Understanding and managing inflammation: A holistic approach to health

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Abstract

Inflammation is a fundamental biological response to injury or infection, aiming to eliminate the cause, clear debris, and initiate repair. Characterized by redness, heat, swelling, and pain, it involves the recognition of harmful stimuli, release of mediators, immune cell migration, and resolution. Chronic inflammation, however, can damage tissues. Management involves lifestyle modifications like an anti-inflammatory diet, exercise, stress management, and adequate sleep, often complemented by medications (NSAIDs, corticosteroids, DMARDs). Natural remedies like turmeric, ginger, and omega-3 fatty acids may also help. A holistic, personalized approach involving healthcare professionals is crucial for effective inflammation management and overall well-being.

Keywords: Inflammation, nonsteroidal anti-inflammatory drugs (NSAIDs), natural remedies

1. Introduction

Inflammation, a fundamental biological defense, arises in response to tissue injury, infection, or irritation. This intricate process involves the immune system, vascular changes, and diverse molecular signals. The main aim of inflammation is to remove the agent causing the initial cellular damage due to pathogens like bacteria or viruses, damaged cells, or irritants, to remove debris from the initial damage, and to initiate tissue repair (1).

Historically, the classic signs of inflammation, first described by the Roman encyclopedist Celsus, are: (2)

- **Redness (Rubor):** An increase in blood flow to the injured tissue leads to the visible redness called rubor
- **Heat (Calor):** The elevated blood flow contributes to the warmth felt at the inflamed area.
- **Swelling (Tumor):** Fluid leaks from the blood vessels into the surrounding tissues.
- **Pain (Dolor):** The release of certain chemicals stimulates nerve endings, causing pain.

2. Inflammation cascade

A holistic approach is crucial in managing inflammation because it recognizes that inflammation isn't just a localized issue but is deeply interconnected with various aspects of your overall health and lifestyle. Addressing inflammation effectively requires looking beyond just treating symptoms with medication and considering the whole person. Inflammation is characterized by a cascade of biological events involving:

2.1. **Recognition of harmful stimuli:** This could be pathogens, damaged cells, or irritants. Specialized receptors on immune cells recognize these threats (3,4).
2.2. **Release of inflammatory mediators:** Cells release substances like histamine, cytokines, and chemokines. These molecules cause blood vessels to widen, become leakier, and draw immune cells to the location of the injury (5).
2.3. **Migration of immune cells:** Neutrophils and macrophages, types of white blood cells, travel to the inflamed area to eliminate the cause of the harm and remove cellular waste (6).
2.4. **Resolution of inflammation:** Ideally, the inflammatory response subsides once the threat is eliminated, and the tissue begins to heal. The resolution phase involves the creation of anti-inflammatory signals and the elimination of immune cells from the site (7).

Chronic inflammation occurs when this process fails to resolve, leading to persistent inflammation that can damage healthy tissues.

3. Management strategies

Management of inflammation can involve various approaches, depending on whether it's acute or chronic and its underlying cause. For both acute and chronic inflammation, certain lifestyle changes can play a significant role (Table 1).

Table 1. Lifestyle modification and management (8-11)

Lifestyle modification	Management
Anti-inflammatory diet	Choosing a diet that emphasizes fruits, vegetables, whole grains, legumes, and healthy fats, notably omega-3 fatty acids from sources like fatty fish, flaxseeds, and walnuts, can be beneficial in mitigating inflammation. Limiting processed foods, refined sugars, unhealthy fats, and red meat is also beneficial
Regular exercise	Regular exercise generally reduces chronic, low-grade inflammation in the long term
Weight management	Obesity is associated with increased inflammation, so maintaining a healthy weight is crucial.
Stress management	Utilizing techniques like mindfulness, yoga, or meditation to mitigate the inflammatory effects of chronic stress.
Smoking cessation	Smoking is a key factor in causing inflammation in the body
Adequate sleep	Prioritizing quality sleep to support the body's natural anti-inflammatory processes.
Hydration	Ensuring sufficient water intake for optimal bodily functions
Gut health	Recognizing the crucial role of the gut microbiome in inflammation and supporting it through diet and potentially probiotics
Mind-body practices	Examining the possible benefits of acupuncture, massage, or chiropractic care in managing inflammation and pain.
Environmental considerations	Minimizing exposure to environmental toxins that can contribute to inflammation.

