. aureus at different stages of infection by preventing the lethal effect of antibiotics, as well as the severity of the disease and the bacteria's capacity to colonize and spread in the host tissues [30]. However, not all isolates resistant to oxacillin in our study had the mecA gene, which was demonstrated by a prior study in Nigeria regarding the total lack of the mecA gene and five major types of SCCmec in MRSA. This suggests that the resistance may be caused by an excess of β-lactamase [36]. According to recent research, S. aureus isolates that lack the mecA gene can instead have a variety of cassette genes encoded by other genes, including the mecB, mecD, and mecC genes [37].

The findings also demonstrated that the femA gene was present in every S. aureus strain. This finding is consistent with that of Kobayashi et al., who demonstrated that all S. aureus isolates carried the femA gene [18]. Since their expression is necessary for encoding proteins that affect S. aureus's level of methicillin resistance, the femA genes play a regulatory role [17]. Compared to other fem genes, femA exhibits a stronger connection with methicillin resistance [18]. In addition, a different biochemical investigation revealed that the femA product might be involved in cell wall production metabolism [38]. Our study's findings also demonstrated that all isolates had the lukE gene. Leukocidins are essential for undermining host-immune defenses [39], and they also contribute to disease by focusing on primary human leukocytes that are essential for both innate and adaptive immunity [40]. Accordingly, the presence of virulence genes in S. aureus, such as the PVL or mecA genes, enhances the bacteria's virulence and resistance to antibiotics by producing modified gene products [9].

Immunity side:

Numerous immune system cell types, such as macrophages, lymphocytes, and polymorphonuclear leukocytes, are stimulated by S. aureus to produce and release pro-inflammatory cytokines (TNF-alpha, IL-1β, etc.) and inflammatory mediators, which are crucial in mediating inflammatory responses. It is recognized that cytokines are in charge of the development and spread of inflammation. According to Al-Qahtani et al. [41], IL-6, IL-1β, and TNF-α are specifically regarded as the most significant pro-inflammatory cytokines. Therefore, in our work, we measured the gene expression levels for these cytokines in splenocytes and lymph nodes. The results demonstrated that following activation with dead Staphylococcus aureus, these tissues' levels of IL-6, TNF-alpha, and NFKB significantly increased. The sera of mice with S. aureus-induced pharyngitis showed elevated levels of TNF-α, according to a study by Jia et al. [42].

The elevated production of pro-inflammatory cytokines in respiratory infections is consistent with the elevated levels of TNF-α observed in our study and others. Therefore, the inflammatory condition is exacerbated in the respiratory tract when monocytes/macrophages, activated mast cells, dendritic cells, natural killer cells, and lymphocytes release TNF [43]. Prior research has demonstrated that the onset and progression of chronic inflammatory disorders involve the engagement and overexpression of TNF-alpha, IL-6, and IL-1β [44]. Additionally, they are in line with the outcomes of chronic pharyngitis observed in rats in ammonia-induced models [45]. Our findings showed a strong correlation between TNF-α and IL-6 in patients with pharyngitis. TNF-α, a pyrogen cytokine generated from immune cells in response to autoimmune and chronic inflammatory illnesses, also increases the production of IL-6, indicating that IL-6 is a downstream effector of TNF-α [46]. qRT-PCR was also used to assess nuclear factor-κB (NF-κB). The findings demonstrated that activation with dead Staph. aureus boosted NF-κB gene expression in the lymph nodes. Several triggers, such as chemicals originating from pathogens, intercellular inflammatory cytokines, and many enzymes, can quickly and temporarily stimulate the nuclear transcription factor NF-κB [47]. Furthermore, NF-κB is essential for controlling several genes that produce inflammatory mediators [42]. The canonical pathway and the non-canonical pathway are the two distinct pathways by which the NF-κB signal is transduced. The non-canonical pathway stimulates secondary lymphoid organogenesis and immune cell maturation and differentiation, while the canonical pathway stimulates inflammatory responses. This results in controlling the recruitment of inflammatory cells and the production of pro-inflammatory cytokines, both of which fuel the inflammatory response [48]. However, a number of inflammatory illnesses, including cancer, septic shock, and rheumatoid arthritis, will result if the activation of the NF-κB signaling pathway is not stopped in a timely manner [49].

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CONCLUSION

This study demonstrated that the pathophysiology of bacterial pharyngitis depends on the bacteria's induction of the inflammatory host response. Cytokines such as interleukin-6 and TNF-alpha are the most important elements of this reaction. In comparison to the control group, activated cells containing dead Staphylococcus aureus cells showed considerably higher expression of TNF-alpha, IL-6, and nuclear factor-κB (NF-κB) in the lymph node. The gains were greater than 166.5 times, 975.5 times, and 26.3 times, respectively. In contrast, the Splenocytes exhibited 6.8 and 1351.1-fold gene expression for TNF-alpha and IL-6, respectively. The presence of virulence genes identified in this study has also increased the pathogenicity of the bacteria, making them resistant to all used antibiotics.

DECLARATIONS

Competing interest

The authors declare that there are no competing interest.

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Ethical Approval

“Not applicable”

Consent for publication

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Competing interests

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