3.1. Anti-inflammatory diet

Limiting processed foods, refined sugars, unhealthy fats, and red meat is also beneficial.

3.1.1. Increase omega-3 fatty acids: abundant in fatty fish (like salmon, mackerel, and sardines), flaxseeds, chia seeds, and walnuts, possess significant anti-inflammatory properties. They contribute to a healthier balance of fatty acids in the body, thereby reducing the production of molecules that promote inflammation (12).

3.1.2. Fruits and vegetables: A generous intake of fruits and vegetables provides a wealth of antioxidants, vitamins, and polyphenols that fight oxidative stress and inflammation. Focus on incorporating a variety of colorful fruits like berries, cherries, and oranges, as well as vegetables such as leafy greens, broccoli, and bell peppers.

3.1.3. Whole grains: Option for whole grains such as oats, brown rice, and quinoa instead of refined grains like white bread and pasta. Whole grains are rich in fiber, which can aid in stabilizing blood sugar levels and decreasing inflammation (13).

3.1.4. Healthy fats: Use olive oil and avocado oil as primary cooking fats. They contain oleic acid, which has anti-inflammatory properties (14).

3.1.5. Lean protein sources: fish, poultry, beans, and lentils over red and processed meats, which can promote inflammation (15).

3.1.6. Anti-inflammatory spices: Incorporate spices like turmeric (containing curcumin), ginger, and cinnamon into your cooking. It has been observed that these have effects that counteract inflammation (16).

3.1.7. Limit pro-inflammatory foods: Reduce or eliminate processed foods, sugary drinks, refined carbohydrates, fried foods, and excessive amounts of saturated and trans fats.

3.2. Regular exercise

Moderate physical activity can help reduce inflammation over time. Regular exercise generally reduces chronic, low-grade inflammation in the long term. While a single intense workout can temporarily increase inflammatory markers, consistent moderate activity has the opposite effect such as:

3.2.1. Improving insulin sensitivity: Reducing inflammatory pathways linked to insulin resistance.

3.2.2. Promoting a healthy weight: Decreasing pro-inflammatory visceral fat.

3.2.3. Releasing anti-inflammatory cytokines (myokines): These substances counteract inflammatory processes.

3.2.4. Improving immune regulation: Helping the immune system function more effectively.

4. Medications

When lifestyle modifications aren't sufficient to manage inflammation, various medications are available. The choice of medication depends on the type, severity, and location of the inflammation, as well as the individual's overall health. An overview of common medication classes used in inflammation management is mentioned in Table 2.

Table 2. Medications used in inflammation management (17-21)

Medications	Types	Common uses	Potential side effects
Nonsteroidal Anti-inflammatory Drugs(NSAIDs)	**Over the counter (OTC):** Aspirin (Bayer, Ecotrin), Naproxen (Aleve), Ibuprofen (Advil, Motrin) **Prescription**: Diclofenac (Voltaren, Cataflam),Meloxicam (Mobic), Celecoxib (Celebrex) - a COX-2 selective inhibitor, Indomethacin (Indocin), Ketorolac (Toradol)	Arthritis (osteoarthritis, rheumatoid arthritis), Muscle aches and sprains, Back pain, Menstrual cramps, Headaches, Fever	• Gastrointestinal issues (stomach pain, heartburn, ulcers, bleeding) • Long-term use, or use in individuals with existing heart problems, may elevate the risk of heart attack or stroke • Kidney problems • Increased bleeding risk • Fluid retention and swelling.

Corticosteroids	**Oral**: Prednisone, Dexamethasone, Methylprednisolone **Injectable**: Triamcinolone, Betamethasone **Topical**: Hydrocortisone cream **Inhaled:** Budesonide, Fluticasone (used primarily for respiratory conditions like asthma) **Nasal sprays**: Fluticasone, Budesonide (used for allergic rhinitis) **Eye drops:** Prednisolone acetate (used for eye inflammation)	Autoimmune diseases (e.g., lupus, rheumatoid arthritis), Skin conditions (e.g., eczema, psoriasis), Joint and muscle inflammation, Asthma and allergies, Organ transplant rejection prevention, Inflammatory bowel disease (IBD)	• Weight gain • Increased risk of infections • Increased appetite • High blood pressure • Increase blood sugar levels • Osteoporosis (thinning of bones) • Skin thinning and bruising • Mood changes • Cataracts and glaucoma • Sleep disturbances
Disease-modifying antirheumatic drugs (DMARDs)	**Conventional synthetic DMARDs (csDMARDs):** Sulfasalazine, Hydroxychloroquine, Leflunomide, Methotrexate **Targeted synthetic DMARDs (tsDMARDs):** JAK inhibitors (e.g.,Tofacitinib, Baricitinib, Upadacitinib) **Biologic DMARDs (bDMARDs):** TNF inhibitors (e.g.,Infliximab, Adalimumab, Etanercept), Interleukin inhibitors (e.g., Tocilizumab, Secukinumab), B-cell depleters (e.g.,Rituximab), T-cell costimulation inhibitors (e.g., Abatacept)	Ankylosing spondylitis, Rheumatoid arthritis, Inflammatory bowel disease (certain types), Psoriatic arthritis, Lupus	• Increased risk of infections • Liver problems • Blood disorders • Skin reactions • Gastrointestinal issues
Other medications	• **Antihistamines:** To reduce inflammation associated with allergic reactions. • **Mast cell stabilizers:** Also used for allergy-related inflammation. • **Colchicine:** Used to treat gout flares, an inflammatory condition caused by uric acid crystal buildup. • **Specific biologics:** For conditions like Crohn's disease and ulcerative colitis that target specific inflammatory pathways.		

5. Natural Remedies and Supplements

Some natural substances have anti-inflammatory properties, but it's essential to discuss their use with a healthcare professional. Certain herbs have demonstrated anti-inflammatory effects.

5.1. Turmeric (Curcumin): Turmeric, containing the active compound curcumin, is a powerful anti-inflammatory and antioxidant agent. Black pepper can enhance its absorption. Beyond the basics, curcumin's anti-inflammatory effects are attributed to its ability to interact with numerous molecular targets involved in inflammation (22).

5.2. Ginger: It contains gingerol, a compound known for its anti-inflammatory and antioxidant effects. Beyond gingerols, ginger contains other beneficial compounds like shogaols, paradols, and zingerone, which also contribute to its medicinal properties. Shogaols, which tend to be more concentrated in dried ginger, can also demonstrate strong anti-inflammatory and antioxidant effects (23).

5.3. Green Tea: Green tea is rich in EGCG, an antioxidant that also has anti-inflammatory properties. Epigallocatechin gallate (EGCG) is the most prevalent and potent catechin found in green tea, but other catechins such as epicatechin (EC), epigallocatechin (EGC), and epicatechin gallate (ECG) also contribute to its beneficial effects on health (24).

5.4. Boswellia (Indian Frankincense): May inhibit pro-inflammatory cytokines. Boswellia has been a staple in Ayurvedic medicine for centuries, used to treat arthritis, asthma, skin conditions, and inflammatory bowel disease (25).

5.5. Cat's claw: Indigenous people of the Amazon rainforest have used cat's claw for centuries for a wide array of health issues, including inflammation for conditions like arthritis and other inflammatory disorders (26).

5.6. Devil's claw: Contains iridoid glycosides, notably harpagoside, which are believed to be the source of its anti-inflammatory and pain-relieving properties. Its mechanism of action may involve blocking the production of pro-inflammatory cytokines and prostaglandins. Primarily used for osteoarthritis, back pain, and general pain relief (27).

5.7. Holy basil: Contains compounds such as eugenol, rosmarinic acid, and caryophyllene, which have shown both antioxidant and anti-inflammatory effects. Additionally, it's classified as an adaptogen, meaning it may help the body manage stress, potentially leading to an indirect reduction in inflammation. Research indicates possible benefits for arthritis and other inflammatory conditions (28).

5.8. Rosemary: Is rich in rosmarinic acid and carnosic acid, potent antioxidants that can also inhibit inflammatory enzymes like COX-2 and reduce the production of pro-inflammatory cytokines. Traditionally used for pain relief and cognitive function. Rosemary extract is being studied for its potential in various inflammatory conditions (29).

6. Conclusion

In conclusion, addressing inflammation effectively involves a comprehensive strategy tailored to the individual. Managing inflammation often involves making lifestyle changes such as adjusting one's diet to include more anti-inflammatory foods, engaging in regular exercise, practicing stress management techniques, and prioritizing sufficient sleep. When needed, these lifestyle adjustments are supported by suitable medical treatments, which can include over-the-counter pain medications and anti-inflammatory drugs, as well as prescription medications that target specific inflammatory processes. Crucially, understanding the specific type of inflammation, identifying its underlying cause, and considering individual health factors are paramount in developing a personalized management plan. Therefore, consulting with healthcare professionals is essential for accurate diagnosis, determining the root cause of the inflammation, and receiving expert guidance on the most suitable and safe management strategies. A collaborative approach between the individual and their healthcare team ensures the most effective and sustainable outcomes in managing inflammation and promoting overall well-being.

References

1.Oronsky B, Caroen S, Reid T. What exactly is inflammation (and what is it not?). IJMS. 2022;23(23):14905.
2.Finlay AY, Griffiths TW, Belmo S, Chowdhury MM. Why we should abandon the misused descriptor 'erythema'. Br. J. Dermatol. 2021;185(6):1240.
3.Gusev E, Zhuravleva Y. Inflammation: A new look at an old problem. Int.J.Mol.Sci. 2022 ;23(9):4596..
4.Wijesekara T, Luo J, Xu B. Critical review on anti-inflammation effects of saponins and their molecular mechanisms. Phytother Res. 2024;38(4):2007-22.
5.Alkhatib AJ. The Role of Adult Stem Cells in Tissue Healing and Therapeutic Applications. PSM Microbiology. 2024;9(3):42-61.
6.Smolgovsky S, Theall B, Wagner N, Alcaide P. Fibroblasts and immune cells: at the crossroad of organ inflammation and fibrosis. Am. J. Physiol. Heart Circ. Physiol. 2024;326(2):H303-16
7.Oronsky B, Caroen S, Reid T. What exactly is inflammation (and what is it not?)Int.J.Mol.Sci.2022;23(23):14905.
8.Nasb M, Li F, Dayoub L, Wu T, Wei M, Chen N. Bridging the gap: Integrating exercise mimicry into chronic disease management through suppressing chronic inflammation. J Adv Res. 2024;70:307.
9.Conte HA, Janket SJ, Diamandis EP. Lifestyle modification is appropriate as primary prevention.JAMA Cardiol. 2022;7(2):231-2.
10.Ghodeshwar GK, Dube A, Khobragade D, Dube AH. Impact of lifestyle modifications on cardiovascular health: a narrative review. Cureus. 2023;15(7).
11.Metsios GS, Moe RH, Kitas GD. Exercise and inflammationBest Pract. Res. Clin. Rheumatol. 2020;34(2):101504
12.Ajabnoor SM, Thorpe G, Abdelhamid A, Hooper L. Long-term effects of increasing omega-3, omega-6 and total polyunsaturated fats on inflammatory bowel disease and markers of inflammation: a systematic review and meta-analysis of randomized controlled trials. Eur J Nutr. 2021;60:2293-316.

13.Swann OG, Breslin M, Kilpatrick M, O'Sullivan TA, Mori TA, Beilin LJ, Oddy WH. Dietary fibre intake and its association with inflammatory markers in adolescents. Br J Nutr. 2021;125(3):329-36.
14.Stumpf F, Keller B, Gressies C, Schuetz P. Inflammation and nutrition: friend or foe?. Nutrients. 2023;15(5):1159.
15.Al Bander Z, Nitert MD, Mousa A, Naderpoor N. The gut microbiota and inflammation: an overview. Int. J. Environ. Res. Public Health. 2020;17(20):7618.
16.Majd M, Saunders EF, Engeland CG. Inflammation and the dimensions of depression: a review. Front. Neuroendocrinol. 2020 ;56:100800.
17.Sohail R, Mathew M, Patel KK, Reddy SA, Haider Z, Naria M, Habib A, Abdin ZU, Chaudhry WR, Akbar A, Patel KK. Effects of non-steroidal anti-inflammatory drugs (NSAIDs) and gastroprotective NSAIDs on the gastrointestinal tract: a narrative review. Cureus. 2023;15(4).
18.L Kiss A. Inflammation in focus: the beginning and the end. POR. 2022;27:1610136.
19.Al-kaf AG, Al-yahawi AA. The Pharmacotherapy of Corticosteroids. 2025. DOI: 10.5772/intechopen.1008693
20.Zhang Q, McDermott GC, Juge PA, Chang SH, Vanni KM, Qian G, Bade KJ, Mueller KT, Kowalski EN, Saavedra AA, Sparks JA. Disease-modifying antirheumatic drugs and risk of incident interstitial lung disease among patients with rheumatoid arthritis: A systematic review and meta-analysis. Semin Arthritis Rheum 2024 (p. 152561). WB Saunders.
21.Houglum JE, Harrelson GL, Seefeldt TM. Drugs for treating inflammation. InPrinciples of Pharmacology for Athletic Trainers 2024 (pp. 96-123). Routledge.
22.Razavi BM, Ghasemzadeh Rahbardar M, Hosseinzadeh H. A review of therapeutic potentials of turmeric (Curcuma longa) and its active constituent, curcumin, on inflammatory disorders, pain, and their related patents. Phytother. Res. 2021 Dec;35(12):6489-513.
23..Ballester P, Cerdá B, Arcusa R, Marhuenda J, Yamedjeu K, Zafrilla P. Effect of ginger on inflammatory diseases. Molecules. 2022;27(21):7223.
24.Jalali Kondori B, Esmaili Gouvarchin Ghaleh H, Hosseini SM. Effect of green tea extract on exercise-induced inflammatory markers. J. Mil. Med. 2022 ;23(1):69-74.
25.Rawat P, Kumar S, Malik JK, Serrata B. Herbal Remedy to Reduce Inflammation.RJMP.2023:02(1)8-14
26.Arado GM, Amatto PD, Marins M, Rizzi ES, França SD, Coppede JD, Carmona F, Pereira AM. Anti-inflammatory and/or immunomodulatory activities of Uncaria tomentosa (cat's claw) extracts: A systematic review and meta-analysis of in vivo studies. Front. Pharmacol. 2024;15:1378408.
27.Gxaba N, Manganyi MC. The fight against infection and pain: Devil's claw (Harpagophytum procumbens) a rich source of anti-inflammatory activity: 2011–2022. Molecules. 2022;27(11):3637.
28.Dakshayani L, Merchant N, Smitha S, Surendra G, Reddy TG, Mamatha D, Deepthi G, Ramana DV, Chandrasekhar T, Reddy MC. Holy basil: A potential herbal source for therapeutic applications. Curr. trends. biotechnol. pharm 2021 Feb 12;15(1):87-100.
29.Elbouny H, Amssayef A, Benjamaa R, Ajebli M, Ouahzizi B, Bammou M, Sellam K, Alem C. Thyme, oregano, and rosemary: herbs and food supplements for the management of metabolic associated fatty liver disease. Nutrire. 2025;50(1):6.